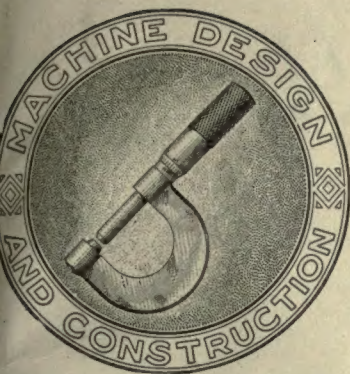


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Technical
A

American Machinist

A PRACTICAL JOURNAL OF MACHINE CONSTRUCTION

ISSUED WEEKLY

VOLUME XLV

July 1 to December 31, 1916



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INDEX TO VOLUME XLV

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Explanatory Note

Illustrated articles are marked with an asterisk (*), book notices with a dagger (†). Cross references to a particular initial word may apply also to its derivatives. The cross references condense the matter and assist the reader, but are not to be regarded as complete or conclusive. So, if there were a reference from "Milling" to "Jigs and fixtures," and if the searcher failed to find the required article under the latter topic, he should look through the "Milling" entries, or others that the subject might suggest, as he would have done had there been no cross reference. In the series on "United States munitions" will be found many sorts of detailed operations not indexed under their special classes of work.

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United States Navy's Repair Ship "Prometheus"

BY FRANK A. STANLEY

SYNOPSIS—*The use of naval repair ships, or floating machine shops, is more of an innovation than many realize. And the scope of their activities is far greater than appears on the surface. They must not only be ready to repair any breakdown, make castings and machine them, to fit and to repair binoculars and periscopes and similar instruments, but such ships must also carry a full line of supplies, bolts, nuts, bars, plates and the hundreds of things that are likely to be called for.*

The U.S.S. "Prometheus," recently arrived at New York from Mare Island navy yard, under the command of Capt. F. D. Karns, is the second repair ship to be

Staten Island, N. Y. The sailing distance over the course followed, coasting down the Pacific, passing through the Panama Canal and heading northward east of Cuba and through the Windward Passage, was 5,260 mi., the steaming time being 26 days. The stay at the Isthmus prior to steaming northward covered a period of 9 days.

THE TOWING CONDITIONS

The tanker "Maumee" was recently completed at the Mare Island navy yard, with the exception of her engines. These are Diesel oil engines, which were built at the New York yard while the ship herself was under construction on the west coast. As the vessel is to serve as an oil-supply ship for the Atlantic fleet and must therefore in any case be sent around to eastern waters, it was decided to tow her to New York for the installa-



FIG. 1. U. S. REPAIR SHIP "PROMETHEUS" LEAVING MARE ISLAND NAVY YARD; VALLEJO IN BACKGROUND

placed in the service of our modern navy. The earlier vessel of this type was the "Vestal," which has been attached to the Atlantic squadron for the past 18 months or so and which has recently come north with the fleet upon the conclusion of the winter maneuvers at Guantanamo, Cuba.

It was my privilege to make the trip on the "Prometheus" as the representative of the *American Machinist*, the first time, so far as I am aware, that a technical writer has been permitted to accompany a naval vessel on a voyage of this kind. This opportunity enabled me to observe at first hand not only the equipment of the vessel, but the many activities that form a part of its duties, many of which are entirely unknown and unappreciated by those who have not actually experienced them.

The "Prometheus" sailed from California City coaling station, San Francisco Bay, on the evening of Feb. 27, with the 14,000-ton oil tanker "Maumee" in tow. Exactly five weeks later, on the evening of Apr. 2, she arrived at the Government anchorage at Tompkinsville,

tion of her engines at this yard. With the exception of the towing of the dry dock "Dewey" to the Philippines some years ago, this is the biggest long-distance towing proposition ever undertaken. It was carried out from start to finish with complete success and in much shorter time than was generally anticipated at the outset.

For 15 days, from San Francisco Bay to Balboa, the "Prometheus" steamed steadily without stop at an average rate of about 9 knots. On the northward passage from Cristobal to New York rougher weather and adverse winds and currents made necessary a reduction in speed; but here again the 11 days' tow was accomplished with no failures on the part of any of the equipment and with only such modification in steaming rate as was necessary to assure the completion of the expedition without excessive stresses upon the towing apparatus.

The "Prometheus" had been given a complete outfit for this undertaking. The equipment included a special towing engine, a method of supporting the cable and means for measuring the strain due to the load and

varying conditions of wind and sea. These appliances are of special interest, so that no account of the voyage from San Francisco to New York would be complete without them, but they cannot be covered in this article.

DETAILS OF THE "PROMETHEUS"

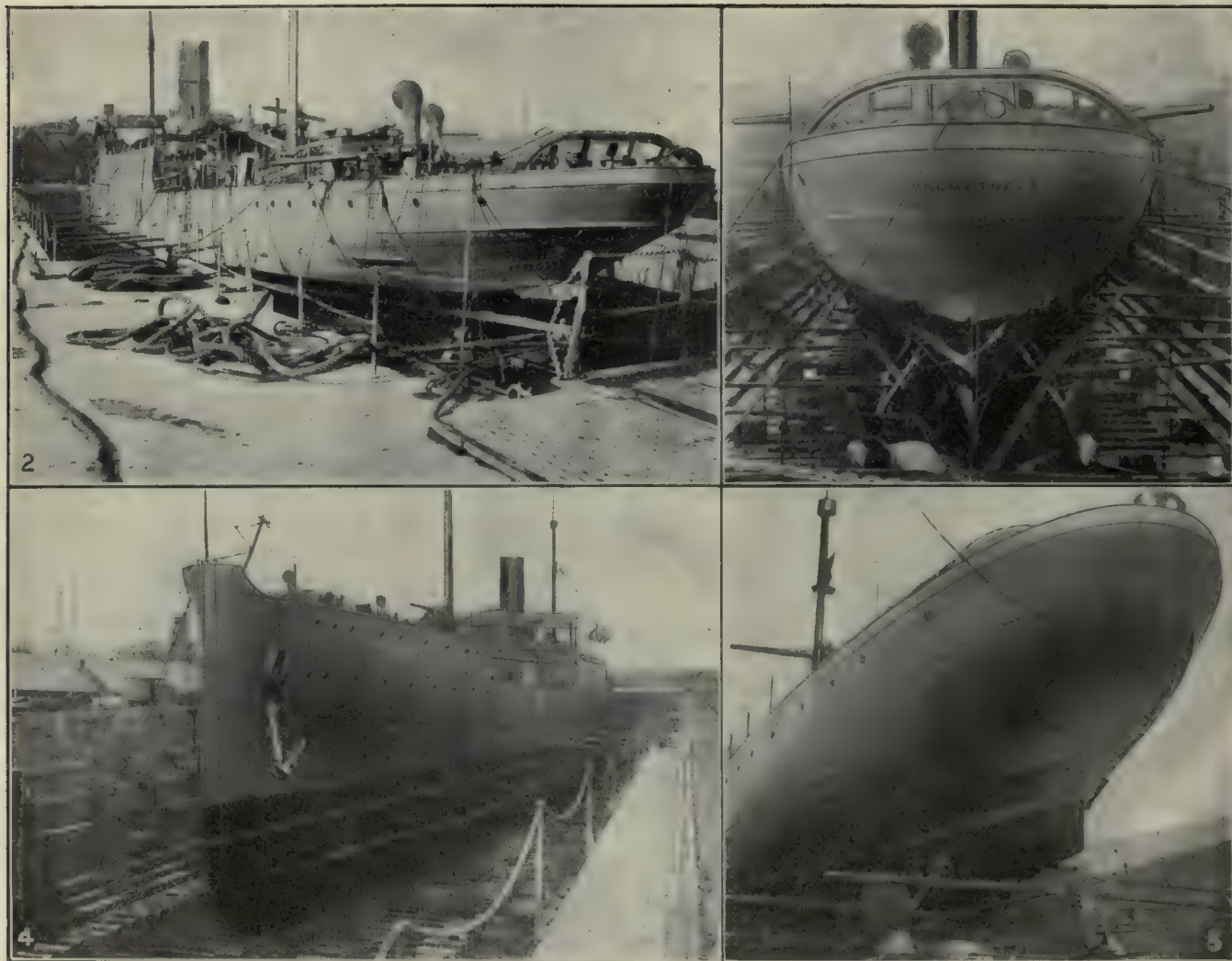
The "Prometheus" was originally built as a collier at the Mare Island navy yard. She was authorized by Congress, Apr. 27, 1904, the limit of cost under the head of contract price of hull and machinery being \$1,550,000. The keel was laid Oct. 18, 1907, and she was launched Dec. 5, 1908. The date of her first commission as a collier was Jan. 5, 1910. She was placed out of commission Apr. 7, 1913, and was then modified and equipped

There are six Babcock & Wilcox water-tube boilers with four doors to each furnace, a total grate service of 493 sq.ft. and total heating surface of 19,974 sq.ft. The bunker capacity, allowing 43 cu.ft. to the ton, is 1,576 tons. The generating sets are two in number.

The armament of the ship consists of four 5-in. 51-caliber rapid-fire guns, two of which are mounted on the forecastle head and two astern.

MECHANICAL DEPARTMENTS

The "Prometheus" is a floating shop with practically every department aboard that would be found in any well-organized machine-building establishment or repair shop ashore. There are a general office for the issuing



FIGS. 2 TO 5. REPAIR SHIP "PROMETHEUS" IN DRYDOCK

as a repair ship and placed in commission as such on Dec. 23, 1914.

The normal displacement of the "Prometheus" is 12,585 tons; her length on designed load water line is 450 ft. and length overall, 465 ft. 10 in. Her breadth on load water line is 60 ft. and draft for repair ship, 20 ft. She is driven by two vertical triple-expansion engines with high-pressure cylinder diameter, 28 in.; intermediate cylinder, 44½ in.; low-pressure cylinder diameter, 75 in. The length of stroke is 54 in. The total maximum indicated horsepower is 7,500; the total estimated weight of machinery, 1,125 tons; the speed on trial, 16 knots.

of orders, the control of operations in all the mechanical departments and for keeping up the stores and issuing materials and supplies of all kinds to departments and to the men aboard; a drafting room and planning department; a general machine shop with heavy tools; gallery shops with millers and the smaller and medium-sized lathes; a toolroom for taking care of cutting tools and machinists' tools of all kinds and for issuing them to workmen on check; an optical shop; a gray-iron foundry and brass foundry; a pattern shop; woodworking shop; forge shop; boiler shop; copper shop; plumbers' shop and pipe shop. As will be noted hereafter, the equipment of each shop is quite complete.

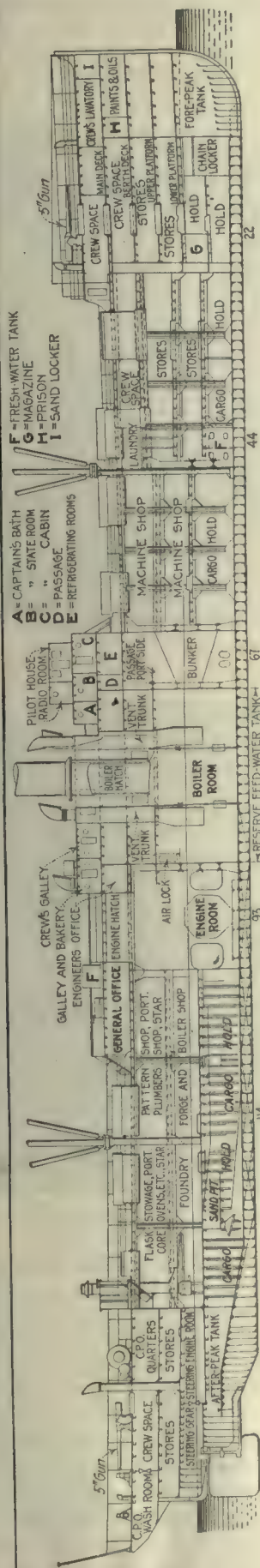


FIG. 6 INBOARD PROFILE

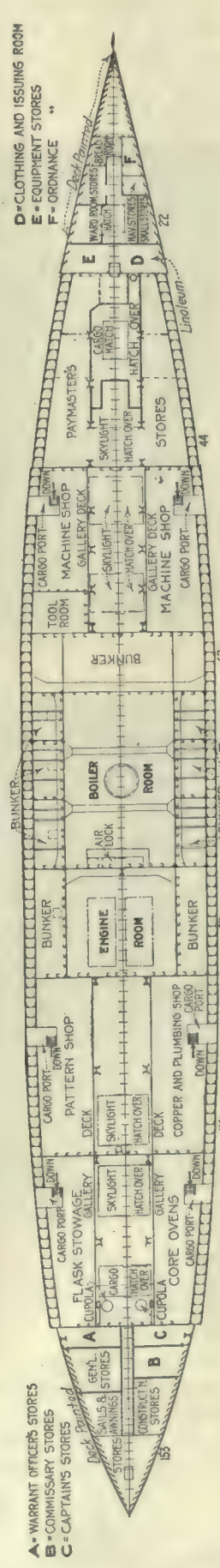


FIG. 7 UPPER PLATFORM DECK

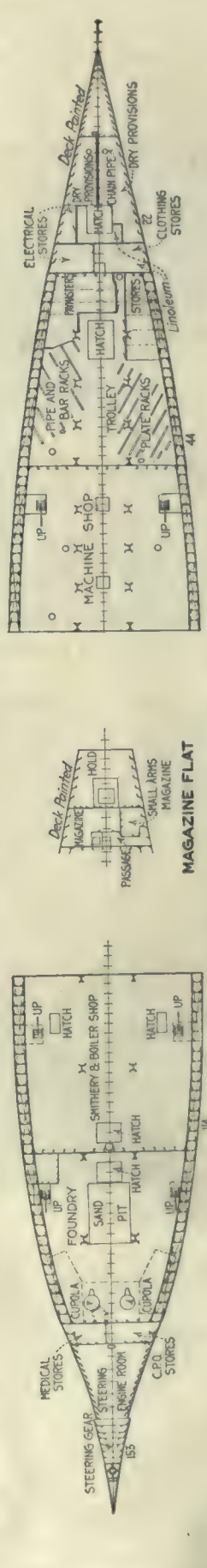


FIG. 8 LOWER PLATFORM DECK

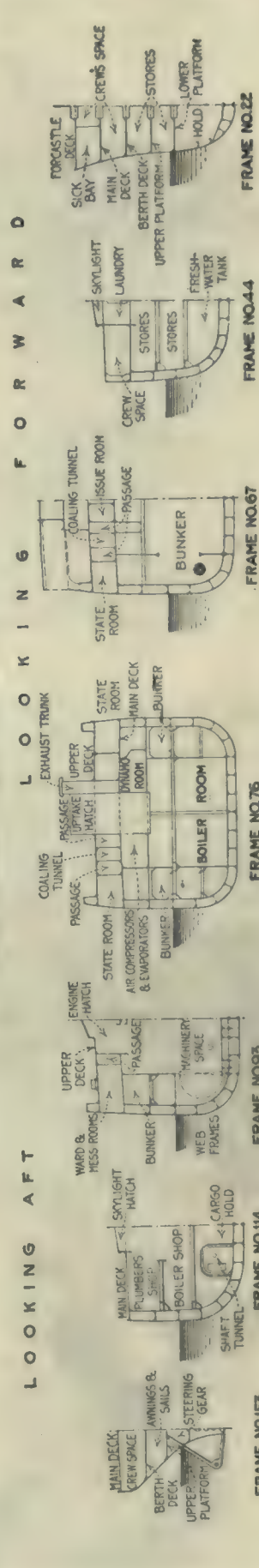
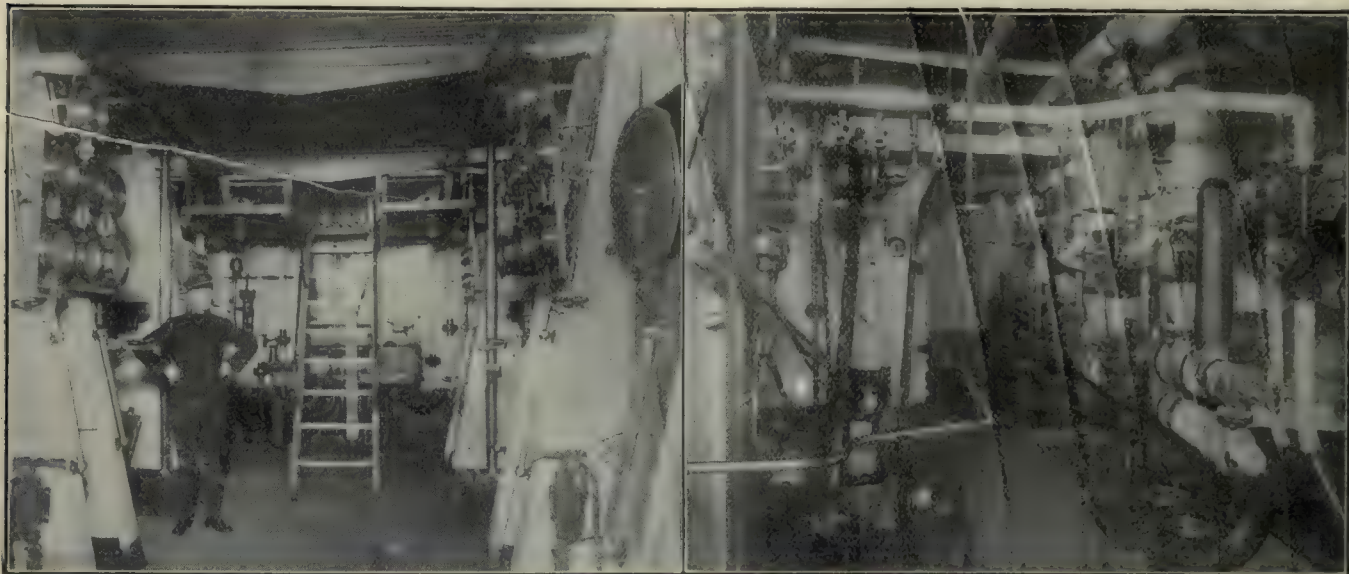


FIG. 9 CROSS SECTIONS

FIGS. 6 TO 9. PLANS AND DETAILS OF REPAIR SHIP "PROMETHEUS"

The tools in the machine shops range up to a 48x72-in. extension gap lathe, 6-ft. vertical boring and turning mill, 36-in. openside planer, 4B plain miller and so on. The forge shop and boiler shop are equipped with, among other apparatus, a 150-ton steam hydraulic forging press and with portable electric-welding machine and oxyacety-

It may be stated here, however, that the main machine shop has an area approximately 51x51 ft., with two galleries 16 ft. wide running the full length of the shop and with runways for a traveling crane between. The foundry is the full width of the ship and over 50 ft. in length, with a deep sand pit measuring 14x18 ft. and



FIGS. 10 AND 11. ENGINE ROOM OF THE REPAIR SHIP "PROMETHEUS"

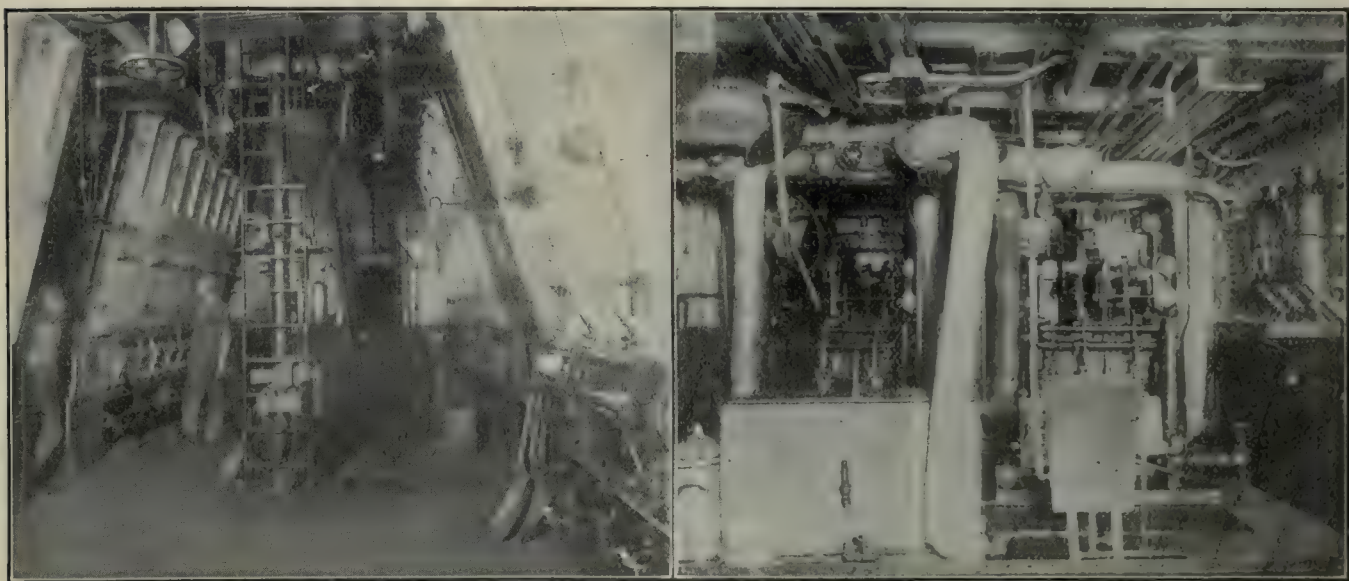


FIG. 12. PART OF FIREROOM

FIG. 13. REFRIGERATING EQUIPMENT

lene outfit. The foundry has two gray-iron cupolas, with respective capacities of from $\frac{1}{2}$ to 1 ton and from 1 to 2 tons per hour, and six crucibles—four with capacity of 110 lb. and two with 165 lb. capacity each.

The machine-tool equipment of the "Prometheus" represents a value of over \$56,000. In the pattern shop there is equipment worth nearly \$6,300; in the foundry, \$4,330; in the forge and boiler shops, over \$8,500 worth of apparatus; in the plumbers' and copper shop, nearly \$2,000 in pipe machines, pumps, rolls, shears and the like. The grand total for the machinery of the different departments exceeds \$77,000. These departments, with details of the equipment and method of operation, will be illustrated in succeeding articles.

with an overhead traveling crane to handle flasks and work. The forge and boiler shops occupy a space practically equivalent to that devoted to the main machine shop, and the pattern shop, pipe shop and plumbers' shop are located on galleries over the forge shop, approximating closely in dimensions the galleries of the machine shop.

It is difficult to realize that this vessel carries as part of her regular outfit about 100 machine tools and other pieces of apparatus for wood and metal work. But in addition to maintaining a big supply of food, clothing and other articles in considerable number for a crew of several hundred officers and men there is also carried an immense quantity (six months' supply at least) of shop

and engine-room parts in the way of bolts and nuts, rivets and washers, bar material—brass, steel and iron—pipe fittings, couplings, valves and the like. Then there are toolroom stores, such as drills, reamers, taps, etc., and an almost endless variety of other articles likely to be wanted at any time when the fleet is far from port. Knowing this, it is an easy matter for one who has not seen the "Prometheus" to imagine her as a square-hulled, blunt-nosed, sluggish craft, towering deck above deck and having all the appearance of a multistoried machine shop and storehouse skidded upon a pontoon and floated ark-fashion upon the surface of the deep. As a matter of fact a preconceived notion of this character could not be farther from the truth.

Painted in the soft hues of some of the ocean liners prior to the outbreak of the European War, the "Prometheus" might easily have rivaled in grace and general neatness of outline many a well-known vessel plying between ports on opposite sides of the Atlantic. Actually, while her dark, monotonously flat surface of bluish-gray paint gives a grim-hulled inconspicuous appearance universally demanded throughout the fleets of the world, her trim lines and close resemblance to a high-class merchantman are still pronounced features. This seems all the more noteworthy when it is recalled that she was originally built as a collier.

The lines of the ship are illustrated perfectly in Figs. 1 to 5 inclusive and in the details that follow. The general view, Fig. 1, represents the "Prometheus" as she appeared in the stream between Vallejo, Calif., and Mare Island navy yard upon returning from Alaska in the fall of 1915 after visiting the various radio stations along that coast for the purpose of supplying them with needed materials, repairing their apparatus and in certain instances dismantling abandoned stations.

Figs. 2 to 5, all reproductions of photographs made of the vessel while in dry dock at Mare Island, bring out important features of construction and equipment—the fine lines of the bow and hull as a whole, the construction of the towing arch over the stern for supporting the cable, the position of the towing engine, the mounting of the four 5-in. breech-loading guns on fore-castle head and stern. Incidentally these views illustrate clearly the method of docking a big ship so that the structure is properly supported by adjustable blocks placed at close intervals under the keel along the entire length of the ship, while a perpendicular position is assured by lateral shores placed between the dock walls and the hull.

PLANS AND ELEVATIONS

The line drawings practically explain themselves though a few words of description may not be out of place. The inboard profile, which is shown in Fig. 6, includes the shops, foundry, engine room and so on in elevation, likewise representing the space for stores and cargo. Figs. 7 and 8 are deck plans showing the officers' quarters, the locations of the mechanical departments, the machinery used on deck, including the towing engine and the arch.

The shops, foundry, pattern storage and core ovens are represented in the upper platform deck plan, Fig. 7. Fig. 8 shows the foundry and smith shop aft and the method of stowing bar and sheet stock forward. Fig. 9 gives several cross-sections which help one to understand the location of the various departments.

The ship's complement of men totals 239 and is made up as follows: Officers—commanding, 1; warrant, 12; warrant, 4; total officers, 17; crew—seaman branch, 55; artificers, 9; artificers in engine room, 63; special, 10; commissary, 6; messmen, 11; repair force, 68; total crew, 222.

The capacity of the fuel-oil tanks, for foundry and similar use, is 35,799 gal., or 119.6 tons, while the fresh-water compartments hold a total of 39,550 gal.

Figs. 10 and 11 are views taken in the engine room, and Fig. 12 shows part of the fireroom. Fig. 13 is a view of the ice machines.

✱

Experience in Drawing Thin White-Metal Tubes

By HERBERT J. RANDALL

Several years ago it became necessary to draw long thin shells, or tubes, from Britannia white metal, and I was unfortunately unable to get the exact information I required at that time.

I was advised to try the extrusion method of producing tubes; but as we had only single- and double-action presses to do the work, extruding was out of the question. Since then, however, I have experimented extensively on this problem, with the result that about two years ago I obtained a shell $1\frac{1}{8}$ in. in diameter by $6\frac{3}{4}$ in. long, with a wall 0.028 in. thick. It was highly polished and secured in four operations, including the cutting of the blank.

The sketches of the dies practically explain themselves. Fig. 1 represents the cutting and first drawing dies used in a double-action press, with a blank $6\frac{1}{4}$ in. square and 0.094 in. thick. These first dies give a cup 3 in. in diameter and $2\frac{1}{2}$ in. high, but do not thin down the walls any, as the difference between the punch diameter and the die was made just twice the thickness of the blank.

During the experiments I always had good results until coming to the final operations; then the percentage of broken pieces would be anywhere between 50 to 75, sometimes more, which was anything but satisfactory. That was with the ordinary way of redrawing; but as I had spent lots of time trying to get the desired results, I thought it could do no harm to try to turn the preceding cup inside out. So I made the second- and third-operation redrawing dies on that idea, and thereafter we had practically no trouble.

The second, third and fourth dies can be used in any ordinary single-action press, provided the stroke is long enough.

The dies, Fig. 2, for the second operation brought the walls of the tube down to 0.037 in. thick and lengthened it to $3\frac{3}{4}$ in. The cup, after passing through the first-operation dies, was inverted over the die for the second operation. This die was made 0.010 in. smaller on the outside than the inside diameter of the work, to facilitate matters when feeding, as the press could be run continuously, the work dropping down through the center of the die into a box.

The third operation consists of the same operation as in the second, only the die was made to draw the work down to the required inside diameter with walls 0.034 in. thick, giving a blank $5\frac{1}{2}$ in. long. See Fig. 3.

The punch for the third operation was used on the fourth or final operation, and the die was made as in Fig. 4. This completed the work, making a cup or tube $1\frac{1}{8}$ in., inside diameter, $6\frac{3}{4}$ in. long and 0.028 in. thickness of wall, with a high polish on the outside. Of course this die had to be highly polished to get these results, and the punch was hardened, ground and lapped perfectly true, as the work after passing through this last die held tightly to the punch.

The dies for the first, second and third operations were made of machine steel and left soft but polished, and the cutting ring for the first operation was of tool steel not hardened.

The work automatically stripped itself from the punches in the first three operations, as there was a little outward spring to the top of the walls of the work. In the last-operation dies four spring fingers were placed

Production of Needles, Pins and Hooks and Eyes

The production of pins of all varieties in the United States in 1914 was valued at \$2,713,782. Common or toilet pins formed the principal variety, the production of which was valued at \$1,248,757. These pins were made of steel and brass wire, and the quantities were reported to the United States Bureau of the Census partly in pounds and partly in packs of 3,360 and 3,600 pins each. The production of metal hairpins was 9,242,012 gross, valued at \$528,362, and of safety pins, 4,744,303 gross, valued at \$936,663. The output of hooks and eyes was reported as 1,076,177 great gross, valued at \$1,394,745.

The production of needles in the United States, which consists almost entirely of knitting-machine and sewing-

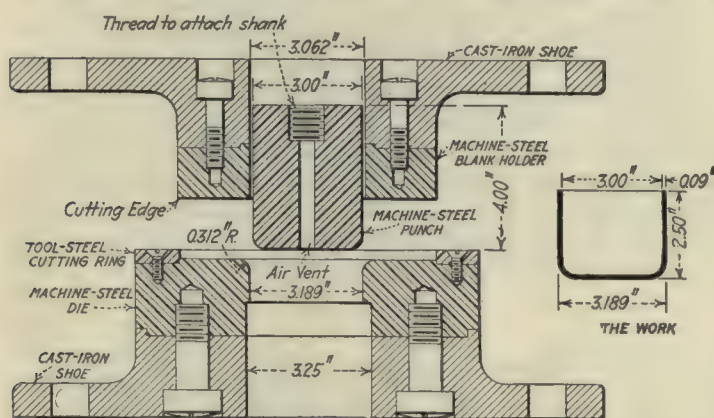


Fig. 1 First Operation, Cut and Draw Dies

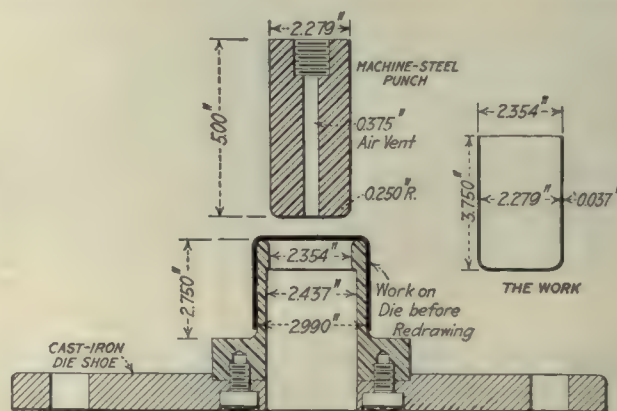


Fig. 2 Second Operation, 1st Redraw Dies

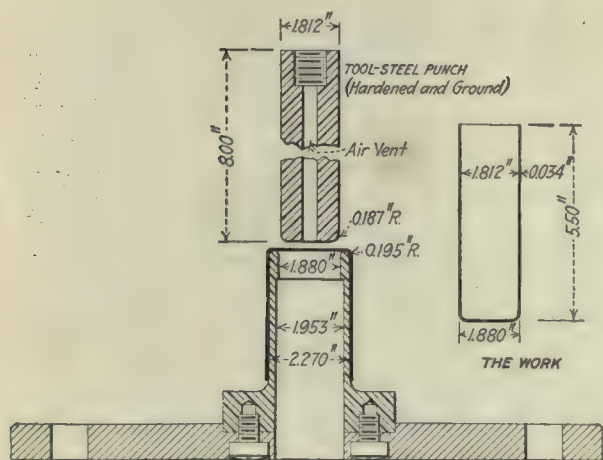


Fig. 3 Third Operation, 2nd Redraw Dies

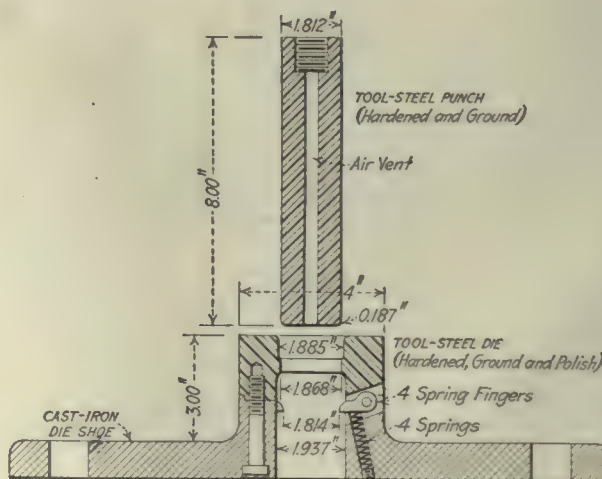


Fig. 4 Fourth Operation, 3rd Redraw and Polish

DETAILS OF DIES FOR DRAWING THIN WHITE-METAL TUBES

around the die, to just let the punch through without touching. When the work was on the punch, these fingers would spring downward and over the top, thus stripping it off from the punch on the upward stroke.

The only lubricant used on these four operations was a mixture of soft-soap, soda, lard oil and water, all boiled together and left to cool before using.

The uneven ends of the work were not trued off between operations, as that was unnecessary and would only have wasted stock and shortened the final tube. The work was not annealed, or touched between operations.

machine needles, amounted to 168,644,000 in 1914 and was valued at \$1,273,084. Of this amount 94,099,000, or 55.8 per cent., were knitting-machine needles, valued at \$621,784, and 74,545,000, or 44.2 per cent., sewing-machine needles, valued at \$651,300. The production of hand-sewing needles was confined to three establishments, which manufactured about 90,000 needles during 1914. This production consisted largely of the small variety of hand-sewing needles, but it also included a considerable number of the large variety used for carpets, bags and other heavy work.

Noon Hour in the Small Shop

BY JOHN H. VAN DEVENTER

SYNOPSIS—Human nature is the most important thing that the small-shop or the large-shop man has to do with. Sometimes it is densely ignorant, sometimes exceptionally bright, on some occasions guileless and again crafty. The stories related in this article are all founded on facts and illustrate these variable phases of human nature.

The millwright at the Ajax plant joined the group in front of Dave Hope's machine shop and proceeded to explore the contents of his dinner bucket. "The old woman is getting absent minded," he complained as he bit into a likely looking sandwich. "Last week she goes and puts salt into my coffee, and now here's the lift off a shoe heel in this liverwurst sandwich!"

"Better begin handing your pay envelope over and see if things don't change for the better," advised Dave.

"Tain't lucky," replied Billy Files; "my helper always done that and he come near killin' himself today." Naturally, after this introduction Billy had to tell what had happened to his helper.

"We had a swingin' scaffold hung from the roof truss in the main bay," related Billy Files; "and when I finished with the job, I told the durned fool to go up and take it down. It was rigged like a painters' scaffold with two sets of blocks and a single rope, so all the cuss had to do was to let himself down easy and gradual like. Instead of this he casts loose on the hitch, grabs the wrong rope and comes down like a shot. If he hadn't have fell on the old man, who was givin' Jim Hartly a rakin' over the coals, he'd have been done for sure. As it is, both of 'em are in the hospital."

STRANGE THINGS HAPPEN VERY FREQUENTLY

"A thing like that happens more often than you imagine," said Dave. "It isn't because a man don't know any better, but because he doesn't think about what he is doing. I worked in a shop one time where they built big sheet-steel fans such as they use for ventilating mines. They used to set these up with temporary bolts to see that everything went together all right and then knocked them down for shipment. One day a fellow who had been 30 years at the business was up on top to take off the scroll sheets from a 25-ft. fan. He simply sat in the middle of one of these sheets and took out the bolts one by one, forgetting that sheet iron will buckle. When he got down to the last three bolts, two on one side and one on the other, he couldn't start the nuts with his fingers, which was quite natural on account of the strain on the sheet. So he grabs a hammer and chisel, an' starts to knock the nuts off. One was as far as he got, and that was the last tap of work he did for six weeks, unless you call it work to take your medicine in a hospital."

"Aweel, it's a' the same in all countries," said Sandy MacPherson. "I was watching some ship carpenters at Vladivostok at a job of fixing shingles on a shed roof. These ship carpenters keep their tools in sma' flat trays like shoemakers' kits. The pitch of the roof was pretty steep; and when the first ship carpenter climbed the ladder and raised his tool box on the roof, off it slid with a

bang. I canna say what he said, because I dinna understand Russian; but I can guess. Down he went, picked up his tools and pit them in the box, climbed the ladder agin, pit the box on the roof and pit his foot in it to hold it doon. Then he stepped off the ladder rung with his other foot. I couldn't see muckle of him as they carried him awa' on a stretcher, but the little I did see was eneuch!"

ED JACKSON COMES TO THE FRONT

Ed Jackson, the machinery salesman of the Eureka Supply Co., entered the conversation at this point. "It sometimes happens that the very fellow that you would put down for a dub pulls off some bright stunt that will make your eyes pop out. We had a case of that kind last week. A Western manufacturer who frequently does business with us wrote us a month or two ago about the possibility of collecting a bill from Judd Jenkins. It seems that he had sold Judd some \$60 worth of goods at 30 days, and the 30 days were up about a year and a half ago. We wrote him that he had as much chance of shaking hands with his money again as Judd has of getting to heaven. He wanted us to collect it on a percentage, and we told him we would not undertake it for 125 per cent. You can get blood out of turnips occasionally, but you can never get money out of Judd Jenkins for goods that have been delivered; C.O.D. is the way to do business with him. They say that when he goes to church, they pass the plate before the first hymn!"

"A week ago, who should show up in our office but this same Westerner who had been stuck for the \$60! He was a typical boob in appearance, had a face as round and unexpressive as a washbasin, stood about 6 ft. 6 and had a pair of fists like hams.

"What are you doing in our town, Mr. Shenkel?" inquired the boss.

"Oh, aye was coming East and aye stopped off to collect dat bill from dat feller Yenkins," replied the Westerner.

"Have you tried it yet?" inquired the boss.

"Sure, I have, I have collected das money," and here he pulled out a wad of bills to prove his statement.

"How the deuce did you do that?" exclaimed the boss, "I'd like to know your secret of collecting bills."

"Vell, you yust got to use diplomacy," returned the big Swede. "I go down py Mr. Yenkins' office one day until I see he is alone mit himself. Then I go in and say, 'I'm Mr. Shenkel vat you owe \$60 to and I've come for das money.' He told me to go to some place what begins with 'h' to get it, so I grabbed him mit one hand by der throat und shook my fist unter his nose and said, 'All right, Mr. Yenkins, I'll take \$60 worth of satisfaction out of your block.'"

"While the big Swede was telling us this, he was illustrating his words on me for the benefit of the boss, and I tell you if you could have felt that grip on your throat and seen the fierce expression on his face, and his big hand ready to land on your countenance, you would have realized that he was a master of diplomacy. I don't wonder that Jenkins paid up after a performance such as the Swede demonstrated!"

"I am glad to hear one of you machinery salesmen admit that you can learn something," said Dave. "Here is a tip on selling micrometers that I picked up while down in Bridgeport the other day. When a man goes to one of the big munition shops to look for a job, the first thing they ask him is if he can use micrometers. If he says no, it's all off; and if he says yes, he gets a chance to prove it. One of the progressive hardware stores in town took advantage of this to boost its sale of micrometers and started a school of micrometer reading in a back room. Every man who bought a mike was instructed free of charge how to use it. Fellows that didn't know a thousandth of an inch from an alligator before they entered the hardware store came out with a pass to a good job. That's what I call keeping up with the times!"

The machinery salesman could not remain quiet for a very long period, and it was evident that he had something to tell. "What is it, Ed?" inquired Dave. "Spit it out before it chokes you."

"I was just thinking about the plant that came near putting itself out of business," replied Ed. "You very seldom hear of a plant being its own competitor, but this case I have in mind was just such a one. They made high-grade edge tools, such as carpenters' chisels, and were very strict about the quality of their goods—something that you can't say about all of the shops in that line of business. When a blade wouldn't come up to the test, out it went regardless of expense. Probably one-third of their total output went to the scrap heap because its quality was not up to their standard. After a while the manager of this company began to find himself up against a rather strict competition in which goods similar to his, but with slightly inferior quality, were being sold at one-half the price. He could not see how it was done, knowing that even allowing for the inferior quality these goods must have cost more than they were selling for. Finally he employed a detective agency to try and trace a source of supply, but was a surprised man when this source proved to be his own scrap pile! The foxie junk dealer who had been buying this scrap for several years had made extensive preparations for just such a coup. Nowadays this is more or less a matter of history, but I notice that the edge-tool companies are particular to break their scrap into small pieces before it gets out-doors."

PAINTING THE BACKBONE ON A BELT

"That concern was almost too conscientious about the quality of its goods, which is more than can be said for some of you salesmen," said Dave Hope. "Old man Ruggles was in the market some time ago for a main-drive belt for his power house. The order went to a good reliable belting concern, and one of the salesmen for a less reliable house began to knock. You know how Ruggles is, and how suspicious he is of everybody. This bright Alex told him that the big belt factories employ artists to paint the backbone on a piece of belt so that it will look like center stock and that all he was likely to get when he got his belt in was a piece of side hide, but that he could make sure of the matter by scraping on the backbone when the belt was received. If the mark came off, that would prove that it was a fake job and had been painted on there."

"Ruggles could hardly wait to get hold of the big belt to make this test, for he was afraid of anyone put-

ting anything over on him. So when the belt came in, he got out his scraper and began to scrape; and naturally enough the mark came off. He jumped for the telephone to call up the belting company. 'Say, you big fakers,' said he, 'send your wagon down right away and take away that fake belt you sent me.'

"What are you talking about?" came from the other end of the line.

"That big belt I bought has the backbone painted on it to make out it was center stock," replied Ruggles. "I scraped off the mark that your painter put there."

"The manager of the belting concern was probably too much astonished to reply. When Ruggles found out later how the salesman had misled him into making a fool of himself, however, he declared he would spend the rest of his life in getting even, and I expect that he will."

Just at this point the whistle blew, and the small-shop noon hour was over.

❧

A Neat Bolt Storage

Much of the value of having a good supply of bolts is in being able to find them when wanted. The illustration shows the excellent system adopted by the Atchison,



SANTA FE SYSTEM OF BOLT STORAGE

Topeka & Santa Fe Ry. at Arkansas City, Kan. The bolts are neatly stacked and labeled, as can be seen, making it easy to select the size wanted and to know how many are in stock.

❧

Machining Cone Pulleys on a Drilling Machine

To run right, a cone pulley must be machined both inside and out, especially if it is to run at any speed. On the drilling machines made by the F. W. Lindgren Co., Rockford, Ill., the cone pulleys are machined all over. Most of this work is done in a drilling machine fitted with special chuck and tools.

The tools for machining the inside of the pulleys are illustrated in Fig. 1. The pullers are in five steps, 1 3/8 in. wide, the smallest step being 2 in. in diameter. The pulley to be machined is placed in the spindle chuck, as at A, and held in by setscrews. It is then brought down over the cone tool, and the cutters at B and C machine the inside of the steps, the outside of the center and partly clean up the small end, leaving the inside as at D.

The chuck to hold the cone is removed in Fig. 2, in order to show the inside. The place where the small step of the cone goes in is taper-bored, so as to act like a self-centering device. The rest of the cone is centered so as to run approximately true by means of the two sets of set-screws conveniently located for tightening and releasing.

used to drill two driver holes at *D*. In actual use, a steady-bracket *E*, Fig. 4, is used close down to the tool block, but this was omitted in the previous illustrations in order to show the parts better.

The outside of the cone is turned as in Fig. 5, which shows the cuts finished and the tools just being drawn

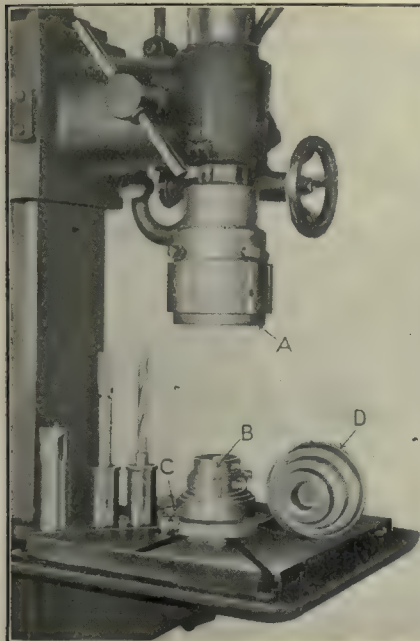


FIG. 1. BORING THE INSIDE

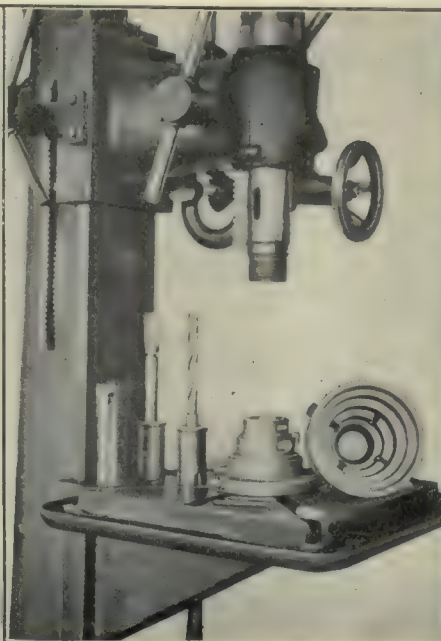


FIG. 2. SHOWING INSIDE OF CHUCK

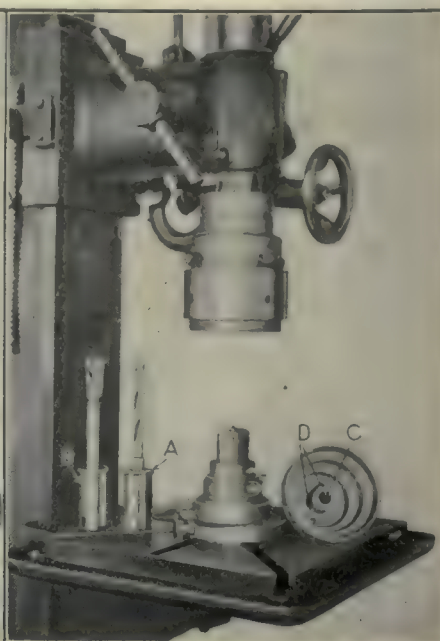


FIG. 3. CENTERING TOOL IN PLACE

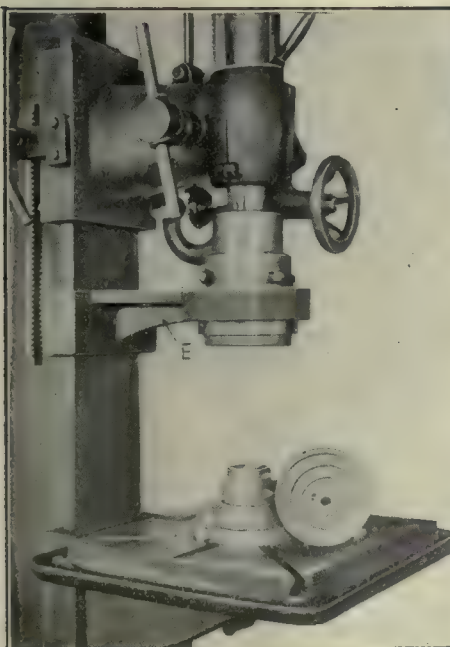


FIG. 4. THE STEADY-BRACKET USED

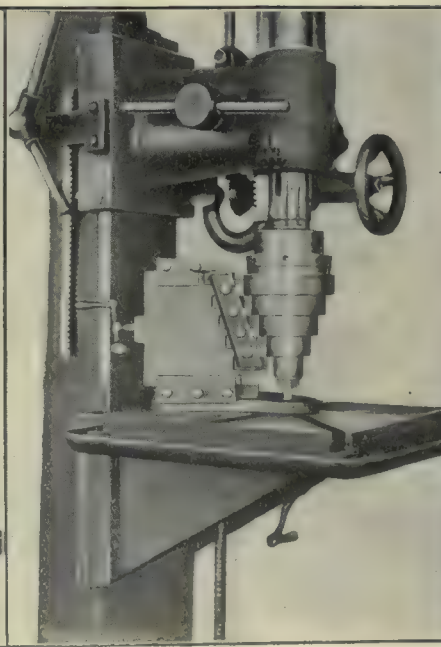


FIG. 5. TURNING THE OUTSIDE

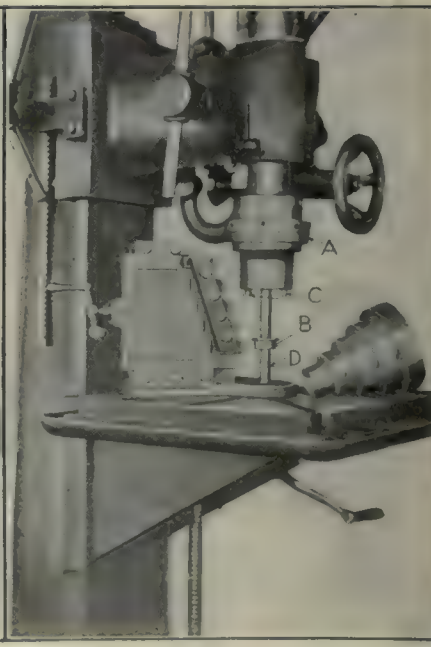


FIG. 6. DETAILS OF WORK HOLDER

After the inside has been machined out, a center drill is placed in the tool block, Fig. 3. As can be seen, the center drill is held in a holder having a keyway on one side. The holder fits in the bore of the tool block, over a key that keeps it from turning. This tool not only carries a center drill, but also a tool for finishing the end of the pulley center. Next, the center-drill holder is removed, the twist-drill holder *A* is put in, and the center, or spindle, hole is drilled. This is followed by reamer *B*, leaving the work as at *C*. A simple jig is next

back. The tools are fed by means of a ball crank. The cone is shown removed in Fig. 6. It will be seen that the part *A* of the holding fixture is beveled so as to receive and center the large end of the cone. The pilot spindle fits the spindle hole of the cone, and the piece is held on by the nut *B*. The pulley is kept from slipping by means of the two driver pins *C*, which enter the two holes previously referred to. The lower end of the pilot *D* fits a bushing in the table bracket and steadies the work during the cut.

Lathe Fixtures Used for Machining Textile Machinery Parts

BY ROBERT MAWSON

SYNOPSIS—In this article are shown fixtures used on lathes in manufacturing parts for textile machines. Some of these tools have a taper shank to fit inside the spindle of the machine. Others are supplied with an arbor supported on the centers of the lathe. All are simple in design and construction, yet are producing good results.

Scott & Williams, Inc., Laconia, N. H., manufacture a variety of textile machines. Some of the tools used in machining the parts of hosiery machines were shown on page 1020, Vol. 44. This article describes fixtures employed on lathes for machining other textile-machine parts. By their use the parts are produced on an economical and interchangeable basis. The locating devices are rapid in action and, as will be noted, simple in design.

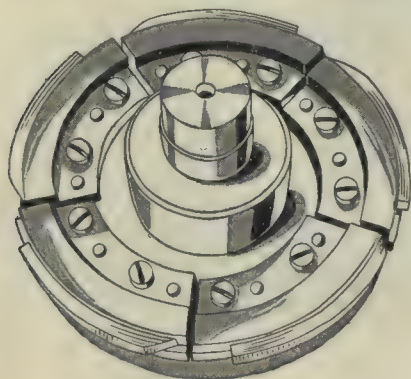


FIG. 2

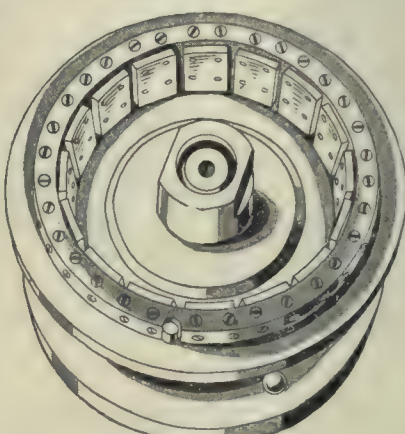


FIG. 4

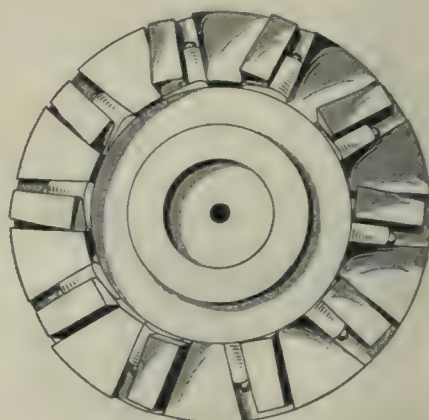


FIG. 6

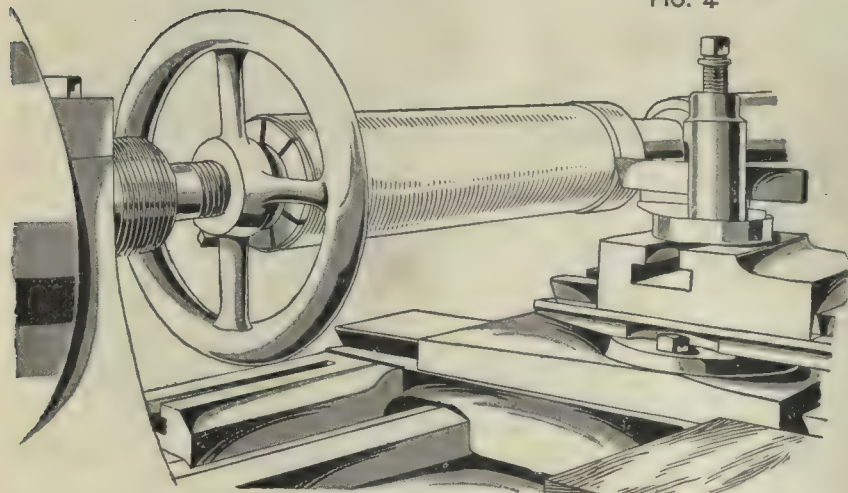


FIG. 8



FIG. 10

TURRET-LATHE FIXTURES FOR TEXTILE-MACHINERY PARTS

FIGS. 2 AND 2-A

Operation—Machining the outer periphery of drum cam, Fig. 1. The castings are located against shoulders on the inside of the five plates shown. The fillister-head screws are then tightened down on the plates and hold the parts in place.

FIGS. 4 AND 4-A

Operation—Machining the inside circular contour on the center post cam, Fig. 3. The steel strips are slid in from the end of the fixture into a turned recess. The headless set-screws in the outside flange, being tightened against the elements, force and hold them securely in the fixture.

FIGS. 6 AND 6-A

Operation—Machining the circular form on the inner edge of the anti-run-back cam, Fig. 5. The steel elements, which have been cut to length, are placed in the various slots and

located against dowel pins. The hooks on the bolts are then swung over the parts being machined and the nuts, being tightened, hold them securely.

FIGS. 8 AND 8-A

Operation—Machining the outside of the cylinder-raising tube, Fig. 7. The casting is held by an expanding arbor, which fits inside one end of the tube. By revolving the large handwheel shown the arbor is expanded against the tube. The other end of the tube is carried on a center in the tail-stock.

FIGS. 10 AND 10-A

Operation—Machining inside of tooth plates, Fig. 9. The pieces are located on dowels that fit into previously drilled holes. The hook bolts, being tightened against the parts to be machined, hold them in position.

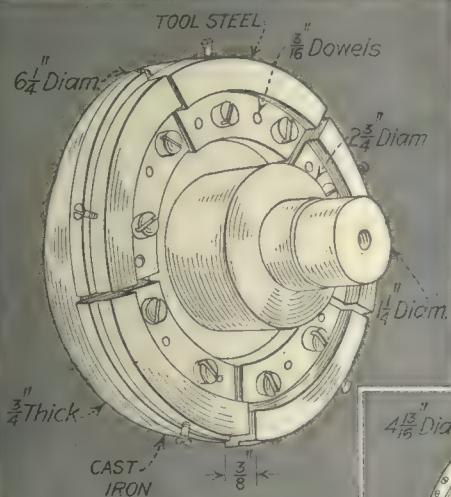


FIG. 2-A

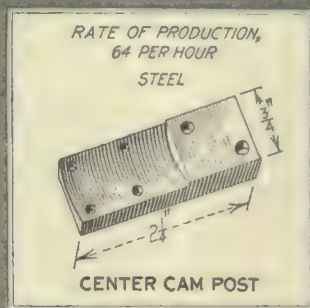


FIG. 3

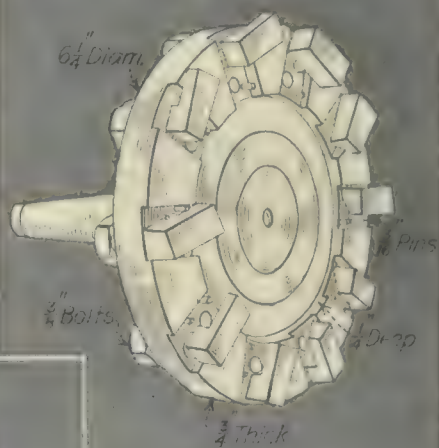


FIG. 4-A

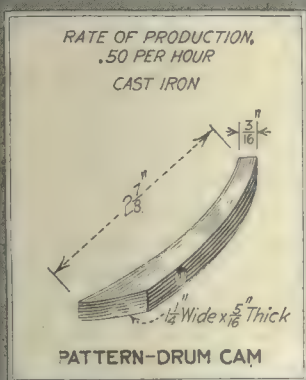


FIG. 1

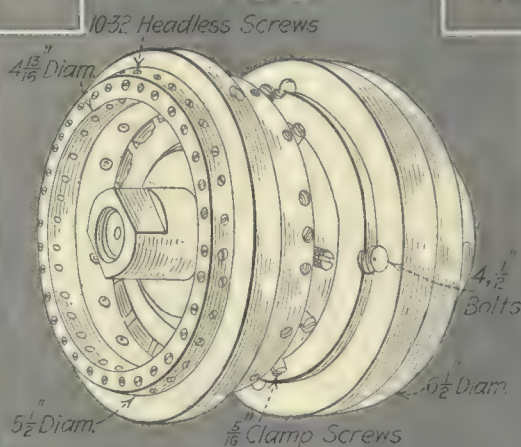


FIG. 4

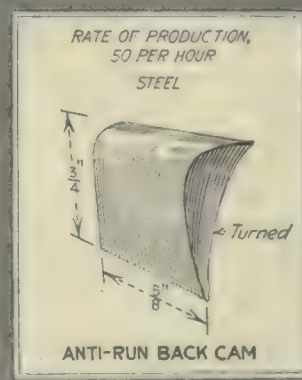


FIG. 5

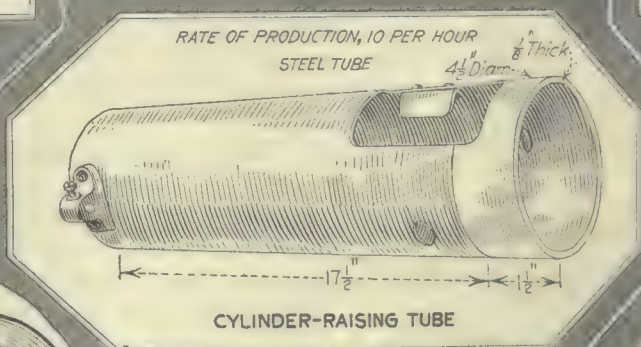


FIG. 7

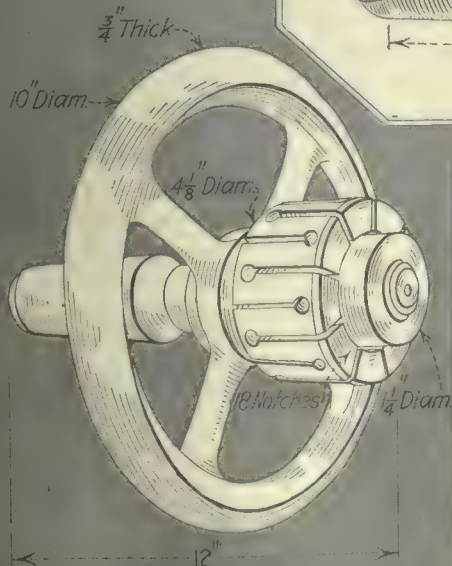


FIG. 8-A

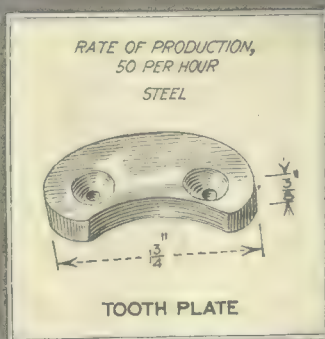


FIG. 9

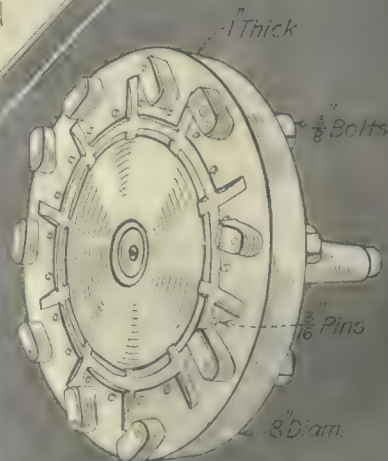


FIG. 10-A

Heating Factory Departments*

By W. ROCKWOOD CONOVER†

Heating factory departments in plants located within the zones subject to low temperatures and frequent climatic changes is one of the difficult problems the manufacturer has to meet. It involves not only a large yearly expenditure for fuel, but also a more or less large outlay of labor and material for maintenance and supervision. It is essential that proper temperatures be maintained in the shops, as otherwise the productive efficiency of the working forces is reduced and mechanical processes are interfered with. It is necessary for the steam plant to be prepared at all times for high peaks of consumption and sudden fluctuation of loads.

All manufacturers are largely conversant with the advantages of the vacuum system for quick heating of shop radiators and coils. This system is far more rapid in action than the old gravity system. The relief of the back pressure on engines which may run from 1 to 3 lb., however, is a more important factor in giving this system a decided advantage over either the gravity or vapor system. The cost of installation is somewhat increased on account of the initial outlay for pumps and valves, but the cost of return piping is relatively equal. The gain in economy and efficiency is a factor meriting consideration when new plants or additional buildings are being projected.

The problem of economical heating and uniform temperatures is a most difficult one. In spite of efforts at control, some departments will be overheated, while in others the temperature is often below the point of health and comfort for employees. Scarcely any two buildings will remain at the same temperature, with equal radiating surface and equal pressure, and the superintendent in charge will frequently find on his round of inspection that much of the heat produced is going to waste. The foreman in a busy department has little time to devote to this subject, and his attention is constantly distracted by other matters. In consequence the windows are thrown open by the workmen and the resultant loss of heat is large. Departments where the nature of the work compels constant, active physical exertion on the part of the employees require a lower temperature than those in which the employees sit at benches, doing light manual labor only. It is obviously important that some competent assistant be delegated to regulate the steam supply to suit requirements, both from a point of economy and for the comfort of the workmen.

STEAM-FLOW METERS AND SUPPLY VALVES

Steam-flow meters should be installed on all mains entering the several shops for the purpose of obtaining data on the flow of steam to each department, whether the supply is used for heating or for manufacturing. These instruments are an efficient aid in regulating consumption and checking waste.

During the operating hours of the day the temperature in shops should be regulated by means of the supply valves to radiators and coils, and not by the opening and closing of doors or windows, thus permitting the continued consumption of steam when it is not required. The main gate valves and the vacuum valves on the

return lines should not be interfered with by employees in endeavoring to regulate temperatures. Care should be taken to cut off the flow of steam at the close of the day from all places not requiring a supply throughout the night. Steam-heating apparatus of various kinds—ovens, tanks, dipping vats, etc.—are often sources of loss because of the connecting valves being left open by the careless operative when leaving the department for the night. These valves and all doors and windows should be closed at quitting time in order to prevent loss and damage from freezing temperatures.

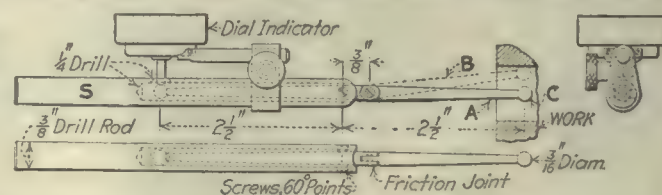
All space about the radiators and coils should be kept open and free, so as to secure the fullest degree of radiation. The careless practice of allowing productive materials, rubbish and inflammable matter of various kinds to accumulate about steam pipes and steam coils during the months when there is no pressure prevails in most factories throughout the country. Such materials not only prevent proper radiation from the pipes and coils, but increase the fire hazard to a very great degree. It is essential that a thorough inspection of all departments be made each year before the fall or winter load is turned into the shops.

Building repairs which have been postponed or neglected during the summer months should be completed before cold weather sets in. No amount of steam pressure will properly heat a department with broken windows and with doors which will not close. The cold drafts, when zero temperatures prevail, will neutralize the greater percentage of heat generated; and besides the loss incurred, much discomfort is forced upon the employees, whose energy and efficiency are thereby decreased. The false economy of such neglect is evident to every thinking manufacturer. Were it not for the fact that such conditions exist to a large extent in nearly every manufacturing center in the country, a reference to the subject would be superfluous.

Indicator for the Miller

By CHARLES A. FREE

This attachment was designed for service in the miller spindle in setting holes (which have previously been bored) in line with the spindle. It is held by the shank *S* in a collet or chuck, with the point *C* in the position



INDICATOR ATTACHMENT FOR THE MILLER

A. The hole can be set approximately in line by eye before moving *C* into position *B* and employing the dial indicator.

With this attachment a dial indicator can be used in very close quarters, such as holes near projections, and in recesses that cannot be reached with any device now on the market.

In a great many cases, such as making a duplicate of a jig, the original can be put behind the duplicate on the miller table. If the holes to be bored are cored or rough-drilled, one can reach through them and indicate the holes in the original.

*Prepared for the author's forthcoming book on "Industrial Economics." Copyright, 1916, Hill Publishing Co.

†Factory economist, General Electric Co.

Japanning in Tumbling Barrels

By T. P. ARCHER

SYNOPSIS—Small articles of metal are now being made in such unlimited quantities and varieties that the necessity for a low-cost, efficient method of obtaining a satisfactory finish has become of paramount importance. The adoption of the tumbling barrel for japanning and in some cases for enameling and lacquering has solved this problem in a way that amounts to little less than a revolution of former methods, and an astonishing degree of economy, efficiency and quality has been attained.

Successful application of the tumbling process is almost necessarily confined to the small-wares field. Such articles as eyelets, buckles, buttons, clasps, knobs, hooks and eyes, springs, snap fasteners and innumerable small articles of trunk, furniture and general hardware are by this method rapidly and satisfactorily finished. The results obtained are in many instances an improvement over the older methods of dipping and brushing.

The process of coating goods with japan in the tumbling barrel is quite simple once the elementary principles involved are thoroughly understood. A quantity of work is placed in a tumbling barrel, preferably of the oblique or tilting type. The required amount of japan is introduced into the barrel either before or after the work has been put in. Some classes of work require very light coatings, and at times it is advisable to paint the japan on the sides of the barrel. This is not often the case, and ordinarily it can be introduced in any convenient manner.

APPARATUS NECESSARY FOR JAPANING SHOP

Briefly, the apparatus required is, first, the tumbling barrel; second, trays or pans into which the work is dumped from the tumbling barrel when the coating is complete; and, third, the oven in which the finish is completed by the usual baking process.

Supplementary equipment consists of japan mixers, measures for both work and japan, dairy thermometers, a hydrometer graduated for liquids lighter than water, trucks to facilitate the handling of the trays between the oven and the tumbling barrels and adequate methods of temperature registration in the oven itself.

Of primary consideration in this apparatus are the tumbling machine and barrel, which must be carefully designed to fit the work and to conform with the handling methods both before and after tumbling, if the process is to be efficiently and economically handled.

Some japanning can be done in almost any sort of apparatus that will revolve. The writer is acquainted with an outfit (now peacefully reaping the reward of long and faithful service in a corner of the factory attic) the chief component of which was an old gasoline can from which the top had been removed. And history has it that the predecessor of the old gas can was a 10-lb. lard pail.

Satisfactory results in the present stage of manufacturing advancement cannot be obtained in a lard bucket, and the expenditure of a little time, thought and money in designing proper apparatus in the beginning will prevent many little profit leaks later on.

Barrels suitable for japanning are manufactured by several concerns in the United States. As a general rule each manufacturer makes only one size, and it is only infrequently that this is properly proportioned to the work in hand. Barrel size has a considerable effect on the efficiency of this type of finishing, and the fact that manufacturers are making such a limited line is largely due to lack of real knowledge of the underlying principles governing tumbling-barrel japanning.

SIZE OF TUMBLING BARRELS IS IMPORTANT

In making a recent installation it was found advisable to use three different sizes of barrels, none of which could be had in the open market. The difficulty was overcome by purchasing tilting-type tumbling machines without barrels and having a local tinsmith make the barrels of the size desired. Thanks to the manufacturer who did not care to take the trouble to make up special sizes, a saving of more than \$10 per barrel was obtained.

As these barrels were for light work, they were made out of No. 14 gage galvanized iron. The bottom was double, one piece being flanged over of a size that would fit the outside of the barrel sides and the other so flanged as to fit the inside. Rivets through both flanges and the base of the barrel sides made a tight and substantial job. Four ribs out of $\frac{3}{4}$ -in. angle iron were provided to assist the tumbling of light work. After a preliminary grinding out with sand and water to get a smooth inner surface the barrels were put to work with satisfying results.

Barrels can be made of any material that will smooth up. Some manufacturers claim that brass is the only satisfactory material for such use, but this is an excessively erroneous idea. Both galvanized and planished iron are being used in many installations with excellent results.

Generally speaking, the barrel should be of the tilting type. Even where it is not advisable to use the tilting feature for discharging the barrel, it is advantageous, as the angle of the barrel can then be varied to get the best results out of work of various sizes and weights. The lighter the work the nearer horizontal, within rather wide limits, will the barrel have to be pitched. Heavy work tumbles well with the barrel comparatively high.

The barrel should be wider at the mouth than at the base and for convenience should not be much deeper than the width of the mouth. An excellent proportion of dimensions is 20-in. diameter of base, 24-in. diameter of mouth and 24- or 26-in. depth. This, for light work, provides an opening that will accommodate a tray of considerable width and the extreme of spreading surface and "evaporative plane"—more along this line later on.

WORK SHOULD BE DIVIDED INTO LOTS

Tumbled work should in the beginning be divided into lots of definite and unvarying size. These individual lots should be kept distinct throughout the various coatings and dryings that go to make up the complete process. They should never be mixed with other lots, even of the same coating, if the best results are to be obtained.

The size of the lots should be determined by but one thing—the quantity that can be most efficiently and

economically handled. It is at this point that barrel size and design and the size and design of the trays or pans into which the work is to be dumped for baking should be carefully studied. Size of the individual articles enters into the problem to some extent, as very small or very weighty articles cannot be handled economically in as large quantities as light, bulky parts.

The lot should be as large as can be handled in a single tray, which should be as big as a man can satisfactorily move about without excessive labor or danger of spilling. The barrel should be of a size that will give the widest tumbling surface possible to a single lot. The barrels can be too large, but the writer has never seen such; they are generally ridiculously small. It really is an amusing sight to see a full-grown man racing around before a half-dozen thimble-sized tumbling barrels, measuring, charging and discharging, when two barrels of the proper size would do the same amount of work in less time and require considerably less labor.

An important point in tray design is to have the tray of such size that the contents can be dumped directly into the barrel for subsequent coatings without any intermediate dumpings into buckets or baskets. If the barrel mouth is small, the tray width must be reduced; and it is very easy to carry this to a point where handling becomes excessive.

ON LIGHT WORK MORE THAN ONE TRAY NECESSARY

It is at times economical, where very light work is being handled, to use two or three trays to a single tumbling lot. Work cannot then be dumped from the barrel to any advantage and must be scooped out into the trays. If this is done with a specially prepared scoop, one or two loadings of which will exactly fill a tray, emptying the barrel is rapidly accomplished; and the time saved in the tumbling easily overcomes the little addition to the handling time.

Trays are made in various forms. They generally have a wire-cloth bottom, and the sides are constructed as lightly as possible to insure rigidity. The possible depth varies with the size of the work. Large work can be baked satisfactorily if quite deep, while buttons, eyelets, tags and small close-lying parts should not be deeper than $1\frac{1}{2}$ or 2 in. to get good results in the oven. Some manufacturers spread their work much thinner than this; but if the oven facilities are right, a little depth does no harm.

Actual application of japan in the tumbling barrel is accomplished through the rubbing contact induced by the tumbling process. When work is introduced into a barrel and the barrel revolved, the tendency of the work is to climb up on the side away from which the top of the barrel is turning. When the work reaches a point where gravity overcomes centrifugal force, the pieces at the top fall of their own weight, sliding down the mass. It is this sliding that produces the rubbing and causes the spreading of the finish that is being applied. Therefore (and this is a point many japanners miss in using the tumbling barrel) only the surface of the mass is in actual, efficient, rubbing contact.

An important adjunct of rapid tumbling is rapid evaporation of the volatile thinner in the japan. This thinner is the medium whereby a rapid spreading of an even coat is accomplished. Tumbling is not complete when a mere even coating is obtained, but must be continued until the thinner has evaporated to a point where the japan be-

comes "tacky" and will not flow after tumbling has stopped, thus causing "runs" or thick and thin spots.

The larger the barrel, therefore, the larger the tumbling or sliding surface, the greater the evaporative plane and the more rapidly the work can be finished. It is a curious fact that two buckets of parts rolling in a barrel just large enough for two buckets will take nearly as long to finish as four buckets rolling in a larger barrel, provided the tumbling speed is the same.

SPEED OF THE TUMBLING BARREL A FACTOR

By "tumbling speed" the number of revolutions per minute is not meant, but the actual speed of the sliding mass of work. This is determined by the barrel's peripheral speed, which should be the same in all sizes of barrels for the same class of work.

The highest peripheral speed that will keep the work rolling and not cause "following around" through the action of centrifugal force is generally the best. Sometimes it appears that too high rolling speed causes too rapid evaporation; that is to say, the work becomes tacky before sufficient spreading has taken place. Frequently this is the result of too little japan being used or of an improper mixture.

For medium-weight work a peripheral speed of about 200 ft. per min. will be found to give very satisfactory results. For lighter work, such as thin cups, small eyelets or tin tags, this may prove too fast. For heavier work or more bulky articles a faster speed can be selected.

The exact amount of tumbling required for various articles must be very carefully determined. It will vary with the temperature of the room in which the work is being done and with the number or kind of coats the work may have had previously. For this reason it is highly important that the amount of work per lot should be exact and the quantity of japan introduced with each lot the same. The quantity of japan may also be varied by the number of previous coats the work may have received. In other words, if the work quantity is exact and the amount of japan introduced for each particular coat the same, the tumbling time will be the same except for the slight variation which may be caused by the temperature of the surrounding atmosphere, which must be carefully regulated. In summer, when it is not practicable to cool the room to the temperature maintained through the winter months, it will be found necessary to reduce the tumbling times, particularly on the finishing coats.

Too much tumbling will leave the work dull and lifeless. Too little will result in improper spreading or, after baking, the work will appear mottled, the articles will cling tightly together and upon being broken apart will show a white spot at the point of cleavage. If the tumbling is properly done, spotting can be entirely eradicated if the work is allowed to air-dry for a few hours after tumbling and is loosened by shaking just before being placed in the oven. After baking, the work will be as loose as so many dried peas and show no blemishes.

SUITABLE JAPAN OBTAINED BY EXPERIMENT

Such an enormous variety of japans at such a diversity of prices are on the American market that it is hard for the uninitiated to choose between the salesman who has a good product and the one who only says he has. Few japan salesmen know anything whatever about japanning, and to the purchaser experimentation seems the only road.

For tumbling work a heavy-bodied varnish is generally required, especially for the finishing coat or coats. During the last few years many manufacturers have found it economical to use a primer coat of comparatively cheap japan, having little varnish in the body, but largely made up of an asphaltum base which gives a heavy body, runs on smoothly and provides an excellent surface for the finish coats. A prime requisite is that the japan must bake hard and cling close to the metal being treated; otherwise, it will either flake off or rub thin at the edges, and brown spots will appear.

Three coats are generally necessary to obtain a perfect finish by the tumbling-barrel method. Two coats are being used successfully, but in some instances where very thin coats must be applied as many as four or five coats are required.

The most important item for consideration in relation to japan is that of mixture. The japans now manufactured are entirely too thick for tumbling-barrel use; that is, their viscosity is such that they will not flow with sufficient readiness to give a perfect coating. Thinners are therefore used to bring them up to a consistency that will attain the best results. A proper mixture will give good results frequently under the most unfavorable circumstances. An improper mixture can never give the best results and often is the cause of downright failure. But the mere mixing of a certain quantity of thinner with a certain quantity of japan will not insure uniformity of the resultant mixtures, nor will this method alone be found continually satisfactory.

USE OF THINNERS IN THE JAPAN

Thinners generally used are naphtha, benzine, turpentine or any of the patented or trade-marked offerings, which usually have naphtha or benzine as a base. For tumbling-barrel work the writer prefers naphtha or benzine. Either of these is generally cheaper in first cost, provides a smooth, even-spreading medium, evaporates rapidly and does not cause such heavy fumes in the japaning oven. These vapors, in cases of poor circulation, are the causes of charring and discoloration.

Temperature enters into the proper mixture of japan and thinners to a surprising degree. Not only should both the japan and the thinner be of a uniform temperature at the time the mixture is made, but the mixing process should always take place at the same temperature, so far as possible. A satisfactory temperature for this purpose is 70 deg. F., as this can be attained most easily both summer and winter.

Uniform consistency of the mixture, which alone insures uniform spreading of the coating, can only be had through maintaining a uniform specific gravity of the mixture at a given temperature. The writer has found that, if both japan and thinner are kept continually above 66 deg. F., an even mixture can be maintained, provided only small lots are mixed at a time, without recourse to the hydrometer. But if japans and thinners are mixed at uneven temperatures or at temperatures below 66 deg. F., uncertain results are almost bound to occur. For particular work the hydrometer can scarcely be left out of the equipment.

For light coatings on light work the mixture should show a specific gravity in the vicinity of 43 deg. Bé. For heavier coatings or heavier work a lower specific gravity can be satisfactorily used. This must be determined by

experiment, but the important feature is that after this is once determined, if uniform results are to be insured, it must be consistently maintained.

Mixing can be done in large quantities with satisfaction, provided some means for stirring and frequent testing with the hydrometer are provided. A common cedar churn with a revolving dasher and holding about 6 gal. has been found satisfactory for small installations. It should be equipped with a funnel in the top and with a molasses gate for drawing off the mixture. If different grades of japan are used, several churns will be required, as the grades cannot be mixed to any advantage. And if the cheaper grades get mixed with the better finishes — well, the japanner might as well prepare the little speech he will soon have to deliver in the office.

Baking of tumbled work involves two features that must be carefully watched. The first is uniformity of temperature and circulation within the oven, and the second is thoroughness of bake.

Tumbled work generally consists of small close-lying parts. When loaded into trays that are usually not very widely separated, this work forms a comparatively heavy mass through which it takes a considerable time for heat to penetrate. Japan gives off heavy fumes, and the greater the japanned surface the more fumes there are. If they are not pretty well cleared out of the oven, discoloration and charring frequently occur. On the other hand, if they are cleared out too rapidly, drafts are set up which result in rapid heating in some portions and slow heating or overheating in others.

The writer has observed ovens that had an interior variation of 300 deg. F. during the progress of a bake. Under such conditions uniform results are virtually impossible if anything like particular work is being done.

Too high a temperature causes cracking of the finished work. And here is a little kink for japanners using more than three-coat work: First- and even second-coat work can at times be baked at a too high temperature without visible damage, particularly if asphaltum-base primers are used. But when a third coat is put on, if it is a heavy varnish japan, a cracked finish may result even if the baking temperature is not carried beyond the danger point. The only safe way is to see that circulation and temperature range are uniform. This condition can easily be assured with the sensible application of the proper heat-measuring instruments.

If japan is not baked at a sufficiently high temperature or long enough, the coating will be soft and will, when a subsequent coating is applied in the tumbling barrel, rub off. The work will then appear brown or worn at the edges and corners where the greatest rubbing occurs.

Japan can scarcely be baked too long. As it can be baked at a too high temperature or not long enough, the economical baking time must be arrived at by using the highest temperature possible with the given japan and for as short time as will insure a hard lustrous coat.

Various japans require various baking temperatures. Some will not permit a higher temperature than 350 deg. F. without cracking. Some will withstand a heat as high as 550 deg. Ordinarily, it is advisable to use the higher-temperature japans for tumbling work, as those finishing at lower temperatures do not get as hard as the higher-heat japans nor do they wear as long. Their chief claim to recognition is that their first cost is a little less.

Generally speaking, a temperature in the neighborhood of 425 deg. F. is a good baking temperature for this class of work. If your japan will not withstand this heat and is not wearing well at the lower heats, get a better grade of japan. If it is wearing well and is still cracking at low temperatures, examine your heat-registering instruments. The frequency with which these are found inaccurate or inadequate is really astonishing. So much depends on proper temperatures, properly registered, that it will pay many times over to see that the instruments are, and remain, dependable.



Comparative Quality of Oil

By G. A. SMITH

The consumer always wishes to purchase the best oil for the least money, and the quality of a certain grade of oil being undeterminable to the eye, resort is had to practical, physical and chemical tests, such as specific gravity, degree Baumé, weight per gallon, refractive index, viscosity at 70, 120 and 180 deg. F., flashpoint, burning point, congealing point, color density, carbon content and free acid. There are manufactured in all commercial products such as oils of a supposedly certain grade, superior and inferior grades, sometimes perhaps beyond the control of the maker. Usually, however, the maker knows to whom he had best ship the inferior grade; his knowledge of this being based upon the fact that there is no inspection at the point where the inferior grade is shipped. I recall an instance where the price asked per gallon of 90-per cent. quality oil was the same as that paid for supposedly the same grade which had 64-per cent. quality.

After having carried on extensive tests of oils for gas and gasoline engines that were submitted by about twenty companies, I found it desirable to establish a rating or percentage of quality. This was arrived at as follows:

RULE FOR RATING OILS

A. Viscosity at 120 deg. F. $\times 1$
 Viscosity at 180 deg. F. $\times 10$
 Flashpoint $\times 1$

Multiply and add the products.

B. Congealing point $\times 1$
 Free acid $\times 100$
 Carbon content $\times 100$

Multiply and add the products.

Subtract B from A, divide by 5 and then multiply by the specific gravity. The result is the percentage of quality.

If the viscosity at 70 deg. F. is considered, divide 100 by this figure and add to the quantities in A.

Example:

Viscosity at 120 deg. F.	1	$\times$	2.09	=	2.09
Viscosity at 180 deg. F.	10	$\times$	1.22	=	12.22
Flashpoint	1	$\times$	402	=	402.00
					416.31

Congealing point	1	$\times$	20	=	20.00
No free acid					
No carbon content					

A — B = 396.31

$396.31 \div 5 = 79.25$
 $79.25 \times 0.901 = 71.40$ per cent.

Out of ten heavy crank-case oils computed in this way the quality varied from 96.94 to 50.94; of twelve crank-case and gas-engine oils the quality ranged from 80.5 to 56.94; of nine motor and automobile oils, from 73.27 to 60.24.

It is of course necessary to change the factors in the rule to suit the characteristics of various oils, such as cooling, thread-cutting, spindle, dynamo and special oils; or by using a fixed rule, one will see that oils with various characteristics are divided into classes after analysis.
 —Power.

Defining Jigs and Fixtures

By A. L. HAAS

Jigs and fixtures are commonplace aids to machining, and their utility is such that modern machining would be impossible without them. Every mechanic knows quite well what is meant by the terms "jig and fixture," but they are so loosely applied in the average shop that the real difference in function is obscured.

These attachments are of endless variety, but all have common characteristics underlying their seeming divergence. To distinguish jig and fixture, it is necessary to define them not by similarity, but by function.

The characteristics common to both appliances are those of location, repetition and dimension of product. Reflection will, however, show that these alone will not separate them from templet and gage. The essential difference is that a jig serves to guide a cutting tool while a fixture locates the work operated on. Both are separate from the machine tool on which they are employed. The definitions that suggest themselves are:

Jig—A piece of apparatus serving to guide the cutting element of a machine tool.

Fixture—A piece of apparatus serving to locate and hold work on a machine tool.

These appear comprehensive until the matter is further examined. To narrow the field and cut out the ordinary appliances, such as angle plates, faceplates and the regular attachments of a machine tool, is desirable. The definition then becomes:

Jig—A piece of apparatus for rapid production of duplicate work within ascertained limits of error, serving to guide the cutting element of a machine tool.

Fixture—A piece of apparatus for rapid production of duplicate work within ascertained limits of error, serving to locate and hold the work on a machine tool.

It may be objected that the two functions may be and often are combined. For this the society precedent of a hyphen will serve. The combined attachment would be termed a jig-fixture or a fixture-jig. This may be defined as:

Jig-Fixture—A piece of apparatus for the rapid production of duplicate work within ascertained limits of error, serving to locate and hold the work and also guide the cutting element on a machine tool.

There is value in definite classifications and exact definition. Only by such means do we avoid lengthy description and misunderstanding; hence the foregoing proposals.

[The first thing to do is to settle definitely which is which. Recently we saw in the Pratt & Whitney works a very fine special machine tool for making a gun part and were told, upon inquiry, that it was a fixture.—Editor.]



Data on Whitworth Thread Gages

The increased use of Whitworth thread gages in connection with the extensive manufacture of British munitions has created additional interest in the methods employed in the manufacture of such gages.

Information is especially desired by a number of correspondents on thread cutting, grinding, hardening and lapping. Present-day British practice in the manufacture of such gages would no doubt prove both timely and unusually interesting.

Operations Followed in Making Commutators for Armatures

EDITORIAL CORRESPONDENCE

SYNOPSIS—In this article are shown various operations and methods of manufacturing commutators. The built-up sheets of mica are first sawed into strips of the desired width, which are sawed to the correct size to suit the insulator strip required. The copper bars are blanked out from a strip. A punch and die for this operation are shown. A fixture is used to assemble the bars and insulating strips to form the commutator. The subsequent machining operations are illustrated and described.

The H. P. Cameron Electric Manufacturing Co., Ansonia, Conn., manufactures a line of commutators both for the United States and for export trade.

In Fig. 1 is shown the saw that reduces built-up sheets of mica to strips of proper width. *A* is a sheet of mica and *B* a pile of sawed strips. On the table *C* are shown

In Fig. 2 is shown one of the steel molds for making insulator rings. The mica strips are first notched and then placed in a die that rough-forms them to size. These forms are molded in the rings with the die shown. After the ring segments *A* have been removed, the mold is transferred to an oven and heated to 400 deg. F.

One of the rough-formed mica rings is placed in the mold *B*, also a quantity of liquid shellac. The steel segments are put in position on top of the mica ring. The mold is set under a screw press, and pressure is applied by hand until the segments have been forced down to the correct depth. The mold is left under the press to cool. The steel segment may then be removed and the molded mica ring taken out. One of the mica rings made in this mold may be seen at *C*. In Fig. 3 are shown molded mica rings of various sizes, the largest being 10 $\frac{7}{8}$ in. in diameter and the smallest $\frac{3}{4}$ in. in diameter.

The punch and die for punching out copper bars are illustrated in Fig. 4. The copper, which has been made

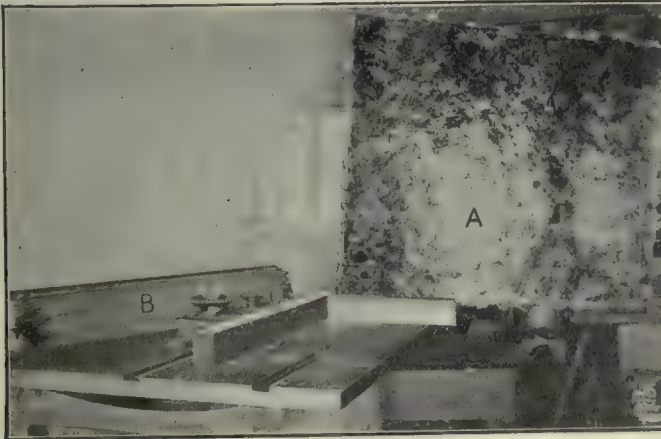


FIG. 1. SAW FOR SLITTING MICA SHEET

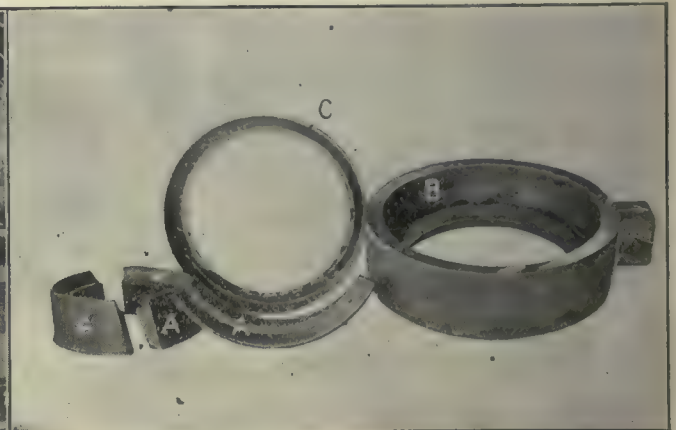


FIG. 2. STEEL MOLD FOR INSULATOR RING

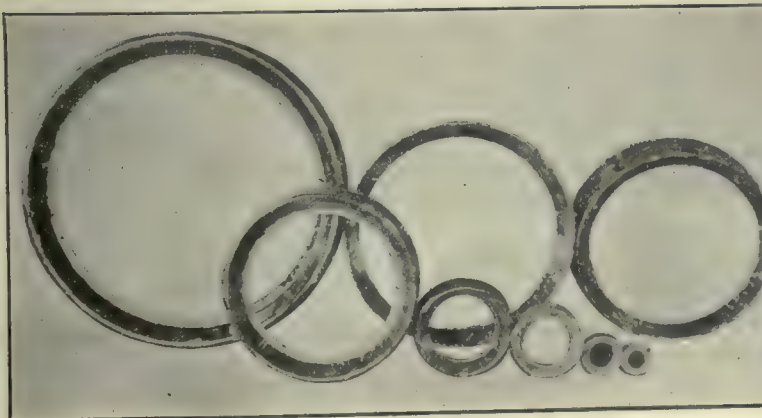


FIG. 3. NUMBER OF MOLDED MICA RINGS

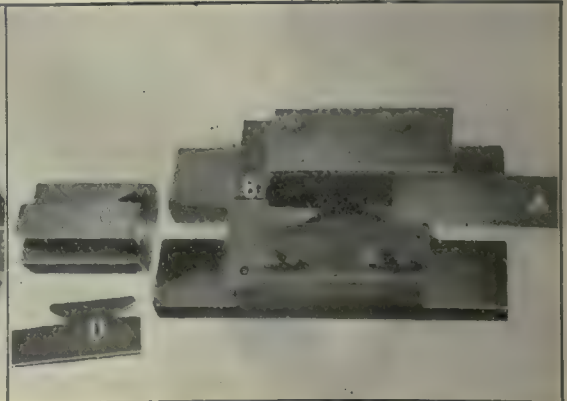


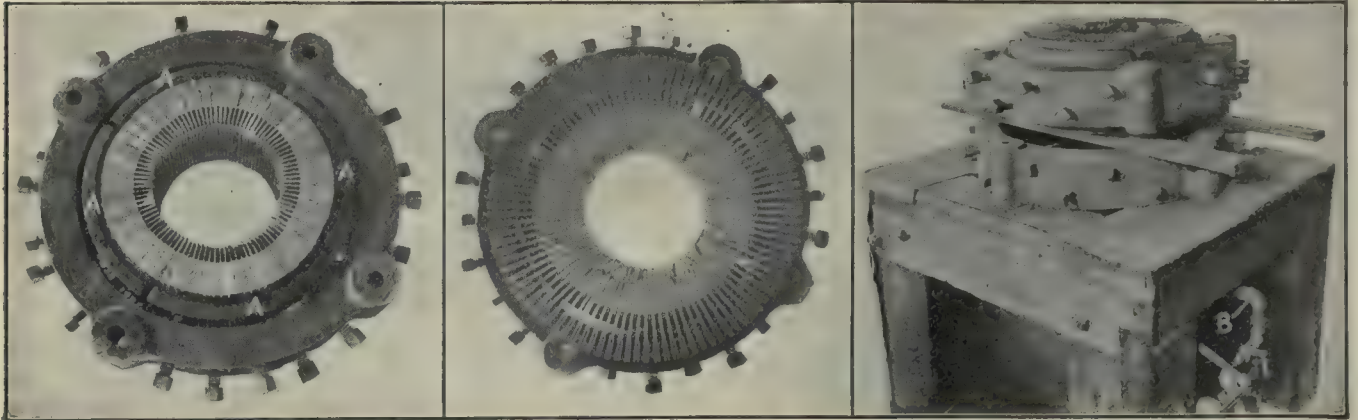
FIG. 4. PUNCH AND DIE FOR COPPER BARS

a number of the strips that have been sawed in blocks. In cutting the mica sheet the guide of the machine is set at the correct distance from the saw, and by guiding the sheet against the block the strip is cut to the desired width.

to the correct width and section, is fed into the die at *A* against the stop *B*. The punch *C* is brought down with the machine and the bar blanked out. One of the blanked bars is shown at *D*. In making the punch and die regular practice is followed.

The fixture for building up a commutator is reproduced in Fig. 5. The copper bars are placed in the fixture with a mica strip between each pair. The screws on the outer periphery are tightened against the circular strips *A*, the

After the commutator has been assembled, it is placed over the furnace at *A*. Gas is admitted and regulated by the pipe *B*. The heat is allowed to come against the commutator until the shellac has been melted out of the mica.



FIGS. 5 AND 6. FIXTURE FOR BUILDING UP A COMMUTATOR

FIG. 7. GAS-OPERATED FURNACE

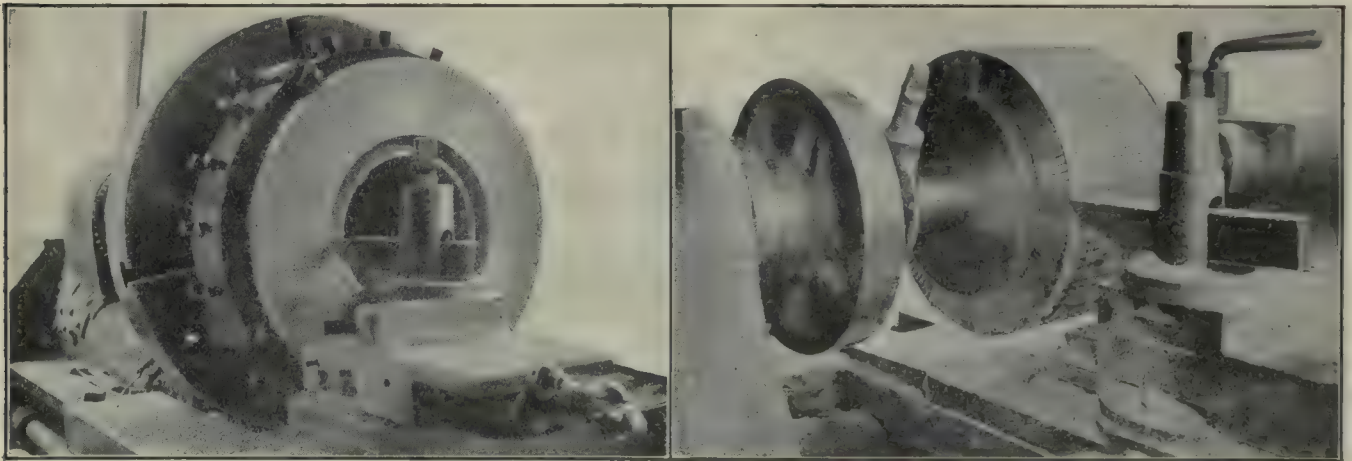


FIG. 8. TURNING COMMUTATOR FACE

FIG. 9. TURNING OUTSIDE OF COMMUTATOR

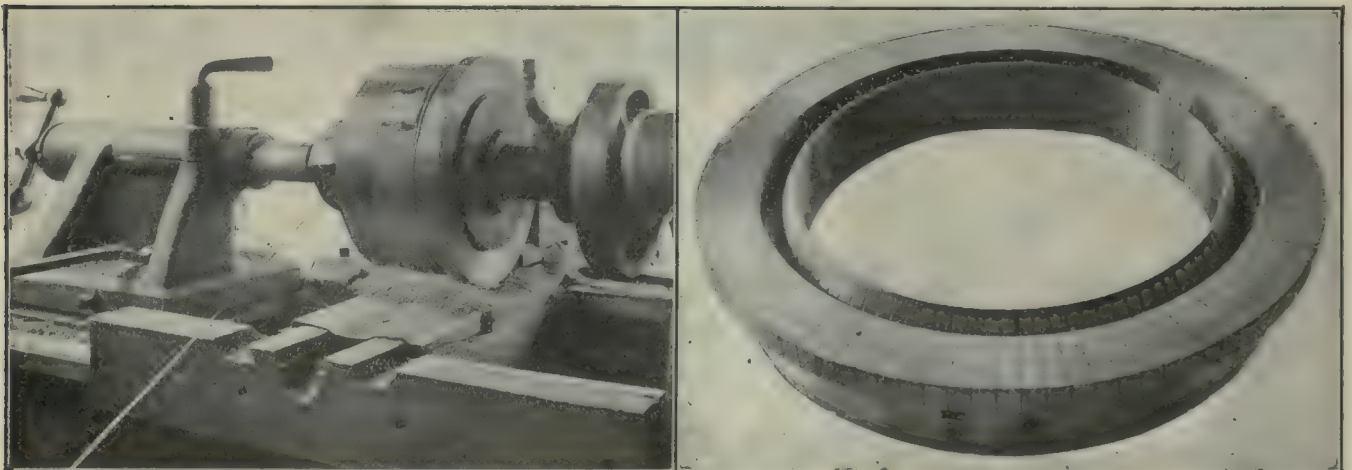


FIG. 10. WINDING BINDING WIRE ON COMMUTATOR

FIG. 11. VIEW OF COMMUTATOR AFTER BEING WOUND

pressure on which forces in the segments. Pressure is applied at various points on the fixture until the ring is circular and the commutator segments held tight. A rear view of the assembled commutator and fixture is given in Fig. 6.

In Fig. 7 is shown the gas-operated furnace for extracting the shellac that is in the mica insulations.

The fixture is removed and the screws tightened to take up any space that had been occupied by the shellac.

The fixture and commutator are then placed in the lathe, Fig. 8, being held by bolts placed in the faceplate slots and through holes in the fixture. The outside face and edge of the commutator are turned and the hole is bored. The V-surface of the commutator is also ma-

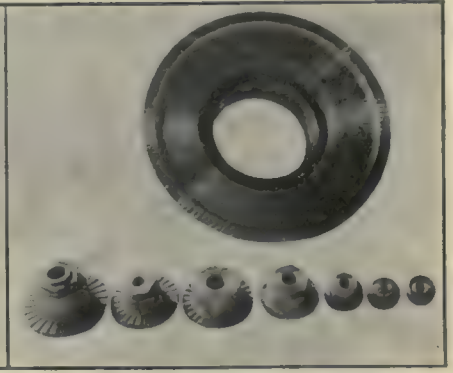
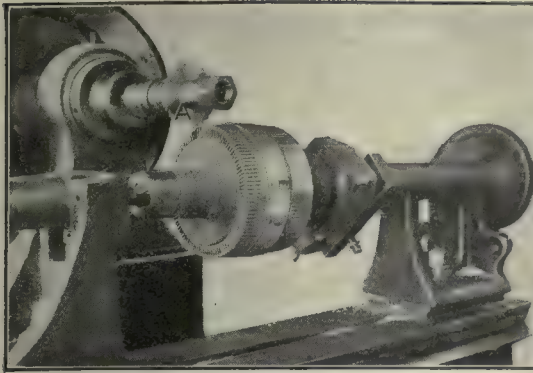


FIG. 12. SLOTTING THE ENDS OF BARS FOR THE LEADS

FIG. 13. THE FINISHED
COMMUTATOR

FIG. 14. NUMBER OF VARIOUS SIZES OF COMMUTATORS

chined, a gage being used to test the correctness of the contour.

The commutator is removed and an arbor placed in the bored hole. A nut is tightened, forcing the commutator against a shoulder on the arbor and holding it securely. The outside of the commutator is turned to size, as shown in Fig. 9.

This factory has adopted the practice of banding the assembled commutators with a tinned wire over insulating paper. By this method the commutator may be tested before being placed on the armature. In Fig. 10 is illustrated this operation of winding the wire over the paper. One of the commutators after being wound is seen in Fig. 11. This commutator is $13\frac{5}{8}$ in. in diameter and has 99 bars.

After the commutator has been wound with the retaining wire, the ends of the bars are slotted for the leads, as shown in Fig. 12. The commutator is held on an arbor and indexed around the various positions with an indexing wheel and pointer. With the wheel *A* revolving, the table carrying the commutator is fed along the required distance and the ends of the bars slotted.

In Fig. 13 is shown a finish-machined commutator, slotted ready for attaching to the armature. This commutator has 111 bars and is $9\frac{5}{8}$ in. in outside diameter. A number of various types and sizes of commutators are illustrated in Fig. 14. The largest is 13 in. in outside diameter and the smallest is $1\frac{1}{8}$ in.

Hand Wire-Bending Fixtures

BY GEORGE P. BREITSCHMID

It takes five distinct operations to make from 0.036-in. music wire the spring shown in Fig. 1. A general description of the tools follows:

In the first-operation fixture, Fig. 2, *A* is a cast-iron base milled at *B* for holding in a vise, so that the operator has free use of both hands to place the work and operate the fixture. The wire is first straightened and cut off in lengths of 2 1/3 in., then placed in the fixture, one end of which is gaged by the stop *C*; the other end is located between the gage *D* and the pin *E*, which is a drive fit in the wiper *F*, operated by the handle *G*.

After placing the work as directed, operate as follows: Draw handle *G* forward, which makes the wiper *H* grip the wire, carrying it around the pin *E* until the handle *G* completes its movement by bringing up against *I*, an adjustable stop, thereby completing the work, forming a half-loop at one end, as shown.

The second-operation fixture, Fig. 3, is almost identical in construction with that for the first operation, employing a similar cast-iron base and round wiper operated by a handle, but has the following differences: The wiper *A* is of one-piece construction, milled with a right angle, as shown at *B*. The gage *C* is milled at *D* with a slot to hold the wire. The gage *E* carries a pin that also helps

to locate the wire at or by the loop made on the first-operation fixture. It will also be noticed that the gage *E* is milled on an angle, to give the loop the desired shape. The gage *C* is milled on an angle at *F*, allowing the wire to be forced enough past a right angle to take care of any spring back, so that when completed the wire will be bent as required.

The fixture for operation 3, Fig. 4, is also of the same construction as the preceding ones, employing a cast-iron base *A* and right-angle tool-steel wiper *C* actuated by the handle *D*. The work is held in the path milled in

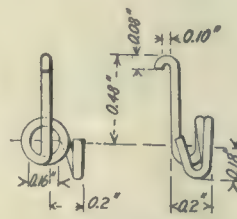


FIG. 1. PART TO
BE MADE

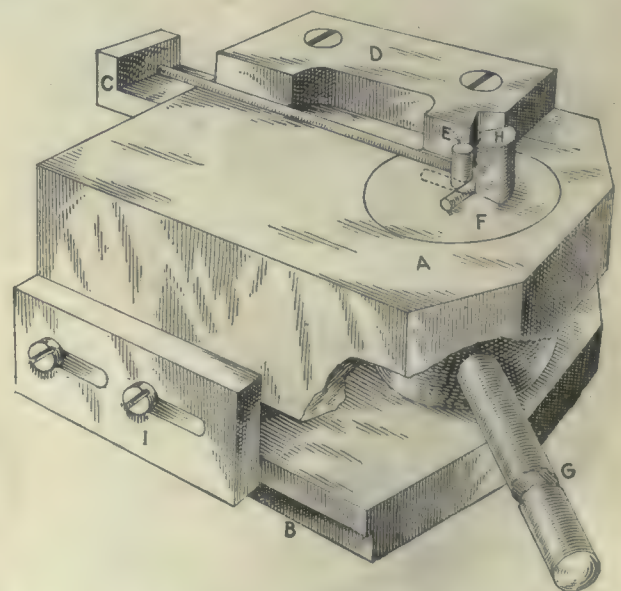
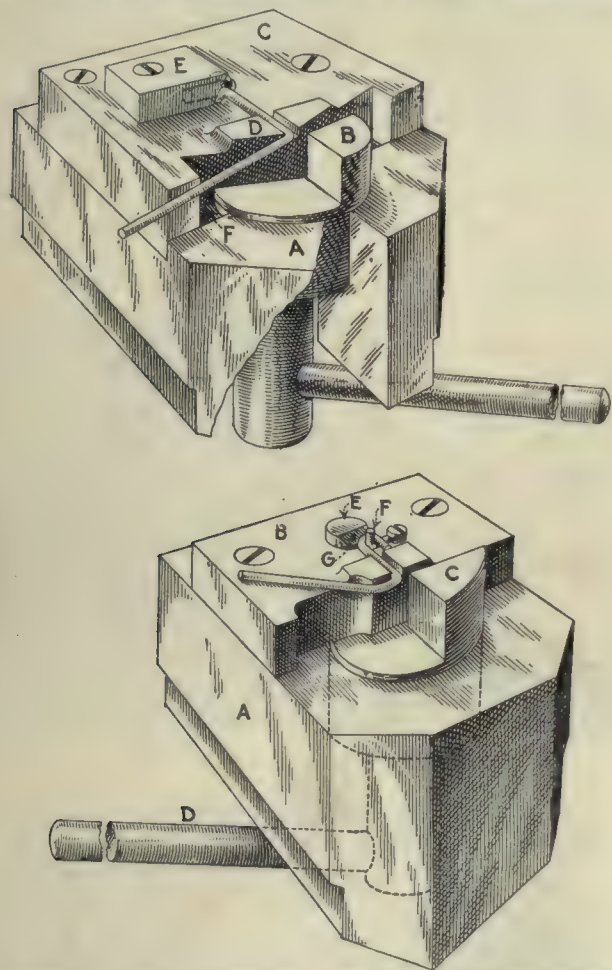


FIG. 2. FIRST-OPERATION FIXTURE

the raised surface is on the gage plate *B*, which also carries a stationary pin *E* that in turn has a milled angular surface *G* acting as a locating point using the loop formed by the first-operation fixture.

The spring pin *F* trips to keep this loop against the milled surface *G* and is fixed to the gage *B* by a No. 5-40 screw in a threaded hole. While the fixture is similar to the second-operation tool, the method of holding the work is of interest, as is also the fact that here we have a very short bend, which is usually annoying in music wire. The handle is rotated until *C* brings up at the stop, finishing the operation. The work may be easily removed by returning the parts to their normal position and depressing the pin *E*.

The fifth-operation fixture, Fig. 6, in general design and construction is similar to the fixtures for the first,



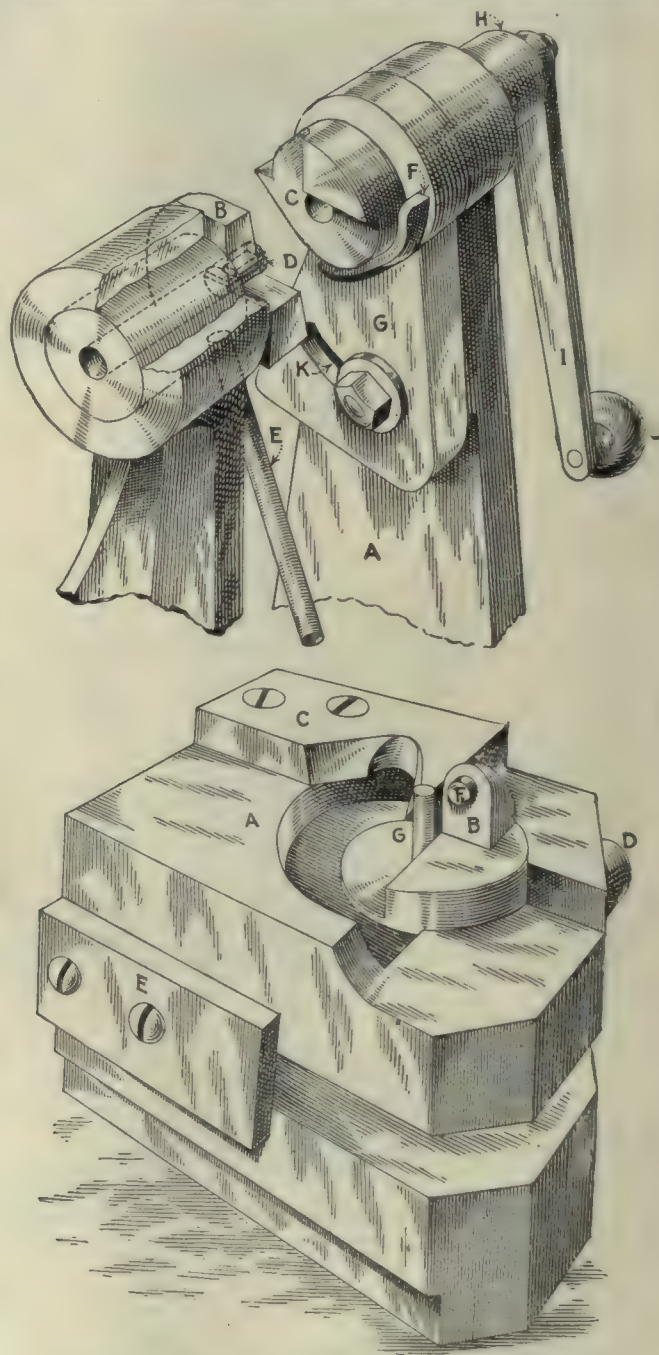
FIGS. 3 AND 4. SECOND- AND THIRD-OPERATION FIXTURES

second and third operations, but the method of holding the work is different. The cast-iron base *A* is milled with two cuts on the bottom for holding in a bench vise. At *B* is a tool-steel wiper with a lug raised upon it for the holding pin *F* and the center pin *G*; while *C* is a gage plate of tool steel, and *E* is a stop that may be made with adjustment.

The method of operating is as follows: Place the work with two close coils upon the pin *F*, allowing the straight end to lie between the pin *G* and the gage plate *C*. Operate as in preceding fixtures until the handle *D* brings up at the stop *E*. This completes the final bend. The labor cost of making this piece does not exceed 20c. per hundred for all five operations.

The fixture shown in Fig. 5 performs the fourth, or coiling, operation. The main portion *A* is of cast iron, with two columns bored to receive the members *B* and *H*. *B* is a tool-steel locating piece carrying the locating pins

E and *D*, which are made of drill rod. As the work is of 0.036-in. music wire and it is desired to wind two close coils, it will be necessary to machine the face of *B* to form a cam. The rise must correspond to the thickness



FIGS. 5 AND 6. FOURTH AND FIFTH OPERATIONS

of the wire. This can be done by gearing a lathe to cut 28 threads per inch. *H* is a machine-steel stud actuated by the crank *I* and the handle *J* and carrying the tool-steel wiper *C*, which is also machined camlike, corresponding to the thickness of the wire. At *G* is a machine-steel piece located on the right-hand column and the carrier stop *F*. It will be seen that *G* can be swiveled along the path *K*, allowing the stop to be advanced or retarded, depending upon the temper of the wire.

The tool is operated as follows: As the wire is delivered by the third-operation fixture, the third-operation bend is inserted in the path of *D* so as to engage the loop made by the first-operation fixture.

Making the 4.5-In. Howitzer Cartridge Case--I*

BY ROBERT MAWSON

SYNOPSIS—In this article are described the successive operations in manufacturing the 4.5-in. howitzer cartridge case. The machines used are shown set up with the tools as in operation, performing the various stages on the work. Detail illustrations are also given of the tools and of the special equipment that has been developed to enable the manufacturers to turn out an accurate product. Thus the article is a complete description of the manufacturing processes followed in making this cartridge case.

Under ordinary conditions the manufacturing of war munitions calls for exceptional thought and skill, owing to the lack both of knowledge and of proper tools. During the present European War, when a firm has been offered an order, time has been at a premium. Often

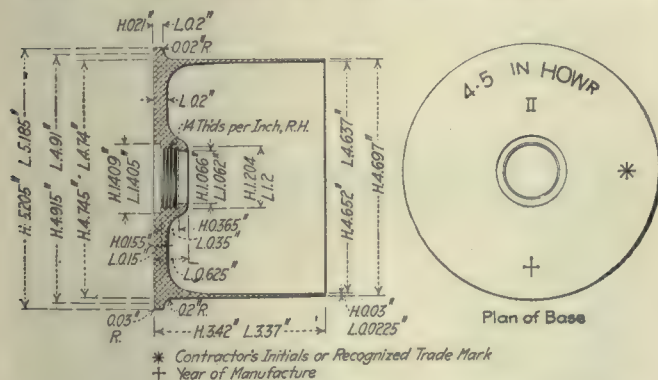


FIG. 1. DETAIL OF 4.5-IN. HOWITZER CARTRIDGE CASE

special machines could not be obtained, and the lack of time has prevented the firm from making its own.

The Worcester Pressed Steel Co. has had considerable experience in making pressed parts in various metals, and one would judge that the manufacturing of a cartridge case would be a simple matter for this concern. Yet it found some experiments necessary before a case to pass the British Government inspection was produced. The company is manufacturing the 4.5-in. British howitzer cartridge case, and the present production is 75,000 per week. The composition from which the cases are made is 70% copper and 30% spelter. The sequence of operations is given in the accompanying table.

TABLE OF SEQUENCE OF OPERATIONS

1. Blank—purchased	18. Wash
2. Cupping	19. First heading
3. First indent	20. Second heading
4. Second indent	21. Final trimming
5. Anneal and pickle	22. Pierce for primer hole
6. Flatten base	23. Tapering
7. First draw	24. Shop inspection
8. Wash, anneal and pickle	25. Face, square to length, rough-thread and counter- bore for primer
9. Second draw	26. Finish-thread
10. Wash, anneal and pickle	27. Finish-counterbore
11. Third draw	28. Face inside of boss
12. Trimming	29. Wash
13. Wash and pickle	30. Final inspection
14. Fourth draw	31. Stamping
15. Wash, anneal and pickle	32. Packing
16. Fifth draw	
17. Trimming	

A detail of the case is given in Fig. 1. In Fig. 2 are illustrated the various stages that the case passes through from the blank till it is ready for packing. The blanks are purchased and measure $5\frac{7}{8}$ in. in diameter by 0.380 in. thick. The next operation, given as the

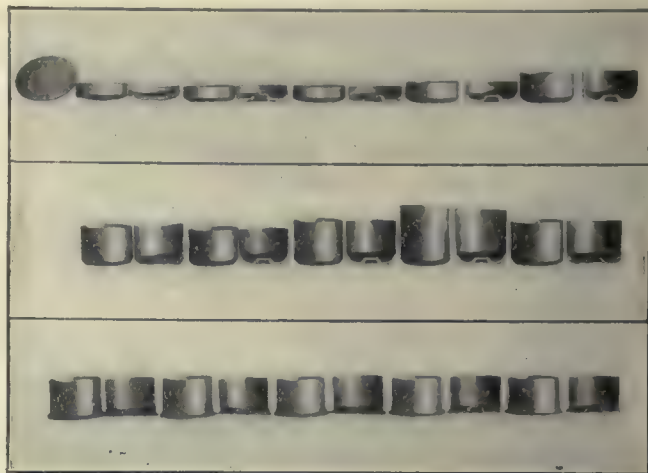


FIG. 2. VARIOUS STAGES OF 4.5-IN. CARTRIDGE CASE FROM BLANK TO FINISHED PART

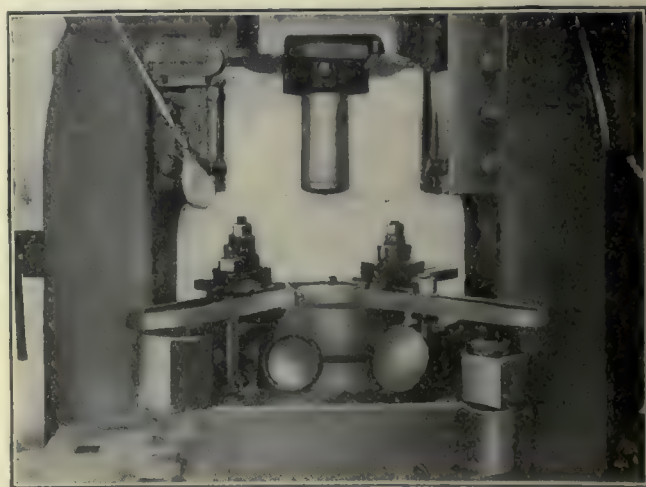


FIG. 3. THE CUPPING OPERATION

second in this article, is cupping. The machine performing this work is seen in Fig. 3. The punch, punch holder, bolster and drawing dies are shown in Fig. 4. The cupping operation is given in diagrammatical form in Fig. 5. During the various punch-press operations the cases are lubricated with Lub-a-Tube made into a solution with the proportions of 30 lb. of the composition to 50 gal. of water.

The next operation is making the first indent. This is done on the press illustrated in Fig. 6. The punch, Fig. 7, and the die, bolster and center-section knock-out, Fig. 8, are used. The punch is fastened to the punch press with a holder, Fig. 5, similar to that for the cupping operation. The first indenting operation is also given in diagrammatical form in Fig. 9.

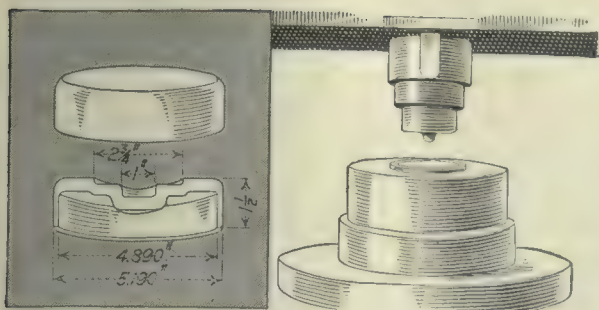


FIG. 9. OPERATION 3: FIRST INDENT

Machine Used—Toledo 18-in. stroke.
 Production—500 per hr.
 Pressure—400 tons.
 References—Figs. 5, 7, 8 and 9.

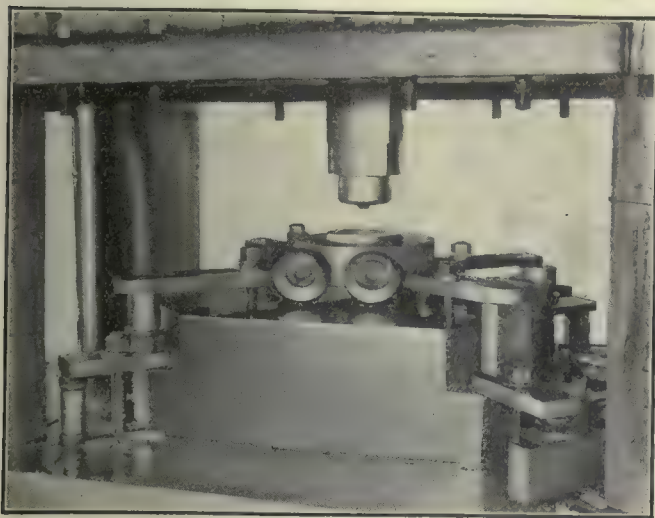


FIG. 10. SECOND INDENTING OPERATION



FIG. 11. PUNCH FOR SECOND INDENT

The next process is annealing and pickling the parts. They are placed on trays and slid into a crude-oil oven, Fig. 13. Three such ovens are provided at the factory for this work, each one holding four 44-in. square pans, in each of which approximately 110 cartridge cases may be placed. The ovens are kept at a temperature of 1,250 deg. F., and the cases are left in the ovens 36 min. The annealing operation is conducted so that a pan is removed from the rear of the oven every 9 min. As the pan is removed, another is placed at the front of the oven. This procedure enables the annealing operation

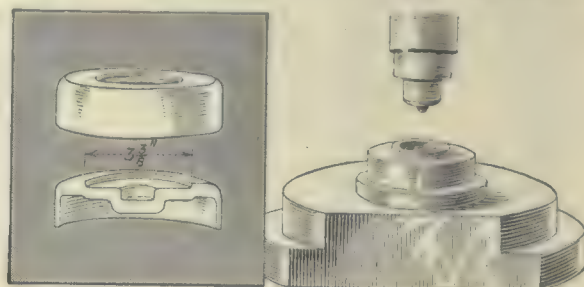


FIG. 12. OPERATION 4: SECOND INDENT

Machine Used—Toledo 26-in. stroke.
 Production—450 per hr.
 Pressure—400 tons.
 References—Figs. 5, 9, 11 and 12.

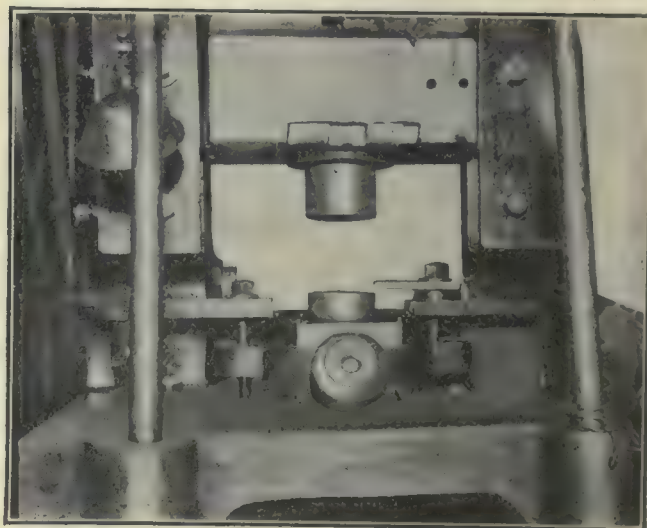


FIG. 15. FLATTENING THE BASE OF THE CASE

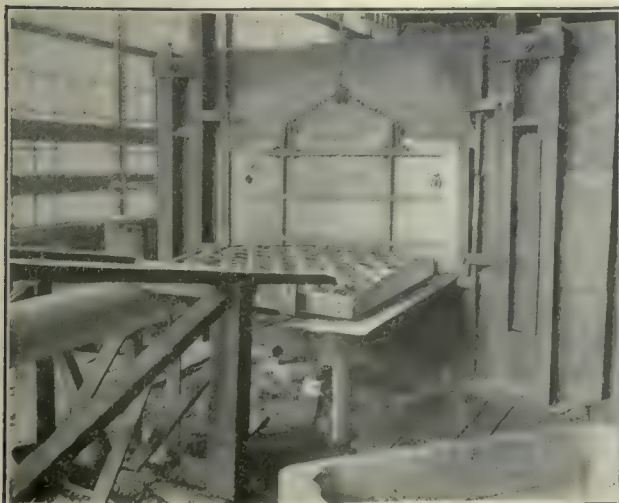


FIG. 13. ANNEALING TANKS



FIG. 14. WASHING AND PICKLING TANKS

to be a continuous one. The three ovens anneal 11,000 cases in 24 hr., requiring 504 gal. of oil.

When the pan has been taken from the oven, the cases are quenched in cold water. They are then conveyed, by means of a 1,000-lb. air hoist, to the pickling tanks, Fig. 14. The solution consists of one part sulphuric

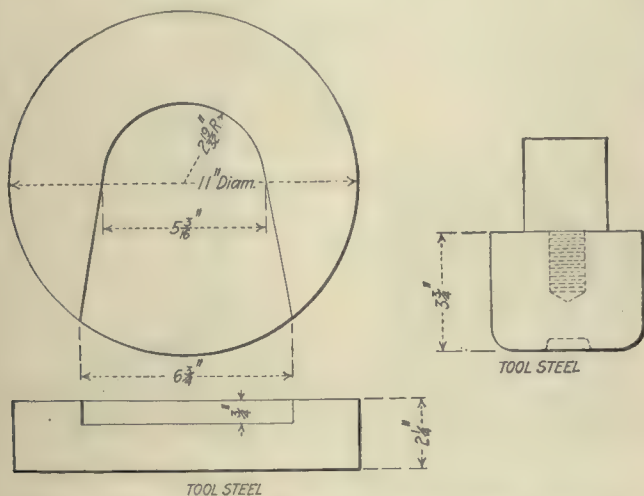


FIG. 16. PUNCH AND DIES FOR FLATTENING BASE

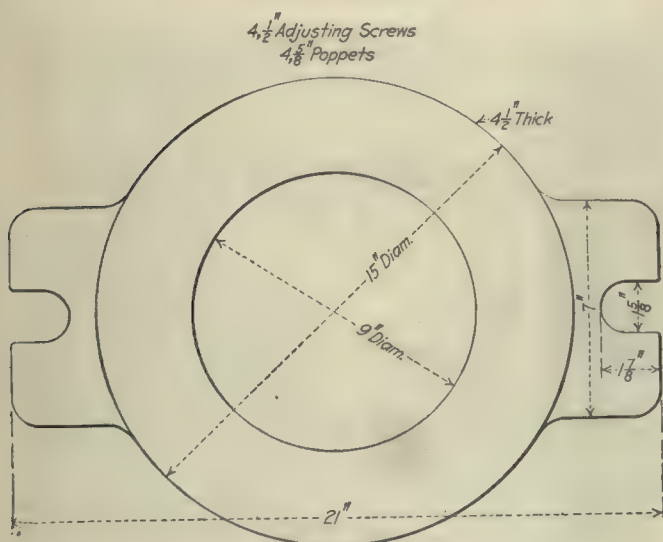


FIG. 17. BOLSTER FOR BASE-FLATTENING DIE

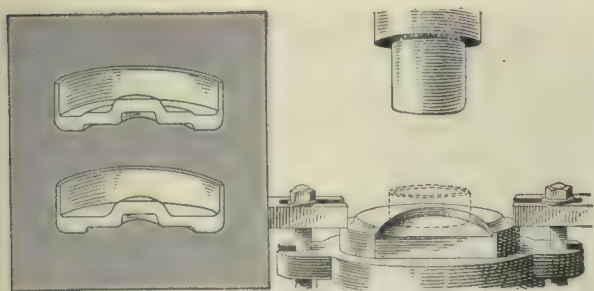


FIG. 18. OPERATION 6: FLATTENING BASE

Machine Used—Toledo 8-in. stroke.
Production—1,100 per hr.
Pressure—100 tons.
References—Figs. 5, 16, 17 and 18.

acid to ten parts water. The cases remain in the pickling tank about 5 min. The parts are then carried to the punch press, Fig. 15, where the base is flattened, so that the cases will present a good surface for the first

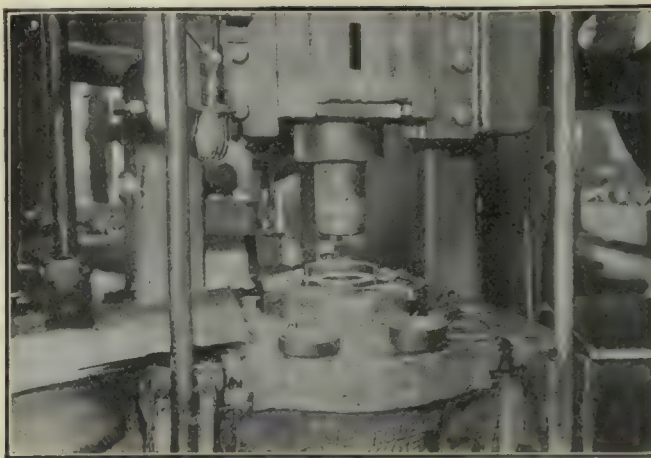


FIG. 19. FIRST DRAWING OPERATION

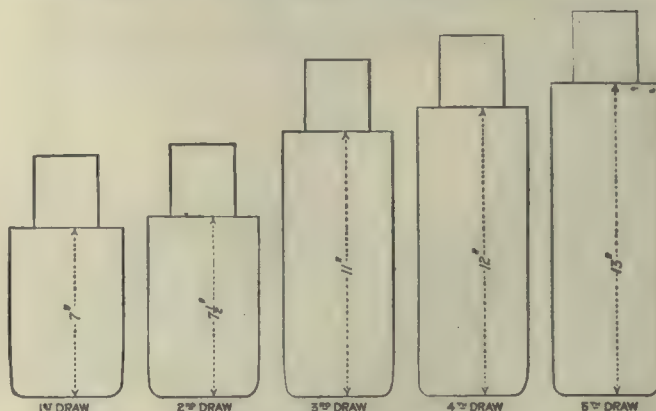


FIG. 20. DRAWING PUNCHES

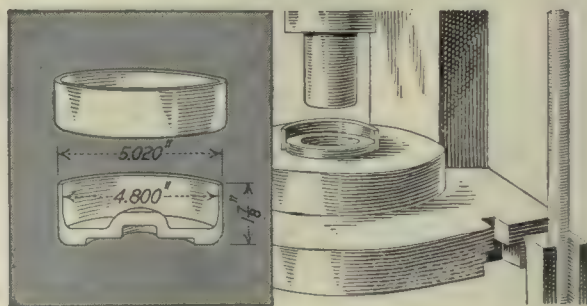


FIG. 21. OPERATION 7: FIRST DRAW

Machine Used—Toledo 8-in. stroke.
Production—900 per hr.
Pressure—100 tons.
References—Figs. 5, 18, 21 and 22.

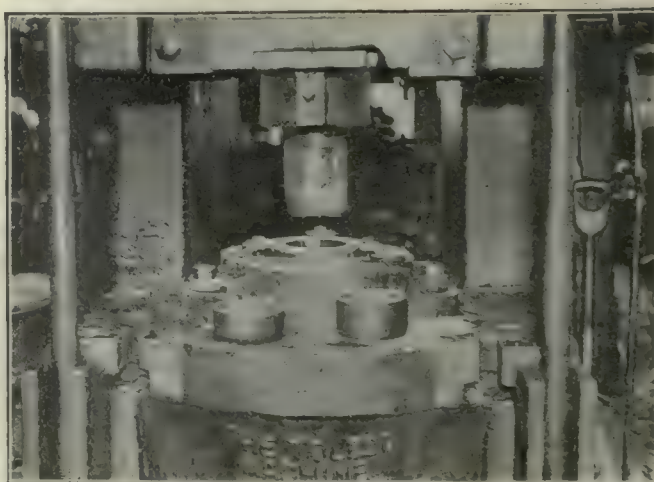


FIG. 22. SECOND DRAWING OPERATION

drawing operation, in which the punch and die, Fig. 16, are used. The die is held with bolts on the bolster, Fig. 17. The punch is placed in the holder, Fig. 4. The

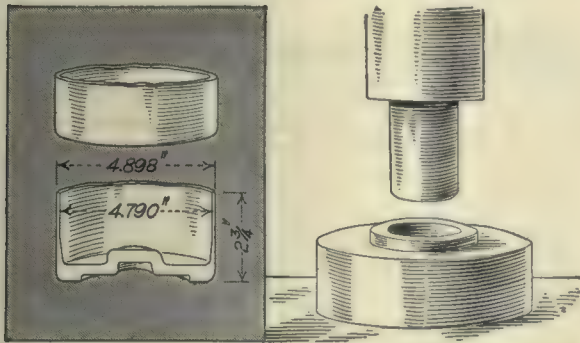


FIG. 23. OPERATION 9: SECOND DRAW

Machine Used—Bliss 12-in. stroke.
Production—550 per hr.
Pressure—75 tons.
References—Figs. 5, 18, 24, 25 and 26.

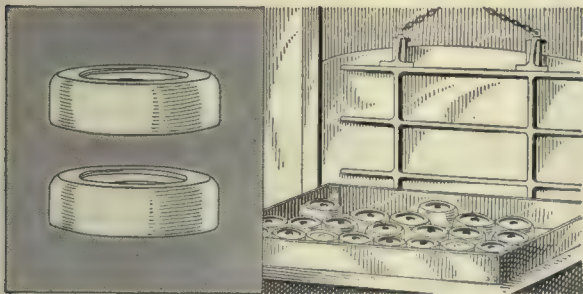


FIG. 24. ANNEALING OPERATION

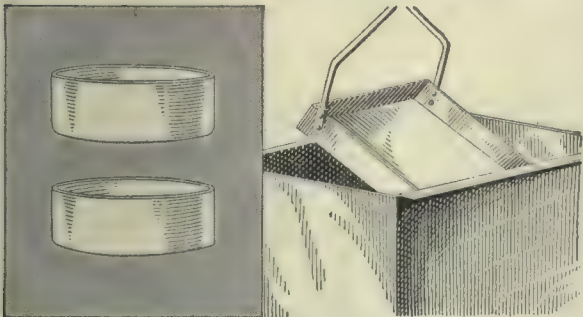


FIG. 25. PICKLING OPERATION

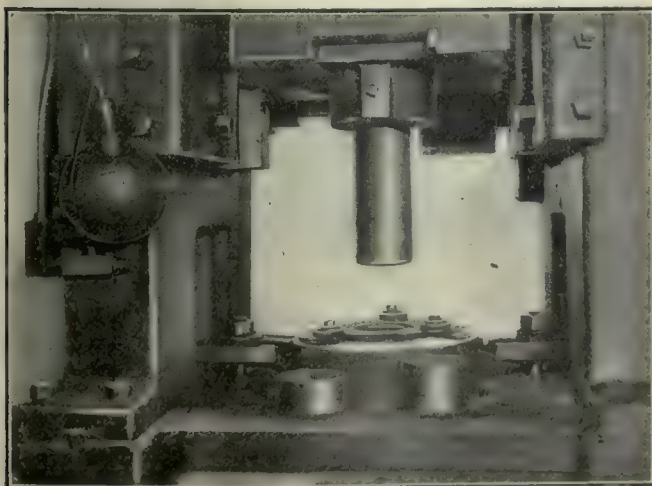


FIG. 26. THIRD DRAWING OPERATION

operation is also given in diagrammatical form in Fig. 18.

The case is now ready for the drawing operations. The first of these is performed in the punch press, Fig. 19. The drawing punches, Fig. 20, are fastened to the machine by the punch holder, Fig. 4. The die is illustrated in Fig. 4. It is held in the bolster, Fig. 17. The

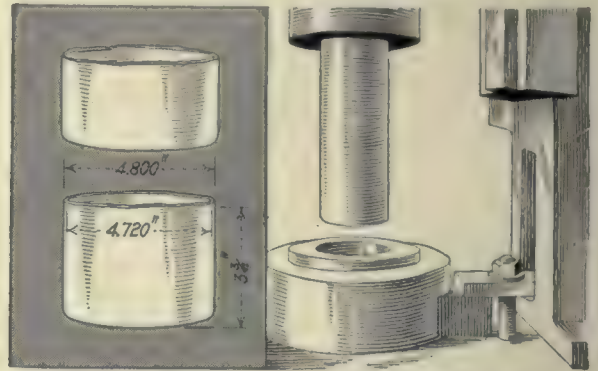


FIG. 27. OPERATION 11: THIRD DRAW

Machine Used—Bliss 12-in. stroke.
Production—550 per hr.
Pressure—75 tons.
References—Figs. 5, 18, 28, 29 and 30.



FIG. 28. CASE-TRIMMING LATHE

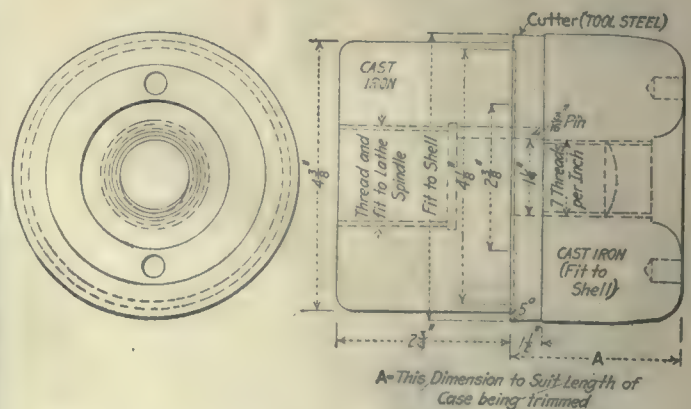


FIG. 29. MANDREL AND CUTTER FOR TRIMMING

operation is shown in diagrammatical form in Fig. 21. The cases are washed in a hot-water and caustic soda solution for about 1 min. They are afterward annealed, quenched in cold water and pickled in a similar manner to that described for operation 5.

The parts are then conveyed to the machine, Fig. 22, for the second drawing. The punch, Fig. 20, inserted

this operation are the punch, Fig. 20, punch holder, Fig. 4, die, Fig. 4, and bolster, Fig. 17. The drawing operation is seen in diagrammatical form in Fig. 33. The cases are washed, annealed and pickled, as previously

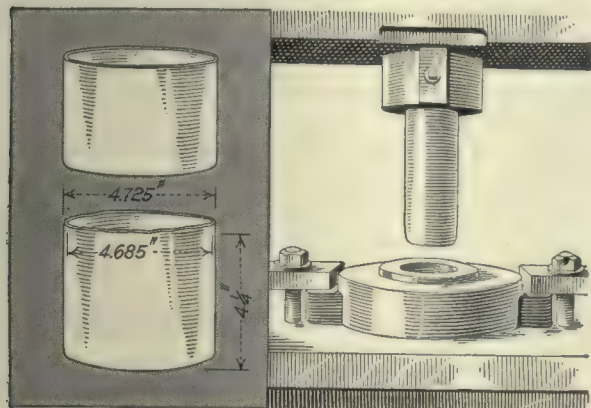


FIG. 33. OPERATION 14: FOURTH DRAW

Machine Used—Bliss 12-in. stroke.
Production—550 per hr.
Pressure—75 tons.
References—Figs. 5, 18, 35, 36 and 37.

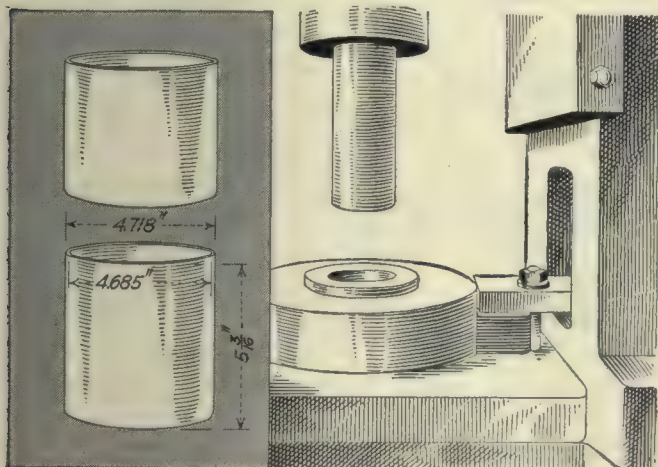


FIG. 35. OPERATION 16: FIFTH DRAW

Machine Used—Bliss 12-in. stroke.
Production—450 per hr.
Pressure—60 tons.
References—Figs. 5, 18, 39, 40 and 41.

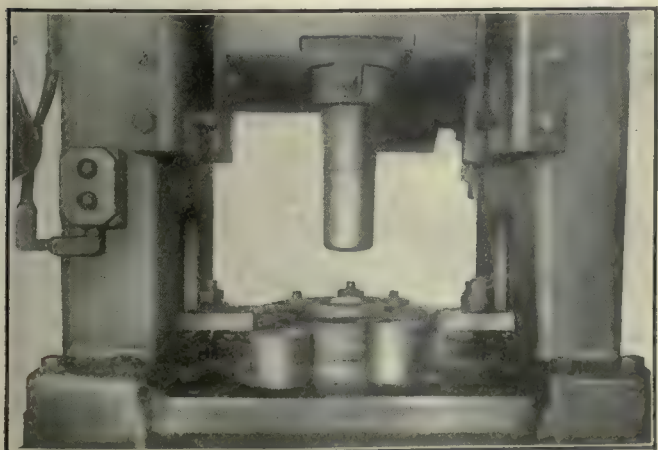


FIG. 34. FIFTH DRAWING OPERATION

described, with the exception that the time of annealing is only 20 min.

The cases are then ready for the fifth, or final, drawing operation. This is performed in the machine shown

in Fig. 34. Details of the tools for this operation are given in the following illustrations: Punch, Fig. 20; punch holder, Fig. 4; die, Fig. 4, and bolster, Fig. 17. A diagrammatical illustration of this operation, which completes the drawing work performed on the cartridge case, is given in Fig. 35.

(To be continued)

✱

Some of the Work Required of an Aeroplane Mechanic

By FRANK C. HUDSON

The tremendous activity in aeronautics on the other side and the probable increase in the numbers of flying machines in this country in the near future open up the question of securing mechanics familiar with the sort of work necessary in looking after aeroplanes in commission, as well as the kind of men needed in building the machines. While it will probably be some time before we have any large number of commercial hangars in the same way that we now have commercial garages, there will nevertheless be a demand for mechanics who understand the keeping of aeroplanes in flying order, for like all kinds of machinery they require attention to keep them at their best and to make them as safe as possible.

As far as the motor is concerned, it is of course the same in principle as the automobile motor, the details of construction adopted by different makers being a subject for study by ambitious mechanics, as in the case of the automobile.

In caring for the aeroplane itself, as well as the various appliances now becoming part of its equipment, a few suggestions may be of value. These will include mostly the handling of the wires for various controls and supports and the method of making good electrical contacts for searchlights, stabilizers or other electrical apparatus used. In addition to this a mechanic should understand the operation and construction of the air compass, the drift indicator, the use of bomb-sighting and other devices.

Most of the wires are stranded cables, each strand being itself twisted up from smaller wires. One of the first things to learn is how to handle this cable without having the ends fray out and become unmanageable. The ends of the wire will usually be found soldered together. When it is necessary to cut off a piece, measure off the desired length from the end and mark it with chalk or otherwise on the wire cable. With a soldering iron, coat the cable with solder all around, for perhaps $\frac{1}{2}$ or $\frac{3}{4}$ in. each side of the point at which it is planned to make the cut. This keeps the wire solid at that point; then when the cut is made, both ends are held firmly in position and no fraying takes place. This operation is illustrated in Fig. 1, where the wire is soldered from A to B, the cut being in the center, as shown. Fig. 2 represents the result of not soldering. The end A was previously soldered. Then the cable was cut at B, and the cable promptly untwisted clear to the soldered end, as shown.

For making electrical contacts the method presented in Figs. 3 and 4 is very successful. It is desired to put a substantial terminal for the contact screws at the end of a small insulated-wire cable. After cutting

the wire, it is advisable to slide the outer covering back, if it is of a sufficiently loose weave to allow this. Then trim off the inner insulation, exposing the bare wires, as at *A*, Fig. 3. These wires are divided about equally, as shown; the small contact washer, seen in section at *C*, Fig. 4, is placed between the two grooves, and the wires are carefully twisted on both sides of this ring, as at *A* and *B*, Fig. 4. The wire fits down into the groove; and after the wire is covered with some good noncorrosive soldering paste, the groove is filled with solder from a properly heated iron. The wire on both sides of the ring is also soldered fast. Then the surplus wire at the outer end is cut off as close to *B* as seems advisable, leaving a good substantial terminal. Care should be taken not to use too much solder, as it may make a lump on one side of the ring or fill the hole. In case this is done, however, it can be drilled out with a little care. Then slide the cover back over the wire and tape it.

Another form of electrical connection is illustrated in Fig. 5, where the ends of the fine wires in the cable are twisted together and soldered to one side of a regular copper washer *A*. This should be substantially done at the joint *B*. Taping is very necessary at all joints, not only on account of the electrical contacts, but to keep out moisture. This is particularly true in the flying boat, or hydro-aëroplane, for the salt water is thrown to a considerable distance in rough or stormy weather.

ELECTRICAL-WIRE JOINTS

Fig. 6 is a diagram of the regular electrical contact, generally known as the Western Union splice. As can be seen, both wires are bent at right angles and then, instead of being doubled back on itself, each end is wrapped carefully around the other wire. This makes a long, strong contact. It should be carefully soldered, to insure a good connection. Taping is done in all cases.

Heavier wire connections for stays and for the various controls are made as in Fig. 7. Here the end of the cable, which has been previously soldered to prevent fraying, is bent around the eye *A*; the brass sleeve *B*, which has previously been slipped on the wire, is slid down over the main wire and the end that has been bent around the eye. Sufficient room is left for the end *C* to be doubled back on the outside of the sleeve, either in the position shown or so as to form a sort of triangle over the connector. The whole thing is then carefully soldered to prevent any slipping and also to keep moisture out of the joints. The solder should extend around the eye and avoid all possibility of the rope, or cable, pulling out of position.

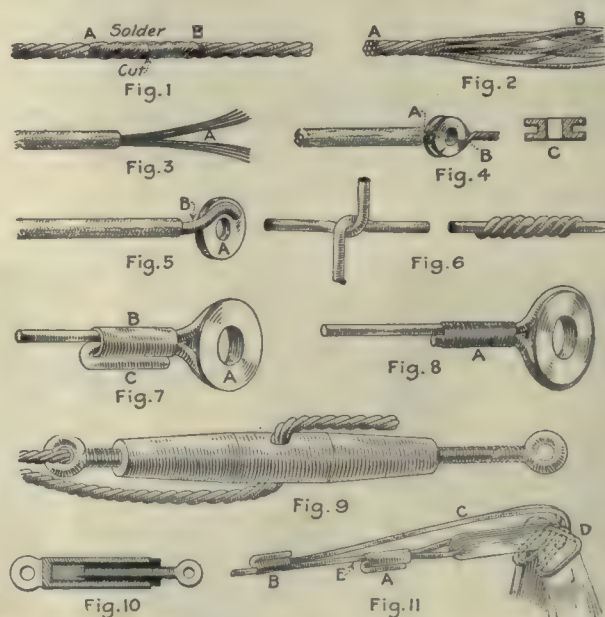
Another and somewhat similar method is illustrated at *A*, shown in Fig. 8, where instead of the sleeve, the two parts of the cable are tightly wrapped together with a strong iron galvanized wire known as "safety" wire and the whole thing carefully soldered. In this case no end is shown doubled back, but this form of fastening is only used when it is necessary for the rope to pass through some opening close to the eye. It is always preferable to double the end back and solder it in either case. Safety should always be the first consideration.

TURNBUCKLES AND SAFETY WIRES

Fig. 9 shows a form of turnbuckle that is commonly used in keeping guy wires at the proper tension. The only unusual features are the pin hole in the center and the safety wire that is run through the hole and wrapped

around the body or else taken to the other eye, in order to prevent the joint buckle being turned accidentally or otherwise so as to disturb the adjustment of the tension. Another and shorter form of turnbuckle is seen in Fig. 10. Here the right- and left-hand threads telescope.

The connection shown in Fig. 11 is a form of safeguard and is largely used on all controls, such as the ailerons, or balancing wings, the elevating and depressing planes, or "flippers" as they are commonly called, and the steering rudder. The usual form of connection is illustrated at *A*. At *B* is an additional connection, carefully soldered in place on the extra wire cable *C*. This goes over and around the two controlling arms, but is not drawn taut,



SOME OF THE WORK OF AN AÉROPLANE MECHANIC

as can be seen. In case of breakage of the direct wire, which is most apt to occur at *E*, the auxiliary wire *C* takes up the load and allows the machine to be handled safely, even though the control wires are somewhat slacker than under normal conditions.

These are only a few of the points to be considered, but they will give mechanics who are interested in entering the field of aviation some idea of the kind of skill and knowledge required. It is extremely interesting work, and there are likely to be many opportunities within the next few years.

✽

A Soldering Kink

I have just run across a scheme to help in soldering. It is new to me and may be to others. As everyone knows, steel will rust after it is soldered, if not thoroughly cleaned. The scheme is to prevent this action.

Most small shops have a soldering iron and a jar of acid for odd jobs. Keep some soda water (washing soda) alongside the acid, and either dip the work into the soda or swab it off with a brush or cloth. My work is small, and I have two 8-oz. screw-topped bottles—one acid, the other soda water—both set into one block of wood.

I have been using this outfit for two months and have had no trouble with rust.

W. B. GREENLEAF.

Letters from Practical Men

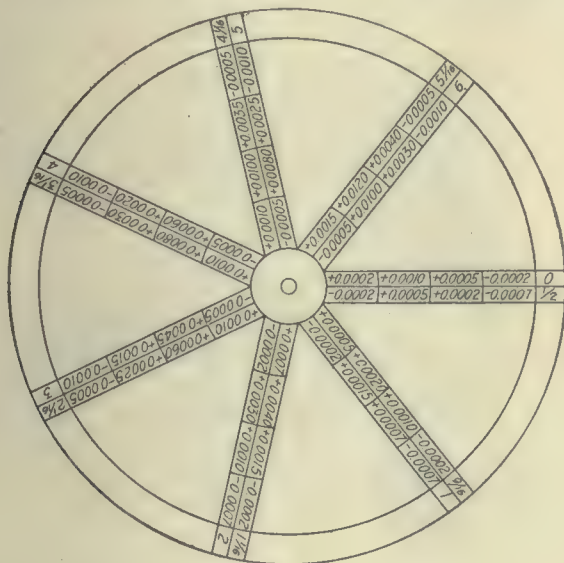
Handy Tolerance Dial

Some time ago, when I was employed on automatic machinery, I had occasion to use the tolerance table quite often. To save time, I made a table in the form shown. It is compact, as can be seen, and is very handy to have on the board.

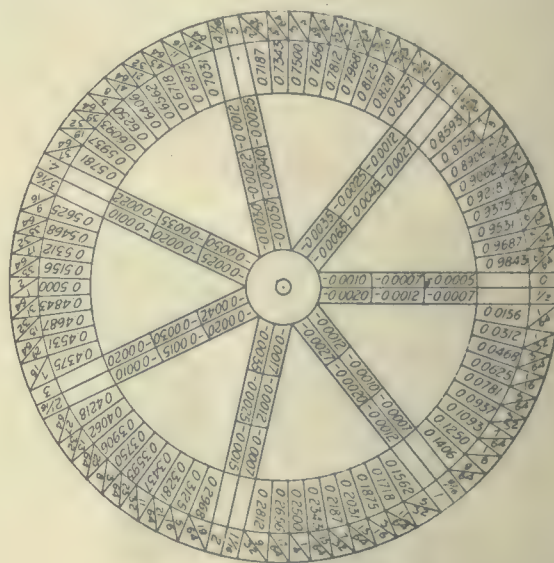
The dial *A* is composed of tolerances for push, drive and force fits for shafts, or the male fits, and for holes, or the

Dial *B* should be pasted on the back of dial *A*. With a sharp knife cut out the slots in the dials *C* and *D*. Punch out the small center circles and with an eyelet or paper fastener assemble the dial *D* on the dial *A* and dial *C* on dial *B*.

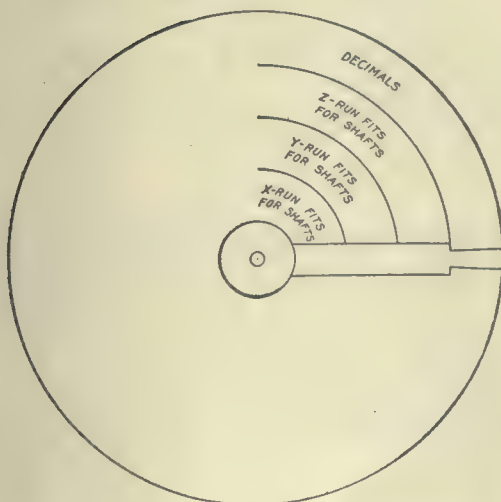
The method of using the dial is simple. For example, if it is desired to find the tolerances for a $1\frac{5}{8}$ -in. shaft that is to run in a bearing, turn the dial *D* so that at the end of the slot, on dial *A*, is found $1\frac{1}{8}$ -2. Under "Holes"



DIAL A



DIAL B



DIAL C



DIAL D

A HANDY TOLERANCE DIAL FOR VARIOUS TYPES OF FITS

female fits. The dial *B* is made up of tolerances for the different grades of running fits for the shafts, or the male members, and decimal equivalents for fractions of an inch to sixty-fourths. *X* running fits, on dial *C*, are used for engine and other work where easy fits are wanted; *Y* running fits are suitable for high speeds and good average machine work; *Z* running fits are for fine tool work.

on dial *D* are the high and low limits, which are in this case $\frac{+0.0007}{-0.0002}$. The diameter of the bearing would read $\frac{1.6257 \text{ in.}}{1.6248 \text{ in.}}$. For the shaft, turn to the kind of fit wanted, which is in this case a *Y* running fit. As before,

with the slot at $1\frac{1}{16}$ -2 under "Y Running Fit" on dial *C*, we find $\frac{-0.0012}{-0.0025}$. Therefore, the diameter of the shaft would read $\frac{1.6238 \text{ in.}}{1.6225 \text{ in.}}$.

The tolerances for the other kinds of fits are derived in the same way. The tolerances for the holes are always found under "Holes," regardless of the kind of fit wanted.

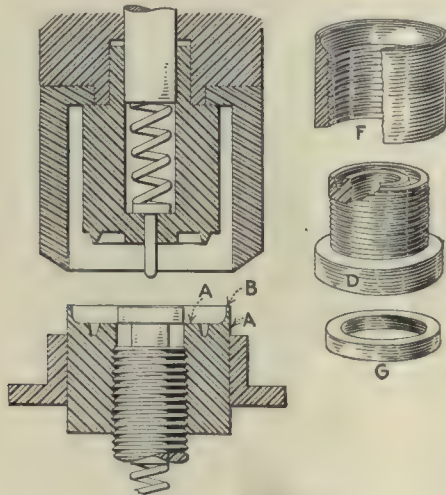
Nyack, N. Y.

L. C. ROBERTSON.

Reducing Cost of Tin-Cap Dies

The cost of maintenance of dies for caps that are soldered on the top of tin cans after filling can sometimes be reduced in the following manner: In Fig. 1 are shown the die and punch with the forms, etc., in place. As will be seen at *A*, the punch and forms were made all in one piece. The cutting edge, at *B*, has about $\frac{1}{16}$ in. for grinding off as the punch becomes dull. The punch *A* is thrown away when this grinding allowance is removed.

The way to overcome this waste is shown in Fig. 2 at *D*. The form is made from a suitable piece of die steel tem-



BUILT-UP CAP DIES

pered. The cutting edge is made as shown at *F*, is screwed down on *D*, ground to its proper shape and size and is used until it wears down $\frac{1}{16}$ in.

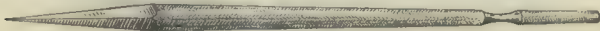
Then it is taken off, and a packing washer *G* is placed under it, screwed up tightly again and reground to size and shape. The process is kept up until the cutting edge is worn down so far that the threads do not take sufficient hold to withstand the stresses. It is then thrown away and a new cutting edge made for the same form block *D*.

Freehold, N. J.

S. CRONK.

Nicking a Round File

When filing out holes with a round file, there is a tendency to push the file too far in, so that it catches on the large diameter. By grinding a nick or groove around the



NICKING A ROUND FILE

file at the point of largest diameter that will go through the hole easily, this catching is avoided, and the nick also acts as a stop. This will not only make it easier to handle

the file, but it saves considerable breakage, due to an unintentional side pressure in withdrawing the file from the hole.

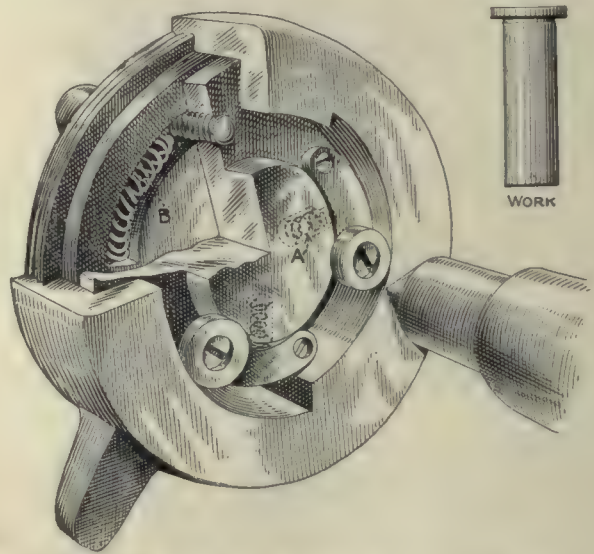
This method is also useful in filing a form tool, as by measuring the diameter carefully and grinding the nick at the proper point, care in filing will give a fairly accurate radius.

JAMES MCINTYRE.

Bridgeport, Conn.

Grinder Dog for Tappet Studs

The tool shown has nearly doubled production on this operation. It will be seen by referring to the stud to be machined that no center could be used on the large end. The gripping is done by three rollers on a cam surface. The three springs at *A* in the light plate keep



GRINDER DOG FOR VALVE TAPPET STUD

the rollers out against the cam surface. The spring at *B* tends to rotate the rollers. Owing to the small amount of stock left for grinding—0.0009 in.—the stud had to be accurately centered in order to clean up.

Kenosha, Wis.

BAXTER W. GEORGE.

Lathe and Mandrel for Roughing 4.5-In. Shell Forgings

The mandrel shown in Fig. 1 is used on heavy 30-in. lathes for rough-turning, cutting off the open end and facing the base of 4.5-in. British high-explosive shells in one operation, using four tools. The output is 10 per machine per hour.

The body of the mandrel is of soft steel well case-hardened. The driving dogs are of hardened tool steel, and the sleeve and shell collar are left soft. The mandrel is driven by the square, which fits into the driver attached to the faceplate. The cutting-off and facing tools are both carried at back on a slide *B* and are operated by a cam plate attached to the carriage, as shown in Fig. 2. This cam plate works against a roller that moves the back slide forward the proper travel to face and turn the shell. The back slide *B* is carried on a strong frame *A* that straddles the carriage and is securely fastened to the ways of the lathe, as shown.

The two tools for turning the shell are held in a casting on the regular tool slide of the carriage and are set to a gage each time after grinding. The cutting-off and facing tools at the back are set in the same manner. One important feature of this outfit is that the stresses set up by the turning tools in front are balanced by those set up by the tools at the back. This construction

ing—conveying information. The draftsman's information to the machinist may have had many sources, but the drawing is the vehicle by which it is conveyed, just as the teacher's lessons are the vehicle by which knowledge is diffused among the students.

Yet we find, unfortunately, that much of the information given by the draftsman to the pattern maker and

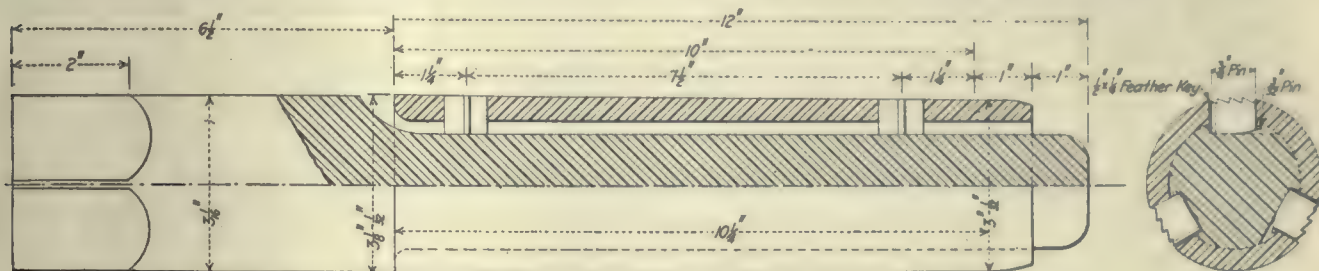


FIG. 1. MANDREL FOR HOLDING 4.5-IN. HIGH-EXPLOSIVE SHELLS

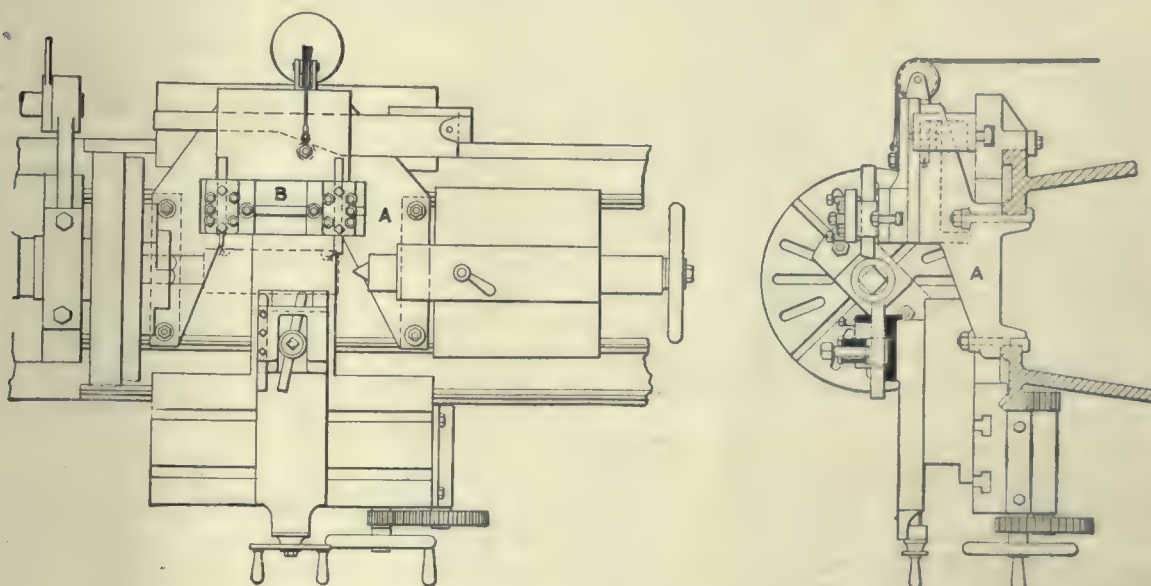


FIG. 2. DETAILS OF THE SHELL-ROUGHING LATHE

prevents the shell from being torn out of the center under heavy cutting stresses.

Another very important feature is using the cam arrangement for moving the back slide. There is no chance of destroying the tools or the mandrel by the operator's failing to throw off the lateral feed of the carriage at the proper moment, because as soon as the roller attached to the back tool slide arrives at the top of the incline on the cam plate, it remains stationary, as that is the limit of its travel, and the cam plate moves forward with the carriage without further moving of the back slide.

H. P. HOAG.

Brantford, Canada.

The Advantages of Machinist Draftsmen

Why do not more machinists become draftsmen? One would think it as natural and necessary for a draftsman to have been a machinist as for a teacher to have gone through the experience of being a scholar. The parallel drawn between the teacher and the draftsman is not so inapt as it at first appears. Both are instruct-

ing—conveying information. We see drawings of castings that cannot be cast, other drawings of castings that can be made at great expense with the combined skill of the pattern maker and molder. I feel ashamed of my own work in this respect. So often the pattern maker has pointed out how a piece can be more simply made without sacrificing any necessary feature. I thank the pattern maker, change the drawings and wish I knew more about molding.

The blunders made by draftsmen who are not machinists are more serious than those made by the draftsmen who are not pattern makers. A good pattern maker will always tell a reasonable draftsman what changes in a drawing will make the piece easier to mold. There his responsibility ends.

After a piece has been cast and found impossible to machine, the trouble is serious. It is as easy as ever to change the drawing, but that does not change the casting. This is where the machinist draftsman shows his value. His work, considered merely as a drawing, may be lacking in some ways; his developments of curves and intersections of surfaces may be defective, but the parts he has drawn can always be machined and usually in

an easy manner. Moreover, his views will not be crowded with dimensions that are of no earthly use, and the dimensions that are there will be given from surfaces that the machinist will measure from. No matter how many years' experience a draftsman has had, he will, unless he has worked in the machine shop, give some dimensions that are not necessary and others from surfaces that cannot be reached with ordinary measuring tools and must be figured from some other surfaces by the machinist himself.

The machinist draftsman has actually built machines. He knows how important it is to avoid interferences, how much allowance should be made for fits, what dimensions should be in decimals, which surfaces to machine and which to leave unfinished, what parts should be hardened and how hard they should be. The non-machinist draftsman either does not know these things at all or knows them only in a second-hand manner. His knowledge is confined to what he reads or to what men tell him, and the source of this information is the machinist. He is, in a manner, wearing the clothes the machinist has cast off. He can make a good picture. Granted; but the art of picture writing is not so difficult after all. The Egyptians did pretty well at that kind of writing, also the Indians. Moreover, the value of a drawing does not consist in the neatness of the work, but in the accuracy of the information.

The art of making a good mechanical drawing from information given is not difficult to acquire. The drafting work on a drawing does not call for one-tenth the skill and knowledge needed to build the machine. I should rather have on the "board" a man who has worked six years as a machinist and six months as a draftsman than one who has worked six months as a machinist and six years as a draftsman.

Leaving plain drafting and entering the field of design, the machinist draftsman has it all his own way. He can usually "see" in his mind just how the machine should be, before he puts pencil to paper. The drafting to him is only the working out of main dimensions, calculations for loads, velocities, areas and weights, the filling in of details and the arrangement of parts to avoid interference. In this field and especially in tool design the nonmachinist is so heavily handicapped that only the smartest men can hold their own. And I have found that even the clever men are left far behind in the matter of time. The man who has built machines in the shop, often without drawings, can build them in his mind at any time and place. He needs no paper and pencil except for memoranda.

Mr. Machinist, get into this field; you are needed.
Brooklyn, N. Y.

F. J. BADGE.

✱

Repairing the Smoke-Stack of a Destroyer

From time to time I notice descriptions in the *American Machinist* of schemes that have been tried and proved successful in repair jobs. I recently saw an account of re-forming a smashed pipe. In order to show to what extent the same scheme has been successfully carried the following experience may be of interest. In January, 1912, when the Atlantic fleet was maneuvering off the coast, a severe storm was encountered that scattered the fleet of destroyers badly. All had interesting tales to tell after

the storm was over and the fleet finally reassembled at Guantanamo Bay, Cuba. During the storm No. 4 smoke-stack on the destroyer I commanded was so badly smashed that we could not use the boiler. Such a job would ordinarily have been considered beyond the capacity of a destroyer's crew.

On our arrival at Guantanamo Bay the ship was secured alongside one of the docks, and a number of old $\frac{5}{8}$ -in. bolts were obtained. The heads of these bolts were finished bright, and a row of them was soldered in the bottom of the deepest dent in the smoke-stack. An old piece of $\frac{1}{2}$ -in. flat iron picked up on the beach was then drilled with a series of holes spaced to fit the positions of the bolts soldered to the stack.

After this piece of iron had been slipped over the bolts, nuts were put on all, forming a makeshift arrangement for transmitting a pull to all bolts simultaneously. A strap was placed on a pile on the dock, and a double purchase was led from the strap to another one secured to the flat iron bar. Four good seamen then hauled away on the purchase, and with the blacksmith tapping the metal adjacent to the bolt heads that part of the dent was pulled out.

The bolts were unsoldered from their position and shifted to one near-by and the entire operation repeated. A templet of sheet metal was cut to the curvature of a good smoke-stack and was used as a guide to re-form the smashed one. The job was completed after a few days' work, and then the inside casing of the stack was hammered out into place by lowering men down into the stack.

The re-forming was so neatly done that, when a coat of paint was applied, it was impossible to see that the stack had ever been injured.

J. F. HELLWEG,

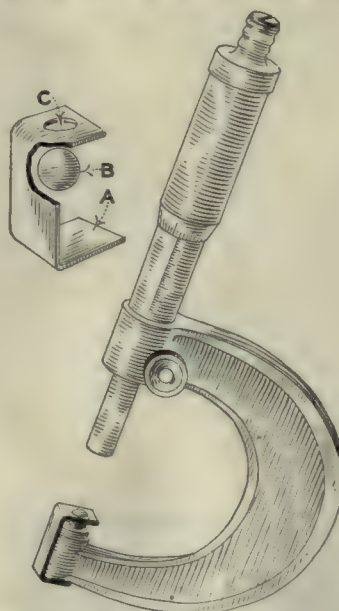
Lieutenant-Commander, U. S. N.

Indian Head, Md.

✱

Micrometer Ball Anvil

The illustration shows an attachment made of thin spring steel, for holding a ball on the anvil of an ordi-



BALL ANVIL MICROMETER ATTACHMENT

nary micrometer. If a $\frac{1}{4}$ -in. ball is used, the hole in the attachment should be 0.230 in. in diameter.

New Haven, Conn.

ERIC H. SUNDKVIST.

Discussion of Previous Question

Finding Surface Speeds for Machinery

Mr. Josselyn's plan on page 854, Vol. 44, relating to surface speeds for machining, is very interesting and relieves the operator of some of the trouble of figuring speeds. However, for checking by the foreman the machine must be stopped and the calculation made. This takes time and would not be satisfactory to either the foreman or the workman.

In teaching lathe work I find the accompanying table very convenient and satisfactory in getting the students to use the proper speeds. This table was made large enough to be easily read 20 ft. away.

As the diameter of the work can be judged closely enough without measuring, a glance at the speed table and the machine speed tells instantly whether the speed

CUTTING SPEEDS FOR 13-IN. WILLARD LATHE

Revolutions of Lathe Spindle per Minute

Cone	First Back Gears		Second Back Gears		Direct Connected	
	Slow	Fast	Slow	Fast	Slow	Fast
1	32	40	90	108	265	315
2	48	56	124	150	380	460
3	68	82	176	220	535	650

Cutting Speeds in Feet per Minute, $\frac{1}{8}$ -In. Depth of Cut

	Material			
	Cast Iron	Soft Steel	Hard Steel	Brass
High-speed tool steel...	35	40	25	65

Revolutions per Minute for Above Cutting Speeds
(Use $\frac{1}{2}$ of these speeds for carbon-steel tools)

	Diameter							
	$\frac{1}{2}$	$\frac{3}{4}$	1	$1\frac{1}{2}$	2	$2\frac{1}{2}$	3	5
Cast iron	268	178	134	89	67	53	45	33
Soft steel	306	203	153	102	76	61	51	38
Hard steel	191	127	95	63	48	38	32	24
Brass	497	330	258	165	124	100	83	62

The cutting speed is governed principally by the hardness of the metal to be turned; the kind of steel of which the turning tool is made; the shape of the tool and its heat-treatment; the feed and depth of cut; the cooling medium used, if any; the power of the machine; its design and condition. As a general rule the tool should stand up from 1 hr. to $1\frac{1}{2}$ hr. before regrinding.

is right or not. The workman has no excuse for not running at the right speed, and the foreman has no difficulty in checking the speeds.

Where a number of makes of machines are used, these speed tables could be hung directly over the machines. The speeds on the table are slower than regular shop practice, but are fast enough for beginning students.

S. V. BRYANT.

Seattle, Washington.

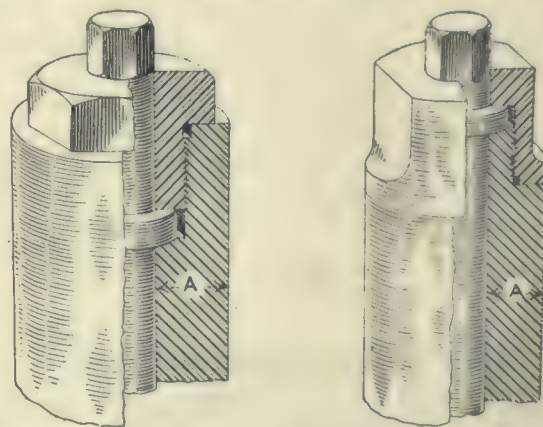
Best Way To Do Certain Things

In my opinion both Mr. Herz, on page 297, and Mr. Poland, page 35, Vol. 44, have missed the best way to discharge collets and cutter shanks from spindles. Taking Mr. Herz's case first and referring to the drawing on page 297, it is clear that the whole thrust to push the cutter out is taken by the point of the small setscrew that fits in the split ring. This is hardly good design.

Mr. Poland's differential-screw arrangement of the drawbolt is powerful, but crude. It also possesses the disadvantage of having the threads directly in the spindle,

and these threads are subject to wear. Owing to the possibility of getting a big pull on the cutter when drawing it up, the pressure on these threads is considerable.

Suppose now that instead of either of the methods previously submitted those shown in the sketches are studied. These arrangements are free from the objections of having small wearing surfaces or screw threads working directly in the machine spindle. The drawbolt, on being backed out of the shank, moves up against the cap or thrust nut, since the thread on this is the opposite hand to that on the drawbolt. The cap or thrust plug tends to get tighter on the main spindle, and the drawbolt



FIGS. 1 AND 2. DISCHARGING CUTTER SHANKS AND ARBORES FROM SPINDLES

pushes the cutter or shank out. Should the cutter stick, a light rap on the head of the drawbolt will always loosen it after the drawbolt has been backed up so as to exert a discharging force. This light rap may be given with the wrench used for tightening or loosening. When there is ample metal at dimension A, the design shown in Fig. 1 is used; when there is not much metal at A, Fig. 2 is used.

On set-ups where the tools have to be constantly changed, either one of these methods has conclusively proved good.

ROLAND V. HUTCHINSON.

Ironton, Ohio.

Some of the Troubles of a Small-Shop Foreman

I was interested in the remarks of Mr. Billton, on page 860, Vol. 44, on the troubles of a small-shop foreman. This is the line of talk you hear from about 75 per cent. of foremen—namely, that the management seems to take pleasure in refusing to buy things that are necessary. Now you will notice that some foremen in all shops seem to get about what they want. If you will examine those cases, you will find that those men use a great deal of tact and diplomacy when they ask for any new machine for their department, backing up their requests with logic that appeals to the "Old Man."

On the other hand, the undiplomatic foreman goes without something he needs until he has developed a good

big grouch. Then he goes at the "Old Man" with a club. If the foreman does not get what he wants he generally says, "Well, do as you — please about it; I can stand it if you can." Most managers are human, and I have never yet found one that would not, if properly approached, grant a request or else give a perfectly satisfactory reason for not doing so.

One thing I have noticed—the "Old Man" has pretty good judgment, which is borne out by the fact that he is where he is.

WILLIAM SUNDAY.

Rochester, N. Y.

❧

Laying Out Blanking Dies

Referring to Fig. 5 of the article by W. B. Greenleaf, page 896, Vol. 44, I believe stock may be saved if the strip is simply turned over and run through the second time,



A SUGGESTION FOR SAVING STOCK

as shown herewith. It may be that the grain of the stock would render punching, as shown on the edge of this sheet, undesirable; but this point is not clear from the article.

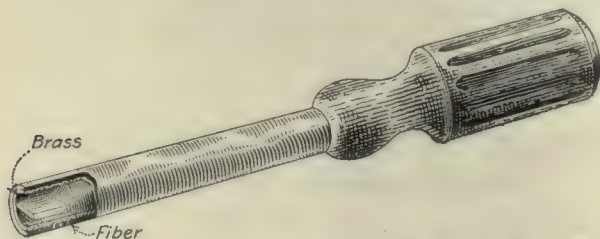
F. B. RIVES.

Hartford, Conn.

❧

Magnetic Screwdriver

Bridgeport, from where James McIntyre writes about a magnetic screwdriver, page 729, Vol. 44, has been the birthplace of similar tools. About six months ago, while there on an outside job, the men with me made several such tools, their first being practically like Mr. McIntyre's. It did not come up to expectations. The exposed contact sometimes caused the circuit to be closed accidentally when the screwdriver lay around, and this put the battery cell out of commission. The hard-steel bit, after being magnetized, retains a certain amount of magnetism and is soon transformed into a permanent magnet. The screws



A MAGNETIC SCREWDRIVER

stick to the bits at undesirable places and at undesirable moments, causing considerable trouble and annoyance.

The men afterward made up very heavy bits and held them in a wire coil under current, tapping the bits slightly, to speed the magnetizing process. To prevent the screws from sticking to the sides of the now permanently magnetic bits, these were covered with a fiber tube, which was strengthened on the inside by a brass tube, as shown in the illustration. An iron tube on the inside

proved to be a failure, as the magnetic flux then did not pass through the point of the screwdriver, but came out of the edge of the iron tube.

Taught by experience, I have personally not much use for magnetic screwdrivers and think a chunk of beeswax on the head of the screw as good as anything.

Brooklyn, N. Y.

JAN SPAANDER.

Mr. McIntyre's magnetic screwdriver, on page 729, Vol. 44, reminds me of a kink that I have used where I have had difficulty in placing screws with my fingers on account of limited room. By simply drawing a common screwdriver across a magnetic chuck two or three times with the switch thrown in I have placed screws as large as $\frac{3}{8} \times 1\frac{1}{2}$ in. Of course, I placed a piece of thin cardboard on the chuck before drawing the driver across, so as not to scratch the face of the chuck.

Speaking about magnetic chucks makes me think of another kink that perhaps is not commonly known. In grinding close work sometimes a piece will come 0.0001 in. or so thin on one end. This can be remedied by making a line with a soft lead pencil under the thick end of the work on the chuck.

J. C. STUART.

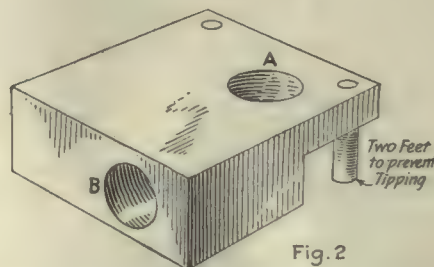
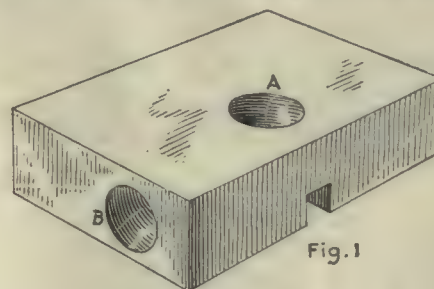
Hartford, Conn.

❧

Drilling Central Crossholes in Round Bars

Will Mr. Dawson, who on page 857, Vol. 44, described a method of drilling central crossholes, tell how he overcomes the difficulty caused by the drill, when it breaks through, pushing out some little chips of metal, making it hard to withdraw the work. In a similar case both the hole and the work were badly scored.

I would suggest a slight improvement. Simply cut a groove under the hole A to admit a file to remove the chips, as shown in Fig. 1. This jig would be more useful



IMPROVED METHOD OF DRILLING CENTRAL CROSS HOLES IN ROUND BARS

if the holes A and B were made large enough to accommodate standard slip bushings, the hole B to receive a bush at each end; or the jig could be made as at Fig. 2, with one bushing only, at B, supporting the work.

Manchester, England.

FRANCIS W. SHAW.

Successful Suggestion System

I read with interest Mr. Tewksbury's article on a "Successful Suggestion System," and I would say that he owes his success with the system to the advertising that he carried on in connection with it. It is one more proof that advertising pays. He begins by saying that he has had 15 years' experience with unsuccessful suggestion systems. Would it not be of interest to the readers of the *American Machinist* to hear of some of his failures?

I am wondering what kind of success Mr. Tewksbury would attain if he gave a certain per cent. of the savings the employee had made instead of tokens such as watches and rings. Understanding human nature as I feel I do, I cannot see how anyone can make a suggestion that will save \$6,700 in one year (Mr. Tewksbury's figures) for a firm and be satisfied when he is handed a watch or a ring for so doing.

Of course, these tokens are nice things to have, but after all it is money we most desire. The eagerness to acquire money will make a man think when everything else fails.

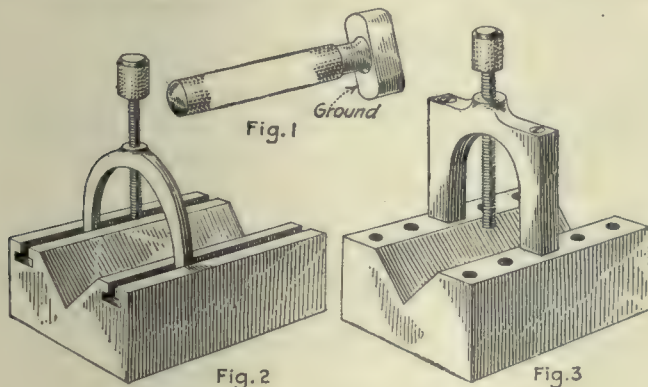
J. C. STUART.

Hartford, Conn.

✱

Making and Testing a V-Block

Making and testing a V-block as described by Mr. Remacle, page 717, Vol. 44, is a good method, but I would suggest a change in the design if it is to be used on precision work, as it is often desirable to grind two or more sides at the same setting—for instance, a gage like Fig. 1. This could not be ground in the block described without chang-



THE WORK AND THE TWO V-BLOCKS

ing the setting, which would give a chance for error. After discarding this kind of block we made one like Fig. 2. We then found that tightening the screw even with the fingers caused distortion enough to show an error in the work ground. So this was also discarded, and a block as shown in Fig. 3 was made. No difficulties have been experienced since.

J. C. STUART.

Hartford, Conn.

✱

Inspection of Castings

I am led to ask a few questions after reading the article by Mr. Nourse, page 648, Vol. 44. He says: "All castings must check reasonably close to the dimensions on the drawings." Having had some experience in the way that officials draw up specifications to govern the supply and inspection of materials, etc., for a government de-

partment, I have noticed how excessively fond they are of the words "reasonable" and "reasonably." In one such specification, which consisted of only three short paragraphs, the words appeared no less than eight times.

Now this may do for a government department, but I consider that such terms as "reasonably close," which are as meaningless as "dead accurate," could be eliminated with advantage from the vocabulary of a live inspection department. If not, then we need not go to the trouble of fixing limits on any of the work. We can simply figure up, say, a shaft as being $1\frac{1}{4}$ in. in diameter "reasonably close"!

We have, however, been brought to see that a variation may exist between pieces of work without being detrimental to the function of the pieces, and these variations are now expressed in definite terms. This being so, why not express in the same definite terms the variations that may exist in castings?

The great drawback to "reasonably close" as a definition is that it will vary very largely according to the health, temper or environment of the individual inspector. Therefore it is not a standard. My advice is to drop "reasonably close" and come to some agreement as to the allowable limits and fix these on the drawings. If this is done, then the inspection of either rough castings or finished work will be put upon a scientific basis.

Guildford, England.

WALTER G. GROOCKOCK.

✱

Blueprints Without Tracing

On page 960, Vol. 44, Mr. Sharkey mentions the disadvantages of drawings made with a soft pencil on thin bond paper. Such drawings are satisfactory for blueprinting and are frequently called for when the drawing is considered to be of only temporary value. However, all such drawings should be carefully preserved and may come into use many times. For this reason it is well to render them permanent by treating the penciled surface with "fixatif" such as is used by crayon artists. This can be purchased at any store handling artists' materials and is applied with an atomizer. One with a mouthpiece is much preferable to those having a bulb, as the latter are liable to become stopped after considerable service. The application of "fixatif" overcomes all the objections cited by Mr. Sharkey. A slight amount only is required, a few drops being sufficient for treating a large drawing. If the commercial "fixatif" is not available, denatured alcohol with a little shellac dissolved in it will be found to be a satisfactory substitute.

On pencil drawings it is the dimensions that are most easily obliterated or rendered uncertain. These should in all cases be made in ink, to secure permanence. It is well also to make the witness marks in ink to insure a correct interpretation of the dimension figures.

Letter-size pads of thin bond paper are convenient for small drawings and for sketches such as are required for repair jobs, simple tools or minor alterations to the plant. On such pads a suitable printed title blank costs but a trifle. It not only adds to the appearance of prints that are sent outside the factory, but is of value in properly indexing the sketches for future reference. In making such pencil sketches it will be found that a large part of the work will be done freehand and the services of a draftsman, in many cases, will be entirely unnecessary.

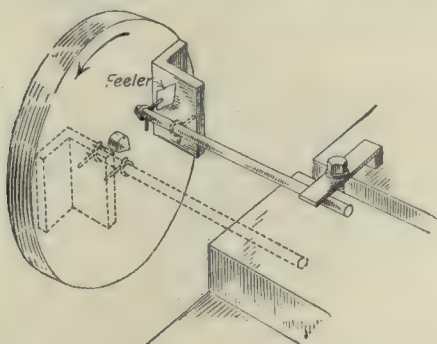
Barberton, Ohio.

FRED B. COREY.

Setting Angle Plates

On page 884, Vol. 44, is shown a method used in small shops for setting angle plates square with the axis of the lathe. But true mandrels or arbors are rare in some shops, and other means must be resorted to.

Fig. 1 shows how to set an angle plate true on a faceplate of an engine lathe. The position can be anything from zero to maximum. All that is required is a boring



SETTING ANGLE PLATES

bar with a piece of wire, or anything inserted that will not scratch or cut the angle plate.

The angle plate is bolted in approximate position. The boring bar is brought to touch at the front and rear. The faceplate is then rotated one-half revolution, the cross-slide moved forward and tried at opposite points. A paper feeler should be used. The angle plate should be counterbalanced during truing, but this is not shown, for the sake of clearness.

G. STROM.

Brooklyn, N. Y.

Design of Holding Jaws

In answer to Mr. Beuter's article on page 1002, Vol. 44, in regard to "hold-downs" I will give the benefit of my experience, as I have used both kinds.

In practice, unless the angle on the contact surfaces is too great, the difference in the holding or downward action of the two styles is so small that it would be hard to tell which is better.

I always preferred the one illustrated in Fig. 1, with the angle on the jaw side only, as there is always a possible chance of the one in Fig. 2 sliding under the work and raising it slightly before the downward movement is started. Of course, if the hold-downs are blocked up so that they do not grip the piece at the bottom, this objection is overcome.

HAROLD E. GREENE.

Ilion, N. Y.

Side Shields for Emery Wheels

I have read with interest Mr. Jacobs' answer on page 780, Vol. 44, to my letter, which appeared on page 606, about grinding on the side of an ordinary wheel, and I am glad to see someone at last give a reason for not using the side of a wheel.

Of course, it is very true that, if the speed is right for the edge, it will not be the best speed for the side. In manufacturing where the grinder is being used all day on the same kind of work, it would be foolish to use the side of an ordinary wheel where a cup wheel or a disk would be better.

In using an ordinary grinder, however, either in the toolroom or job shop, convenience outweighs speed of actual grinding. Easily two-thirds of the time of the grinder is taken up in grinding lathe and shaper tools. A man who sharpens a tool will spend probably 90 per cent. of his time in removing and resetting his tool, walking back and forth, and waiting his turn at the wheel. When he is actually at the wheel, he will give half his time to looking at the tool to see, if the shape is right and in cooling it, so that the percentage of time devoted to removing metal is very small and the efficiency, within pretty wide limits, is of no consequence. On the other hand, he can more easily get the shape he wants and more readily see what he is doing if he is free to use both the side and the edge of the wheel.

Even if there were an ordinary wheel running at its best speed and a cup wheel 3 ft. away, also running right, I believe I should stick to one or the other and save time doing it in grinding a lathe tool.

Of course, under these ideal conditions if I had a small die to grind I should go to the cup wheel. But if the cup was in use, it would be quicker to use the side of the ordinary wheel than to wait.

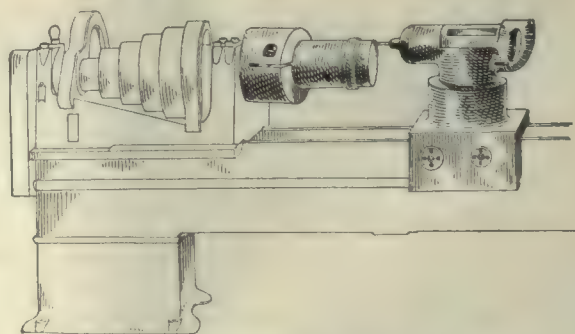
As a matter of fact, however, these ideal conditions do not exist in the job shop or toolroom. The new wheel is usually 8 to 12 in. and is allowed to stay on the machine until it is not much larger than the flanges. The men are lucky if the speed is right, for either the edge or side, at any point of the wearing-down process, and it is just about as apt to be right for one as the other.

Plymouth, Mich.

W. B. GREENLEAF.

Increasing Base Diameters of Shells

The illustration shows a pneumatic hammer mounted in a special carriage of a lathe and used for upsetting the bases of shells that have been turned too small. One shell



INCREASING BASE DIAMETERS OF SHELLS

shop, where there were a number of undersize shells, is reclaiming them in this way. Shells as much as 0.005 too small are upset to size and cleaned with a file.

Chicago, Ill.

W. DAVIS.

The Iron-Ore Production of the United States in 1915 reached a total of 55,526,490 tons, according to the figures collected for the United States Geological Survey and prepared by E. F. Burchard. This was an increase of about 14,000,000 tons over 1914 and was a larger production than in any previous year except 1910 and 1913. The average value at mine, as computed by the Survey, was \$1.83 per ton in 1915, against \$1.81 in 1914.

Editorials

Run Up the Flag

Recently an editor of the *American Machinist* while visiting a shop in New England inquired of the owner what he intended to erect as the next addition to his plant. He replied, "A flagpole." Sure enough he had ordered a spiral riveted steel pole and was anxiously awaiting its arrival so that he might erect it and run up the Stars and Stripes.

To most American manufacturers—a few there are undoubtedly who are beyond the power of being influenced by anything save money or self-advancement—the American flag is a symbol whose presence cannot fail to influence toward the development of best ideals. It is the patriotic shop owners, however, who form the bulwark of industrial defense, and from what the *American Machinist* has observed during the last year or two this bulwark in time of need would indeed be a strong one.

One of the regrettable things about our large cities, and possibly New York in particular, is the absence of our country's flag. Here are hundreds of tall buildings, surmounted by hundreds of tall flagstaffs, most of which seem to have been placed there for no evident purpose. It is rare, except on special holidays, to be able to count two dozen flags over the business heart of New York City.

Possibly this is owing to carelessness, or rather thoughtlessness. Let us think so at any rate. Then, again, it may be because of a lack of organization or "preparedness" that includes in someone's daily routine the task of putting up the flag. American machine shops, however, are places where routine is a matter of course, and in every shop there is a man with enough time to spare for this daily pleasant duty. All that may be lacking is the flag and its staff, and unlike the delayed deliveries on machine tools, there has been no such excessive demand for these articles as to prevent one from getting either of them at once.

It is a good thing to "hitch your wagon to a star," but it is a still better thing for American manufacturers to hitch their shops to the Stars and Stripes. Get busy and see that the new addition to your shop is erected at once, and that the good old flag goes up to stay.

✕

The Metric System--Compulsion and Propaganda

In a recent letter a correspondent asked the *American Machinist* to define its position clearly in regard to the metric system of weights and measures. We had not realized that there was any possibility of misunderstanding or misinterpreting the comments in these columns that have dealt with some of the phases of the metric propaganda and proposed metric legislation. On the contrary, we believed that our utterances were so plain spoken that their meaning was unmistakable. However, if one reader has been at a loss in trying to comprehend our position,

another attempt must be made to clear up the situation.

The *American Machinist* is not opposed to the metric system. It has the same legality as the older English system of weights and measures. Anyone who wishes to use it in preference to another has this full right, and to this right there can be no objection.

But the *American Machinist* is opposed to each and every effort that tries to make the metric system compulsory and exclusive throughout the United States. The *American Machinist* is also opposed to the active prometric propaganda that seeks to overthrow our present English system. This effort at education is really an effort to injure and hamper American industry. Stated somewhat more affirmatively, the *American Machinist* believes in the maintenance and improvement of our present system of weights and measures, knowing that this will bring nothing but good to the industry and commerce of our great country. We also believe that the public should be educated in regard to the importance of the subject of our weights and measures. We believe further that sane legislation should be promoted seeking to conserve our basic English units.

There is no question as to where the interests of the manufacturer lie. In fact, the metric controversy in this country can be said to be between men who measure in order to produce articles from raw materials and those who measure existing things in order to make a record of dimensions. It is a conflict between the engineer and manufacturer on the one hand and the scientist and pseudo-scientist on the other.

✕

On a Naval Repair Ship

It is believed that the first voyage ever made by a technical correspondent on a United States naval vessel has recently been completed by Frank A. Stanley for the *American Machinist*. His first article is in this issue. This journey on a floating machine shop began at the Mare Island navy yard, California, and ended at New York. The kindness of Navy Department officials and navy officers made this trip possible and afforded means of studying at first hand how machine tools act when set on the moving deck of a vessel at sea, and the nature of emergency repairs to naval equipment.

The machine-tool designer always thinks of his finished machine as set up on a rigid floor or substantial foundation, carefully aligned and leveled, and given all the advantages of a fixed position when called upon to do accurate work. It probably never occurs to him that a machine tool may be set on the pitching, rolling deck of a vessel and be required to do good work under such conditions. It is possible that if those unusual surroundings were fully understood there might be modifications in design from those that are now common.

To be sure, not many machine tools are bought for use at sea. However, it is not uncommon for a manufacturer to point with pride to the fact that his particular product

has been selected for such service. It is therefore justifiable to present the query, What steps have manufacturers taken to adapt their machines for use on naval repair ships and for similar purposes?

What is the angle of repose of the slides of machine tools as ordinarily designed and tightened? Will they move of themselves if tipped at an angle of 15 deg. or more or less? How nearly accurate holes will a lathe or boring mill bore when it is being pitched about on a deck in a heavy sea? Are machine tools strong enough to resist the inertia strains brought upon them if thrown about when at work? Are the ordinary fastening devices for work substantial enough in design and ample in number to withstand the inertia forces set up on shipboard?

In future articles Mr. Stanley will attempt to answer some of these questions.

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What Makes an Engineer?

At the recent Virginia meeting of the Society for the Promotion of Engineering Education, Dr. C. L. Mann, of the Carnegie Foundation, made a preliminary report for the Joint Committee on Engineering Education. A digest of part of this report appears in this issue, taking up the statistical summary of replies to a questionnaire on the reasons for engineering success.

The figures given in this preliminary statement are well worthy of study, for on a percentage basis they rate character at 24, judgment, 19.5; efficiency, 16.5; understanding of men, 15; knowledge of fundamentals, 15; and technique, 10. That is, the purely technical equipment of the trained engineer is placed at only 25 per cent. of the necessary qualifications for his success. The other 75 per cent. includes those qualities of mind and character that are the possession of every truly successful man.

This does not, however, imply that a 100 per cent. possession of the mentioned characteristics of mind and moral nature will make a successful engineer. It does rather mean that a 100 per cent. possession of those characteristics is 75 per cent. of the engineer's needful equipment. The other 25 per cent., including the specific knowledge of his profession, is of course as essential as the others. But a 100 per cent. rating in the latter forms only 25 per cent. of the necessary equipment for success in engineering work. Turning now to other features of the report, the dominant elements are as follows:

1. The present system of engineering education is a development based upon the industrial progress and the industrial needs of the country.

2. Just as industry is progressing from a stage where material equipment marked the highest degree of excellence to the present stage in which the human element in production takes a dominant part, so it is true that the demand for the best results in engineering makes necessary the development of the human element in those who practice.

3. The school records of men graduated recently from representative institutions indicate mediocre attainment in the fundamental subjects, although their subsequent work in practice may be counted upon as being reasonably good. Whether this means poorly taught subjects or the relative unimportance of a knowledge of engineering fundamentals does not appear.

4. There are indications that the schools give major attention to the training of students in engineering science, to the exclusion of training in other characteristics that are greatly involved in the successful man's career. In this comes the great constructive problem as to how the schools may develop methods that will result in a more adequate preparation for professional work, but beyond indicating the character of the problems the investigation as conducted cannot go.

At a later date a final report will be made, and it is hoped that the knowledge gained from the investigation can be put into practical use in the engineering schools. Obviously it is to the advantage of technical educators to know just what is wanted in mental and moral equipment to make a successful engineer before trying to direct a school to meet those wants. Let us hope that one result of the study will be to modify technical educational methods so that future cadet engineers will not be tied and gagged by the precedents of what they have been taught.

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Making Shells with Regular Shop Equipment

While it is undoubtedly true that special single-purpose machinery affords the most economical methods of manufacturing if the quantity be sufficient to warrant such an installation, there are comparatively few shops that manufacture in this way. And it is probably well that this is the case. The average shop, with its more or less standard equipment, gives a flexibility as to the goods that can be manufactured, which has many advantages. This feature is especially desirable in such emergency manufacturing as the making of shells and similar munitions.

The ability to adapt the standard machines already in a shop so that they can make a new product at a low cost is of great importance and shows a high grade of practical mechanical knowledge. Such a possibility is particularly valuable in emergencies like the making of shells and other munitions of war, as hundreds of small shops are thus able to begin work promptly and to secure a constant flow of munitions with little delay. It is for this reason that we consider the methods described on page 1077, Vol. 44, of special significance.

It is believed this article will prove helpful in shops of all sizes not equipped with special machines, and few will be after present war contracts are filled. A careful study of these methods may well be a part of the preparedness program of small shops in all sections of the country.

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The prediction of the preparedists that in case of war in this country there will be a great scramble for material seems to be coming true. Emergency specifications are being sent out and bids demanded almost at once. Some of those that have interested machine-tool and small-tool builders have called for large quantities of engineering material including hardware, trenching tools, surveying and drawing instruments and the like, and also 36 complete motor-truck machine shops. The latter is of interest to men in the shop, for it purports to be a complete list of everything needed for a small repair shop. Its extent can be imagined from the fact that the equipment specifications alone cover 5½ pages of legal-size paper including 103 items.

Shop Equipment News

Self-Contained Grinder

The illustration represents a recent addition to the line of self-contained grinders manufactured by the Modern Tool Co., Erie, Penn. In addition to the size shown, the machine is made in an 8x30-in. size.

The bed is a one-piece casting, braced to insure stability. It is of compact design, and the units are so located as to be easily accessible. To maintain alignment of parts, V and flat guides are used throughout, on the sliding table, swivel table and under the wheel stand. The base rests upon three points, designed to prevent

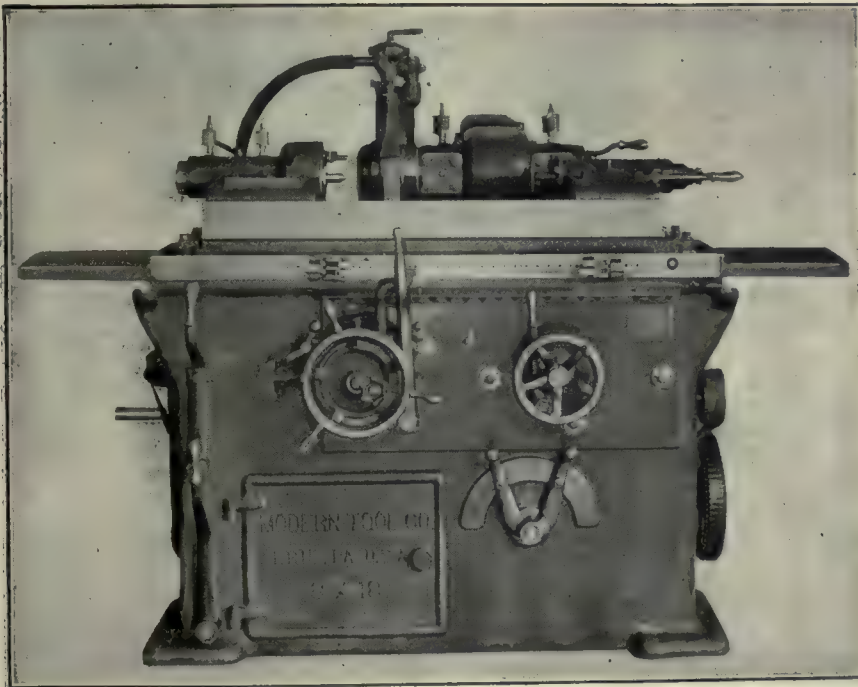
transmission. All-steel spur gears are used for the reversing mechanism. The power table traverse is controlled by a lever immediately at the left of the table handwheel, which provides for starting or stopping the table at any point in its stroke. When the table is under power, the handwheel is automatically disengaged. When power is removed, the handwheel is automatically engaged for traversing the table by hand. There are four table feeds, derived from a single-unit gear box and controlled by a lever at the right immediately below the table handwheel.

The automatic crossfeed is positive in its action and is simplified without losing any of its features. It can be set for a reduction of any amount from 0.0005 in. to 0.005 in. at either or both ends of the table reverse. This latter feature is especially advantageous when grinding against a shoulder. The feed is automatically thrown out when the work is ground to size, and a positive stop is provided for feeding by hand. The crossfeed handwheel is graduated in 0.0005-in. divisions in plain view of the operator. Adjustment of the crossfeed is made by the movement of a lever to the amount of feed desired, as indicated on a graduated dial plate, and may be instantly changed to any feed while the machine is in operation.

The headstock is driven from a shaft under the sliding table. This shaft is driven by a pulley, which is carried in a bracket on the bed, on which the power is taken from the gear box. The shaft under the table is splined its full length for the ball driver, which is contained in the pulley mounted on the bed. These balls

not only drive the shaft, but are also designed to reduce the friction in the traversing movement. The headstock is driven from this shaft by a belt that runs over an idler pulley and gives a large surface of contact to the headstock pulley. The belt drive is designed to provide a smooth movement to the work and to eliminate chatter. The headstock is fitted to the swivel table by means of V and flat ways and is held in position by clamp bolts. The headstock spindle is hardened and ground and runs in bronze bearings adjustable to wear. It is lubricated by means of sight-feed oilers.

A feature of the headstock is the combination of live and dead centers. The spindle is carried in bearings in the headstock base, in which it revolves for live-center work. The faceplate is clamped to the spindle, and the spindle revolves in the headstock bearing for live-center work. To change for dead-center work, it is only necessary to loosen a screw that clamps the face-



SELF-CONTAINED CYLINDRICAL GRINDER

Size, 8x18 in.; wheel spindle, 2 1/4 in. in diameter; driving belt, 4 in. wide; eight work speeds, 26 to 390 r.p.m.; four table feeds, 22 to 104 in. per min.

cross-strain, preserve the alignment and provide for irregularities in flooring.

The wheel-stand pile is bolted to the bed of the machine and is of heavy proportions. The wheel stand is held in place by gravity, but is provided with a safety gib to guard against danger of lifting under abnormal conditions. The wheel center is of large diameter, has a long bearing on the spindle and will take any of the recognized standard grinding wheels.

The table slide is of heavy proportions and ribbed to resist torsional strains. The swivel table has a large bearing on the table slide and pivots on a large central stud. The table provides for grinding tapers and is graduated to read taper per foot in inches. The table drive is of a simplified type, eliminating what was formerly known as the table transmission. This table drive consists of a single unit, contained in the bed of the machine, which is a combination of table drive and

plate to the spindle and tighten the clamp on the headstock, which holds the spindle firmly in the headstock base. The dead-center pulley is then free to revolve upon its bearing for dead-center work.

The footstock is fitted to the swivel table and preserves its alignment in the same manner as the headstock. The footstock spindle is held in any position by a spring, or it may be set positive against the work and locked. The work centers on the headstock and footstock are directly over and between the guides of the table.

The wheel-truing device is mounted on the footstock and is adjustable to all diameters within the range of the machine, so that the wheel can be trued without removing the work from the centers. All work speed and table feeds are controlled by levers on the front of the machines and are derived from a separate-unit gear box that in addition to occupying a small space is so located as to be easily and readily inspected.

Vertical Continuous Millers

The illustrations show two continuous millers recently developed by the Becker Milling Machine Co., Hyde Park, Boston, Mass. In general these machines follow the design and construction of the high-powered continuous miller built by the same concern, which was described in detail on page 1101, Vol. 41.

The single-spindle machine shown in Fig. 1 is exceptionally heavy and is designed for the production of large work at high speeds. The two-spindle machine is used for the continuous milling of such work as connecting-rods for gas engines. The work is mounted in

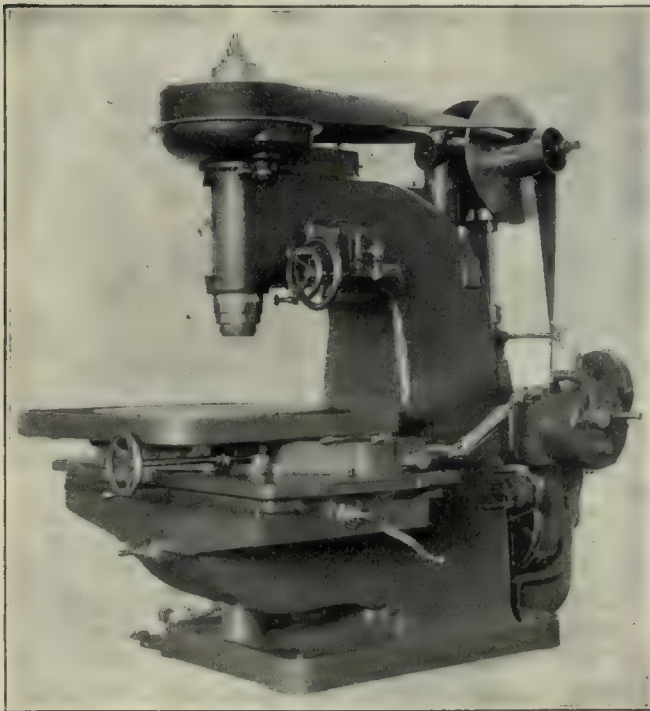


FIG. 1. HEAVY CONTINUOUS MILLER

Table diameter, 40 in.; one central T-slot and three at right angles to it; driving pulley, 25 in. in diameter; height overall, 100 in.; floor space, front to back, 93 in.; length, 118 in.

work is of course placed and removed while the table is in motion. With a proper equipment of accurate jigs, highly accurate work can be produced. The production time varies between comparatively wide limits, small pieces being finished as quickly as they can be placed and removed by the operator.

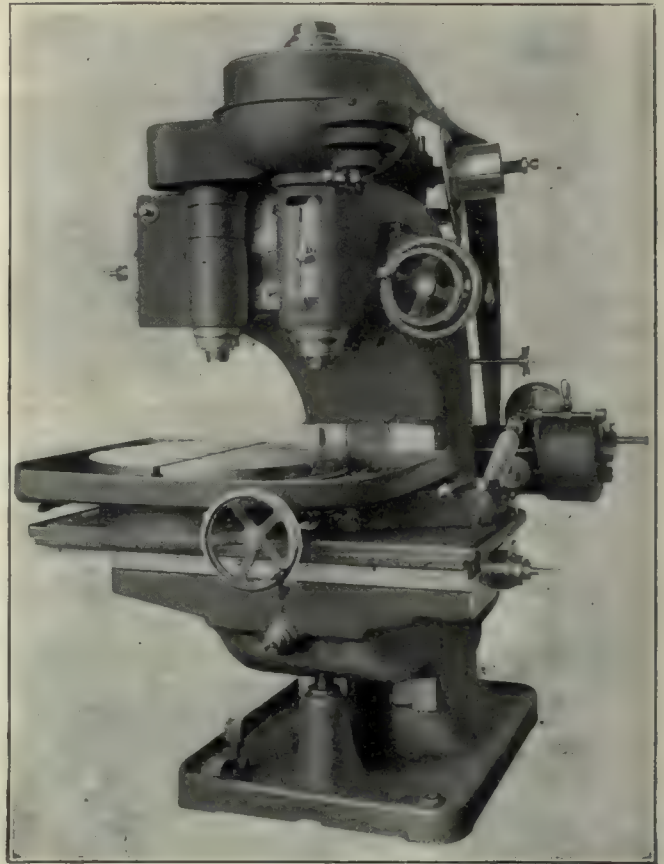
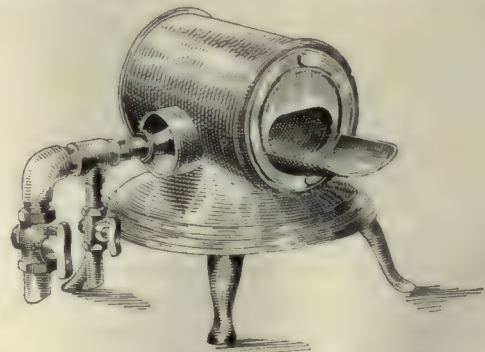


FIG. 2. SPECIAL CONTINUOUS MILLER

Table diameter, 29 3/4 in.; one central T-slot and three at right angles to it; driving pulley, 20 in.; spindles center to center, 8 1/2 in. minimum, 18 in. maximum; height overall, 90 in.; floor space, 91 1/4 in. front to back; length, 77 1/2 in.

Gas-Fire Pot

The gas-fire pot shown is a recent product of the Tirrill Gas Machine Lighting Co., 103 Park Ave., New York City, and is large enough to accommodate two soldering



GAS-FIRE POT

suitable fixtures on the rotary table, which is off center from the spindle. Each spindle carries a pair of straddle cutters properly spaced to straddle-mill the wristpin and crank ends respectively of the connecting-rods. The

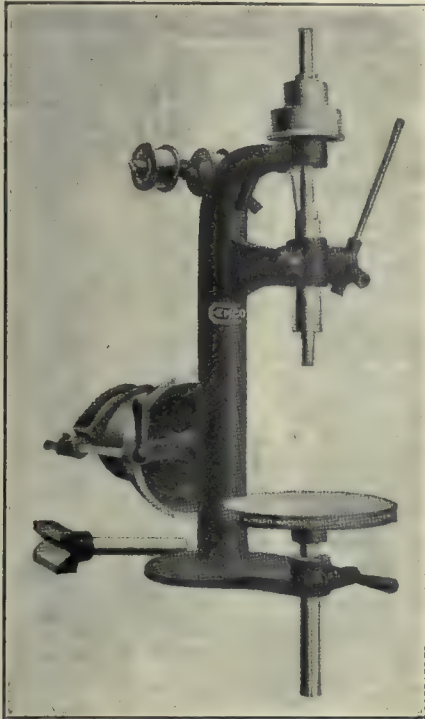
coppers, weighing 6 lb. each, while the pot is equally well adapted for the smaller-size coppers.

The pot can be operated on all kinds and grades of gas, with or without valves. It may be used as an atmos-

pheric burner or under air pressure, from a blower or other air supply. The whole pot is constructed of cast iron with a heavy sheet-iron outer jacket. The intensity of the heat is under minute control through a Rose heating burner.

Bench Drilling Machine

The design and construction of this bench drilling machine are made apparent by the illustration. While designed primarily for tool and experimental work, the



BENCH DRILLING MACHINE

Distance of spindle to table, $8\frac{1}{4}$ in.; movement of spindle, $3\frac{1}{4}$ in.; movement of table, 4 in.; diameter of table, $7\frac{1}{4}$ in.; swing, $9\frac{1}{4}$ in.; capacity, $\frac{3}{8}$ in.; speed, 1,500 to 5,000 r.p.m.; height, 26 in.; weight, 48 lb.

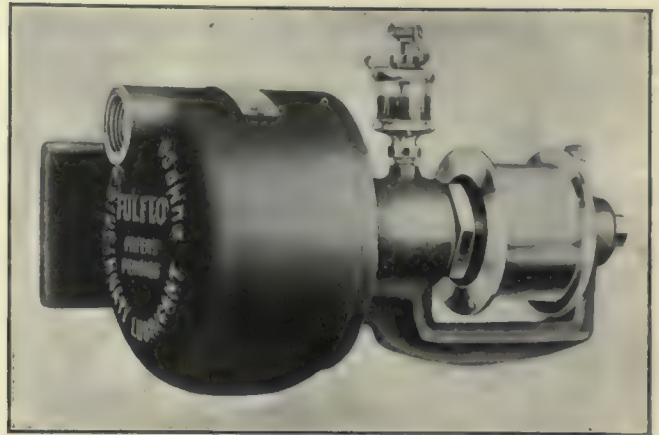
machine is believed to be suitable for a variety of light manufacturing operations. The machine is made by the Enterprise Machinery Co., Chicago, Ill.

Grinder Pump

The grinder circulating pump shown is centrifugal in action. Although smaller than the submerged fan type of pump commonly applied to grinders, it is claimed to deliver a greater volume.

It may be mounted above the level of the liquid and because of its positive trap arrangement will retain its prime without the aid of a check valve or other working parts. This form of pump has no bearings in the pump proper. The impeller, the only working part in the pump, is mounted on the driveshaft. The absence of gears or other close-fitting parts renders harmless the grit and dirt present in the grinding fluid.

The driveshaft is hardened and ground, running in bearings on both sides of the drive pulley. The outer bearing, which also takes care of the end thrust, is of phosphor bronze. The inner bearing, which is combined with the stuffing-box gland, is of cast iron. This inner bearing is protected from the emery grit and dirt by the



GRINDER CIRCULATING PUMP

Capacity: Flow per minute at pulley speed of 1,200 r.p.m., 5 gal.; at 1,400 r.p.m., 10 gal.; at 1,600 r.p.m., 15 gal.

ample use of a combination of metallic, graphite, rubber and flax packing.

The pump shown is a recent product of the Cincinnati Lubricant Pump Co., Cincinnati, Ohio.

Counting Machine

The form of counter shown was designed for application to all classes of machinery. It is of all-steel construction, with large bearing surfaces. As the parts are made from sheet steel formed by dies, interchangeability is assured.

The machine has large plain figures, the feed of which is such that they cannot jump or repeat and can



MACHINE COUNTER

be readily set back to zero. The figures move an entire space on the downstroke of the lever, thus eliminating any confusion that might arise in reading the counter while the machine is in operation.

The counter is finished in black and copper and is a recent product of the F. B. Redington Co., Chicago, Ill.

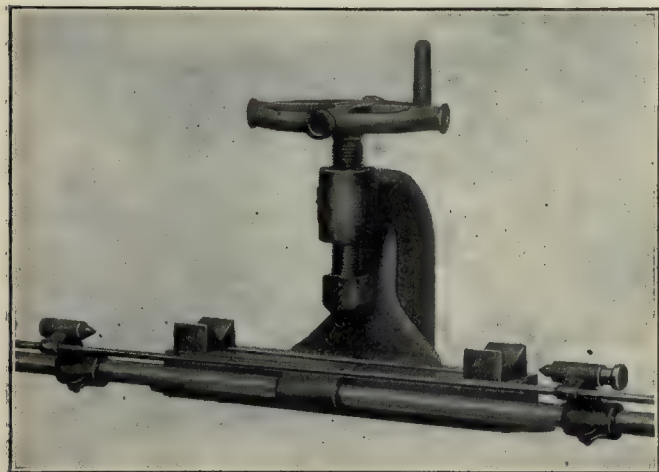
Bench Straightening Press

The V-blocks of the straightening machine shown are adjustable on a planed surface. By using pieces of copper in the blocks and under the screw head, tools and finished work are rapidly and easily straightened.

The base is one solid casting heavily ribbed and braced. The screw is of steel, with square-thread, five-pitch. The nut is $4\frac{1}{2}$ in. long, tapped in the solid cast-

ing. The handwheel has four cored openings to receive a $\frac{7}{8}$ -in. steel bar for applying the pressure. A steel collar is placed between the shoulder of the screw and the head piece to reduce the friction.

The heads are adjustable on a polished shaft, having a keyway to keep them in line. One of the centers springs



BENCH STRAIGHTENING MACHINE

Capacity for stock up to $2\frac{1}{2}$ in. in diameter, 48 in. long; base, 16 in. wide, 28 in. long; screw, $1\frac{1}{8}$ in.; handwheel, 12 in. in diameter

back far enough to receive the stock without changing the head. A convenient rod is attached, as shown, for resting the hand while chalking the work.

The machine is made by the John T. Towsley Manufacturing Co., Cincinnati, Ohio.

Characteristics for Success in Engineering

Last March the Joint Committee on Engineering Education, acting under the auspices of the Carnegie Foundation for the Advancement of Teaching, sent to the members of the national engineering societies the following card:

Please prefix numbers to the groups of qualities listed below to show the order of importance that you give them in judging the reasons for engineering success or in sizing up young men for employment or promotion:

...Character, integrity, responsibility, resourcefulness, initiative.

...Judgment, commonsense, scientific attitude, perspective.

...Efficiency, thoroughness, accuracy, industry.

...Understanding of men, executive ability.

...Knowledge of the fundamentals of engineering science.

...Technique of practice and of business.

Submitted by.....

Address

Years in practice...

Up to the first of June 6,773 of these cards had been returned; 352 were accompanied by letters explaining the views of the writers. A statistical summary of the returns was begun on May 1, when 6,069 cards had come in. Of these, 5,441 were regular, each one rating the six groups in the order of importance by some single combination of the numbers 1 to 6. There were 489 irregular cards, in which one or more of the numbers appeared more than once or in which the qualities were weighted by percentages instead of being numbered. On 139 cards, the qualities were numbered in two or more different orders—one for engineering success, another for employment, etc. The regular cards were sorted accord-

ing to the number of years in practice and the vote counted separately for each five-year period. Cards on which the years in practice were not given were counted together.

Differences in years of practice were found to make but little difference in the vote. The following table gives the regular vote by ten-year periods. The table reads: Character was rated higher than judgment by 84.8 per cent. of the voters who had less than ten years of experience, by 86.3 per cent. of those with from 10 to 19 years of experience, etc. The last column gives the percentage vote on each item for all the 5,441 voters.

Initial Letters of Group	Years in Practice				Total
	Under 10	10 to 19	Over 20	Not Given	
	1,000	2,000	1,941	500	5,441
Percent- age Vote	Percent- age Vote	Percent- age Vote	Percent- age Vote	Percent- age Vote	Percentage Assembled Vote
C > J	84.8	86.3	88.6	88.2	87.0
C > E	92.5	92.5	92.8	91.8	92.5
C > U	92.7	93.0	95.0	95.8	93.9
C > K	91.8	91.0	91.9	91.4	91.5
C > T	97.3	98.0	98.0	98.0	97.9
J > E	77.8	78.7	76.3	75.4	77.4
J > U	80.8	82.1	84.1	82.0	82.5
J > K	78.4	79.7	74.7	75.8	77.4
J > T	96.8	96.2	95.0	96.2	95.9
E > U	59.7	61.5	68.5	65.4	64.0
E > K	65.0	63.0	64.9	64.4	64.2
E > T	93.9	92.9	92.7	95.8	93.4
U > K	57.7	57.3	54.5	52.2	55.9
U > T	89.9	87.1	85.7	86.0	87.0
K > T	92.3	90.3	90.7	91.2	90.9

The most probable values of the relative importance of these groups of qualities have been computed from these percentage votes by the method described in Chapter VIII of Thorndike's "Theory of Mental and Social Measurements." These values are given in the first column of figures. The last column gives these same values as determined by the summary of the replies to the first circular letter, explained in *Engineering Record* for Jan. 29 and *Engineering News* for Jan. 27, 1916.

Character	24.0	41.0
Judgment	19.5	17.5
Efficiency	16.5	14.5
Understanding of men.....	15.0	14.0
Knowledge of fundamentals.....	15.0	7.0
Technique	10.0	6.0
	100	13
		100

Because of the constancy of the percentage of the votes, as shown in the table, it is clear that this statement of the factors essential to engineering success corresponds to a rather definite ideal in the professional mind. It is therefore safe to make use of this definition in testing and planning the work of the schools.

When applying this definition to the schools, it is desirable not to forget several perfectly obvious facts. In the first place, all the qualities mentioned are essential to genuine success, and conscious effort should be made to develop all of them as far as is possible. Second, character, initiative, commonsense and qualities of this sort cannot be taught explicitly like multiplication tables and rules of grammar. Third, education is a continuous process of growth, and therefore the conscious development of the qualities of the first four groups cannot to advantage be arrested for four years, even for the sake of a mastery of knowledge and technique. Fourth, the man whose character, judgment, efficiency and understanding of men have developed most during his college years has the best show after graduation, since these

qualities constitute 75 per cent. of his equipment. Fifth, the fact that character is rated at 24 per cent. does not mean that an engineer can succeed with a 24 per cent. character. It does mean that even a perfect character is but 24 per cent. of the engineer's total equipment.

With these facts in mind, it is evident that instruction in mathematics or machine design that aims only at a mastery of fundamental principles and technique cannot be nearly as efficient as instruction which, while paying due regard to technique and the mastery of principles, yet develops integrity, initiative, resourcefulness and commonsense.

NEW PUBLICATIONS

VALVES AND VALVE GEARS—By Franklin de Ronde Furman. Second edition. Two hundred and fifty-three 6x9-in. pages; 237 illustrations; indexed; cloth bound. John Wiley & Sons, Inc., New York City. Price, \$2.50.

This book, when first issued two years ago, referred chiefly to steam engines. In the present edition the first volume treats of valve mechanism applied to steam engines and turbines. A second volume (in preparation) will cover internal-combustion engine valve gears. The present volume should be adapted to the work of instruction, because of the large number of problems and exercises given. The usual forms of slide, riding-cutoff, Corliss and other four-valve gears are adequately described. A feature of the book is the complete treatment given to poppet, uniflow-engine and steam-turbine valve gears. The treatment of turbine gears includes a description of the De Laval mechanism, the hydraulic, steam-actuated and mechanical valve gear used on the Curtiss turbine and the direct, hydraulic or oil-operated relay and steam-operated relay used on the Westinghouse machines. The new material added in the present edition includes the semi-plug and high-pressure piston valves of the American Balance Valve Co., the Rice & Sargent-Corliss engine, including the Rites and Sargent governors and directions for setting valves and valve gears, the Nordberg valves and valve gears, the J. T. Marshall valve gear and the Sulzer steam-engine valve gear.

Small Tool Manufacturing Equipment Wanted

Advices just received from F. R. Ratcliffe, manager, small arms factory, Department of Defense, Lithgow, Australia, indicate that his arsenal will soon be in the market for equipment for a small-tool plant for manufacturing reamers, taps, milling cutters, etc., in fairly large quantities on automatic or semiautomatic machines.

The kinds of tools it is expected to manufacture are mainly profiling cutters, small end mills, small taps, mostly under $\frac{3}{8}$ in. in diameter, with a few occasionally up to 1 in. in diameter; standard, plain, side and straddle milling cutters, rifle barrels, drills, etc.

The new equipment is desired to replace the ordinary tool-room equipment now being used at the small-arms factory.

Interested manufacturers are requested to furnish Mr. Ratcliffe promptly with catalogs, circulars and other descriptive literature.

OBITUARY

James B. Doan, Sr., father of J. B. Doan, president of the American Tool Works Co., Cincinnati, Ohio, died on June 24, aged 79 years.

Robert F. Hoxie, associate professor of political economy, University of Chicago, whose recent studies of scientific management attracted considerable attention, died on June 22.

Henry B. Brown, for many years president of the H. B. Brown Nut, Bolt and Screw Machine Co., East Hampton, predecessors of Costello Bros., died on June 15, aged 82 years.

Sir H. Frederick Donaldson, for many years mechanical head of Woolwich Arsenal and since the organization of the British Ministry of Munitions its chief technical adviser, was lost with Lord Kitchener in the sinking of the "Hampshire" on June 5.

Leslie S. Robertson, well known throughout the mechanical world through his long service as secretary of the British Engineering Standards Committee, and for the past year assistant to the director of production of the Ministry of Munitions was lost in the sinking of the "Hampshire" on June 5.

PERSONALS

J. A. Cutshaw has joined the selling staff of the Moller & Schumann Co. and will look after its interests in the Chicago territory.

S. H. Humphrey has resigned as vice-president in charge of manufacture of the Chalmers Motor Co., to accept a similar responsibility with the Briscoe Motor Corporation, Jackson, Mich.

H. E. Streeter has been succeeded by G. E. Smith as works manager of the Precision Tool and Machine Co., Montreal, Canada. Mr. Smith was formerly superintendent of the Singer Sewing Machine Co., St. John, Quebec.

Walter N. Polakov, recently superintendent of power of the New York, New Haven & Hartford R.R. and consulting engineer to the Board of Estimate and Apportionment of the City of New York, is now directing the foreign-trade engineering work of David Vershbinsky, Inc., New York City.

BUSINESS ITEMS

Brown & Sharpe Manufacturing Co., Providence, R. I., announces the annual suspension of the shop work from July 28 to Aug. 8. During this period the office will remain open as usual.

The Luster-Jordan Co., Inc., recently acquired the plant and business of the Jordan Machine Co., Norristown, Penn. In addition to the manufacture of the Jordan lock-corner wood box machinery, contract work will be carried on.

TRADE CATALOGS

Providence Sanitary Fountain. Harwood B. Day, 29 Weybosset St., Providence, R. I. Circular. Illustrated.

Steel Strips Hardened, Tempered and Polished. Edgar T. Ward's Sons, 44-54 Farnsworth St., Boston, Mass. Booklet. Pp. 16, 4x9 in.

Electric Hoists. Sprague Electric Works, 527 W. 34th St., New York. Bulletin No. 48,906. Pp. 32, 8x10 $\frac{1}{4}$ in. This illustrates and describes Type S-1, one-half-ton and one-ton hoists.

FORTHCOMING MEETINGS

American Foundrymen's Association and American Institute of Metals. Annual meeting, September 11-16, Cleveland, Ohio. A. O. Backert, secretary, American Foundrymen's Association, Cleveland, Ohio.

American Society of Mechanical Engineers. Monthly meeting first Tuesday. Calvin W. Rice, secretary, 29 West Thirty-ninth St., New York City.

Boston Branch National Metal Trades Association. Monthly meeting on first Wednesday of each month, Young's Hotel. W. W. Poole, secretary, 40 Central St., Boston, Mass.

Providence Association of Mechanical Engineers. Monthly meeting fourth Wednesday each month. J. A. Brooks, secretary, Brown University, Providence, R. I.

New England Foundrymen's Association. Regular meeting second Wednesday of each month. Exchange Club, Boston, Mass. Fred F. Stockwell, 205 Broadway, Cambridgeport, Mass.

Engineers' Society of Western Pennsylvania. Monthly meeting third Tuesday; section meeting first Tuesday. Elmer K. Hiles, secretary, Oliver Building, Pittsburgh, Penn.

Rochester Society of Technical Draftsmen. Monthly meeting, last Thursday. O. L. Angevine, Jr., secretary, 857 Genesee St., Rochester, N. Y.

Superintendents' and Foremen's Club of Cleveland. Monthly meeting third Saturday. Philip Frankel, secretary, 310 New England Building, Cleveland, Ohio.

Western Society of Engineers, Chicago, Ill. Regular meeting first Wednesday evening of each month, excepting July and August. J. H. Warder, secretary, 1785 Monadnock Block, Chicago, Ill.

Philadelphia Foundrymen's Association. Meetings first Wednesday of each month. Manufacturers' Club, Philadelphia, Penn. Howard Evans, secretary, Pier 45 North, Philadelphia, Penn.

Technical League of America. Regular meeting second Friday of each month. Oscar S. Teale, secretary, 35 Broadway, New York, N. Y.

Prices--Materials and Supplies

IRON AND STEEL

Pig Iron—Quotations were current as follows at the points and dates indicated:

	June 29, 1916	One Month Ago	One Year Ago
No. 2 Southern Foundry, Birmingham.	\$14.00	\$15.00	\$10.00
No. 2 X Northern Foundry, New York.	19.75	20.75	14.25
No. 2 Northern Foundry, Chicago.	19.00	19.00	13.00
Bessemer, Pittsburgh.	21.95	21.95	14.65
Basic, Pittsburgh.	18.95	18.95	13.60
No. 2 X, Philadelphia.	18.25	20.50	14.25
No. 2, Valley.	18.25	18.50	12.50
No. 2, Southern Cincinnati.	16.90	17.90	12.65
Basic, Eastern Pennsylvania.	19.50	20.50	13.75
Gray forge, Pittsburgh.	18.70	18.70	13.35

Steel Shapes—The following base prices in cents per pound are for angles 3 in. by 1/4 in. and larger and tees 3 in. and larger and plates 1/4 in. and heavier from jobbers' warehouse at the places named:

	New York			Cleveland		Chi- cago
	June 29, 1916	One Month Ago	One Year Ago	land	land	
Steel angles, base.	3.25	3.50	1.85	3.25	3.10	
Steel T's, base.	3.30	3.55	1.90	3.25	3.10	
Machinery steel (bessemer)	3.25	3.55	1.80	3.25	3.10	
Plates	4.00	4.10	...	3.65	3.50	

Steel Sheets—The following are the prices in cents per pound from jobbers' warehouse at the places named:

	New York			Cleveland		Chi- cago
	June 29, 1916	One Month Ago	One Year Ago	land	land	
No. 28 black.	3.65	3.65	2.60	3.20	3.20	
No. 26 black.	3.55	3.55	2.50	3.10	3.10	
Nos. 22 and 24 black.	3.50	3.50	2.45	3.05	3.05	
Nos. 18 and 20 black.	3.45	3.45	2.40	3.00	3.00	
No. 16 blue annealed.	4.45	4.70	2.35	3.70	3.60	
No. 14 blue annealed.	4.35	4.60	2.25	3.60	3.50	
No. 12 blue annealed.	4.30	4.50	2.20	3.55	3.45	
No. 10 blue annealed.	4.25	4.55	...	3.50	3.40	
No. 28 galvanized.	5.40	5.65	6.00	5.50	5.50	
No. 26 galvanized.	5.10	5.35	5.70	5.20	5.20	
No. 24 galvanized.	4.95	5.20	5.55	5.05	5.05	

Standard Pipe—The following table shows the comparison in discounts, together with the net prices in cents per foot:

	Black		Galvanized	
	June 29, 1916	One Yr. Ago	June 29, 1916	One Yr. Ago
3/4 to 2 in. steel butt welded.	70%	79%	50 1/4 %	57 1/2 %
2 1/2 to 6 in. steel lap welded.	68%	78%	48 1/4 %	56 1/2 %
Diameter, In.				
3/4	3.45	2.42	5.69	4.89
1	5.10	3.57	8.42	7.23
1 1/4	6.90	4.83	11.39	9.78
1 1/2	8.25	5.78	13.61	11.69
2	11.10	7.77	18.32	15.73
2 1/2	18.72	12.87	30.13	25.45
3	24.48	16.83	39.40	33.28
4	34.88	23.98	56.14	47.42
5	47.36	32.56	76.22	64.38
6	61.44	42.24	98.88	83.52

From New York stock the following discounts hold:

	New York		Cleveland	
	Black Galvanized	One	Black Galvanized	One
3 1/2 to 6 in. steel lap welded	61%	36%	64%	44%
3/4 to 3 in. steel butt welded	64%	42%	66%	46%

Malleable fittings, Class B and C, from New York stock sell at 30 and 5% from list price. Cast iron, standard sizes, 55%.

Bar Iron—Prices are as follows in cents per pound at the places named:

	June 29, 1916	Three Months Ago
Pittsburgh, mill	2.60	2.45
Warehouse, New York	3.25	3.10
Warehouse, Cleveland	3.25	3.25
Warehouse, Chicago	3.10	3.10

Swedish (Norway) Iron—This material per 100 lb. sells as follows f.o.b. places named:

	New York	Cleveland	Chicago
Today	\$6.00	\$3.75 @ 4.00	\$6.30
One Year Ago			\$5.25

In coils an advance of 50c. is usually charged.

Cold Drawn Steel Shafting—From warehouse to consumers requiring fair-size lots, the following quotations hold:

	June 29, 1916	Three Months Ago
New York	List price plus 20%	10% above list
Cleveland	List price plus 20%	20% above list
Chicago	List price plus 10%	List price

Drill Rod—Discounts from list price in New York are as follows: Standard, 65%; extra, 60%; special, 55%.

High Speed Tool Steel containing from 10 to 18% tungsten sells as follows per pound in New York:

Billets	\$2.40	Bars	\$3.25
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METALS

Miscellaneous Metals—The present quotations in cents per pound, with a comparison of practically a month and year ago, are as follows:

	New York		
	June 29, 1916	One Month Ago	One Year Ago
Copper, electrolytic (carload lots).	28.00	30.00	20.25
Tin	39.00	48.00	39.25
Lead	7.00	7.50	5.75
Spelter	11.75	15.00	22.00

ST. LOUIS

Lead	6.85	7.37 1/2	....
Spelter	11.87 1/2	14.75	....

At the places named, the following prices in cents per pound prevail:

	New York			Cleve- land	Chi- cago
	June 29, 1916	One Month Ago	One Year Ago		
Copper sheets, base.	37.50	37.50	25.00	37.50	37.50
Copper wire (carload lots)	37.50	37.50	21.00	33.00	38.00
Brass rods, base.	44.50	44.50	29.00	42.00	38.00
Brass pipe, base.	46.50	46.50	33.00	45.00	46.00
Brass sheets	44.50	44.50	29.00	42.00	38.00
Solder 1/2 and 1/2 (case lots)	25.37 1/2	30.00	28.50	28.75	25.75

Old Metals—The following are the dealers' purchasing prices in cents per pound:

	New York		Cleveland	
	June 29, 1916	One Year Ago	June 29, 1916	Three Months Ago
Copper, heavy and crucible.	21.00	17.00	20.00	25.00
Copper, heavy and wire.	20.00	...	19.50	24.00
Copper, light and bottoms.	17.00	14.00	17.00	21.00
Lead, heavy	5.00	4.50	5.75	7.50
Lead, tea	4.50	4.00	4.25	6.00
Brass, heavy	11.75	8.50	12.00	19.50
Brass, light	9.25	10.00	10.00	13.00
No. 1 yellow rod brass turnings	12.75	...	12.00	15.00
Zinc	8.00	15.00	8.00	16.00

Monel Metal—The following are the prices in cents per pound for mill lengths 8 ft. and over:

	10,000 Lb.	6,000 Lb.	2,000 Lb.	500 Lb.	Less Than 500 Lb.
Size, In.	of a Size and Over	of a Size and Over	of a Size and Over	of a Size and Over	of a Size and Over
Rounds—Squares					
1/4 to 1 1/2	35.50	36.00	36.50	37.00	38.00
1 1/2 to 2 1/2	35.25	35.75	36.25	36.75	37.75
2 1/2 to 3 1/2	35.00	35.50	36.00	36.50	37.50
3 1/2 to 4 1/2	35.75	36.25	36.75	37.25	38.25
Rounds					
3 to 3 1/2	36.50	37.00	37.50	38.00	39.00
Squares					
3 to 3 1/2	36.50	37.00	37.50	38.00	39.00
Rounds					
3 1/2 to 4 1/2	36.25	36.75	37.25	37.75	38.75
Squares					
3 1/2 to 4 1/2	36.25	36.75	37.25	37.75	38.75
Rounds—Squares					
4 to 4 1/2	37.00	37.50	38.00	38.50	39.50
4 1/2 to 6 1/2	38.00	38.50	39.00	39.50	40.50
7	38.50	39.00	39.50	40.00	41.00
Flats	36.50	37.00	37.50	38.00	39.00

Flats not rolled wider than 6 in. or less than 1/4 in. thick. Hexagon bars 2c. per lb. over corresponding size of round rod.

For cutting to any specified length not shorter than 1 ft. add 1c. per lb.

The scrap allowance is 18c. per lb. delivered at works.

Zinc Sheets—The following prices in cents per pound prevail:

Carload lots f.o.b. mill.				18.00
	(In Casks)		(Broken Lots)	
	Three		Three	
	June 29,	Months	June 29,	Months
	1916	ago	1916	ago
New York	21.00	26.00	22.00	26.50
Cleveland	22.75	26.25	23.25	26.50
Chicago	21.00	28.50	21.50	29.00

Copper Bars from warehouse sell as follows in cents per pound:

	June 29, 1916	Three Months Ago
New York	43.00	40.00
Cleveland	40.25	39.00
Chicago	40.25	38.00

Babbitt Metal—Quotations are as follows in cents per pound from warehouse at the places named:

	New York	Cleveland	Chicago
Best grade	60.00	47.50	60.00
Commercial	30.00	18.00	25.00

Antimony—Chinese and Japanese brands are quoted in cents per pound for spot delivery, duty paid:

	June 29, 1916	Three Months Ago
New York	19.50	45.00
Cleveland	20.00	50.00
Chicago	22.00	44.75

Operations on the Sterling Marine Engine

By E. A. SUVERKROP

SYNOPSIS—It is not the intention of this article to cover the whole process of manufacture of even one size of engine. An attempt is, however, made to show a few of the operations which impressed the author as being of special interest.

The Sterling Engine Co., Buffalo, N. Y., manufactures four-cycle marine engines exclusively. They are adapted to every type of motor boat from cargo carriers to high-speed yachts and tenders, and are built in sizes from 10 to 300 hp. The working speeds of the engines also vary within wide limits, say from 400 to 1,700 r.p.m. The heavy-duty motors will run without skipping at speeds as low as 200 r.p.m.

The bases of the engines are made of cast iron, manganese bronze or aluminum, governed by service and price, cast iron being heavy and low in price, aluminum light, but with no remarkable strength, and manganese bronze extremely strong even in a thin, light casting. Both these latter metals have of course the further ad-

vantage of not rusting when exposed to fresh or salt water. The same care is also taken in cleaning the crankshafts. These are received at the factory with the main-bearing journals and crankpins ground to size. In the cleaning department the crank webs are ground all over to remove every particle of scale.

In Fig. 2 is shown an oil-hole drilling machine built in the works. The table, or bed, is of cast iron planed and provided with a longitudinal slot in which the two V-blocks slide, their centers being in line with the drill spindles. Two vertical members support the rail, on which are two carriages carrying the slides for the electric drills. The slides are arranged so that they will swivel in either direction. At the left-hand end of the table is a similar head for drilling the central oil hole A, Fig. 3. The heads on the rail are used for the diagonal holes B in the crank webs.

By referring to Fig. 3 it will be noticed that the tolerance of the bearings is $+0$ and -0.001 in. It is almost impossible to bore bearings commercially to limits like this, so they are broached. The leading end of the broach is toothed, but the finishing end is provided with

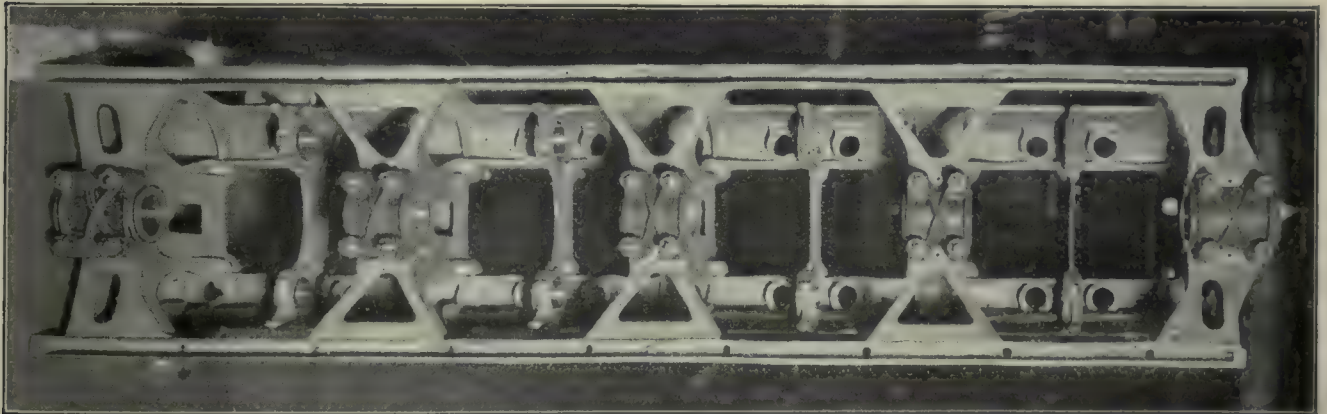


FIG. 1. MANGANESE-BRONZE CRANK CASE FOR MARINE ENGINE

vantage of not rusting when exposed to fresh or salt water.

One of these manganese-bronze bases is shown in Fig. 1. With the exception of the main-bearing caps it is a single casting $72\frac{1}{4}$ in. long, $16\frac{1}{4}$ in. wide and $10\frac{3}{4}$ in. deep over all. The pattern is a single block, the interior being entirely formed by cores. The walls vary from $\frac{1}{4}$ in. up. Altogether it is as fine an example of careful pattern and foundry work as I had ever seen. The only concern that has so far successfully tackled the job of molding it is the Light Foundry and Machine Co., Pottstown, Penn. The total weight of the casting is 340 lb. A larger base of similar design, but 91 in. long, $21\frac{1}{2}$ in. wide and 14 in. deep, weighs 900 lb. in manganese bronze.

One thing which struck me very forcibly was the excessive care in the cleaning department. Every particle of sand is removed from the castings. This is obviously necessary, as it does not require much sand in the crank case of an engine making 1,700 r.p.m. to cause a lot

several polished bulbs that not only bring the hole to exact size, but compress the babbitt metal and burnish the bearing surface.

When all the machine work on the crankshafts is completed, they are tested for running balance in the machine shown in Fig. 4.

In Fig. 5 is shown a flywheel that had just been completed on the Bullard vertical-turret lathe. The limits on this are very close. The shoulder at the top forms a seat for a ring spur gear that is forced and screwed on. The spur gear in place can be seen in Fig. 6. It forms part of the electrical starting mechanism. The time on this flywheel, which is about 20 in. in diameter and turned all over, is 3 hr. To a man familiar with the machine on which the work is done, this would not appear to be high production. It must, however, be borne in mind that the work is day's work and the limits very close, the "fit" for the gear wheel being to snap gage without any tolerance, which means in this case about 0.001 in.

After the gear is pressed and screwed on, the flywheel is tested for static balance in the Fay & Scott balancing machine, Fig. 6. It is brought to static balance with the drill that forms a part of this machine. The fly-

being first tested for static balance on the horizontal ways. While the machine is portable, it is obvious that to obtain exact results even in static balances the ways must be leveled up each time the machine is moved.

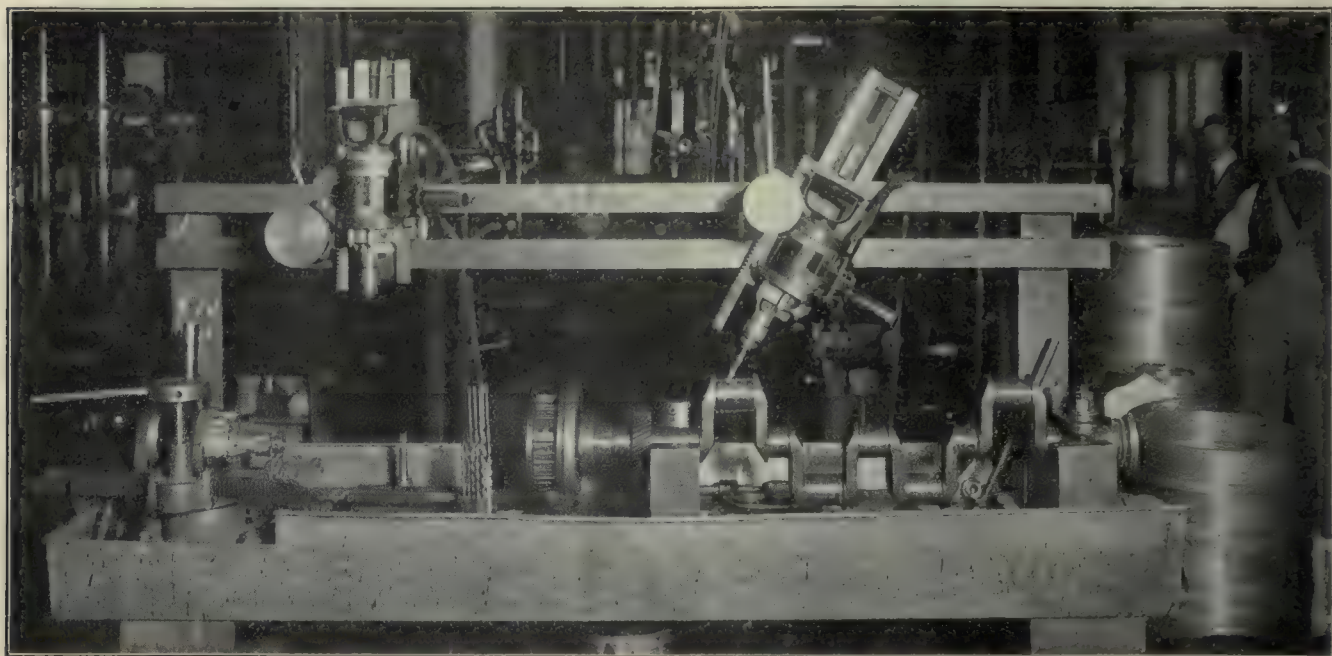


FIG. 2. OIL-HOLE DRILLING MACHINE FOR MARINE-ENGINE CRANKS

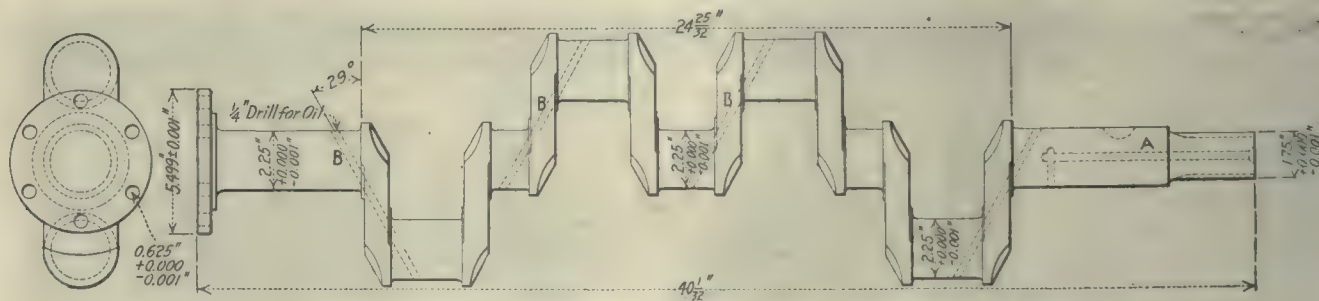


FIG. 3. DETAIL OF ONE SIZE OF CRANKSHAFT USED IN THE STERLING MARINE ENGINE

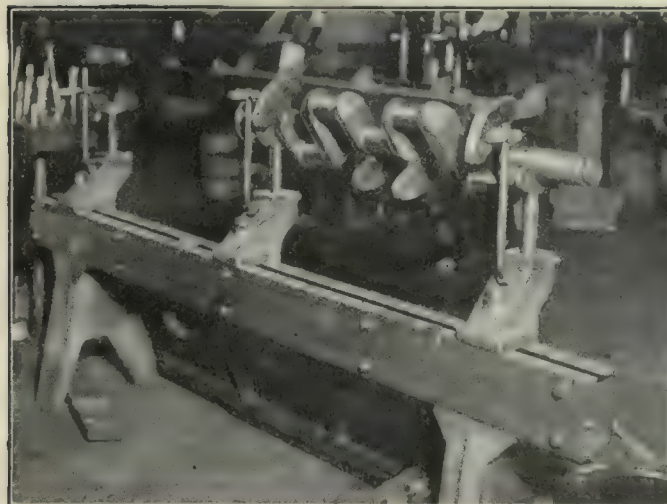


FIG. 4. RUNNING-BALANCE TESTING MACHINE AND COUNTERBALANCED CRANKSHAFT

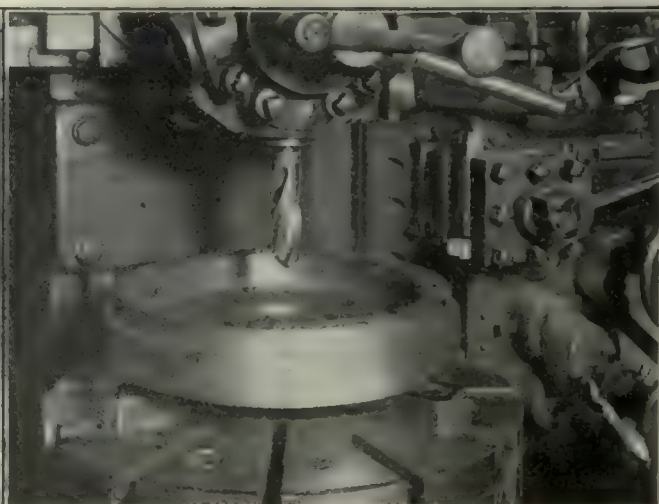


FIG. 5. TURNING FLYWHEEL ON BULLARD VERTICAL-TURRET LATHE

wheels are finally tested for running balance in the machine illustrated in Fig. 4.

In Fig. 7 is shown another use for the Fay & Scott balancing machine. Here the complete reverse gear is

The reverse-gear clutch shown is of the well-known disk type, with alternate steel and bronze disks alternately engaging with the central-shaft member and the case.

The turning of the bronze disks, shown in Fig. 8, is a nice job, as these are required to be within 0.003 in. of uniform thickness. The original castings are about $\frac{5}{16}$ in. thick. In approximately four cuts, taken on alter-

disks vary in diameter with the size of the clutch, but 12-in. disks require about 15 min. to finish-turn.

In Fig. 9 is shown the drilling of the holding-down bolt holes in a cast-iron base. Mounted on the table

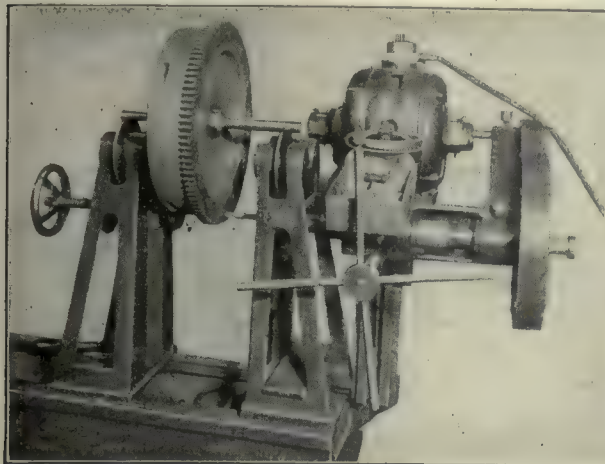


FIG. 6. DRILLING FLYWHEEL FOR STATIC BALANCE

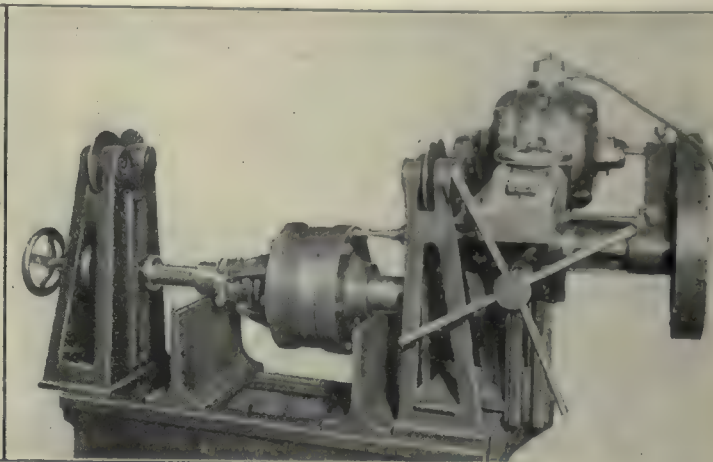


FIG. 7. BALANCING A REVERSING GEAR

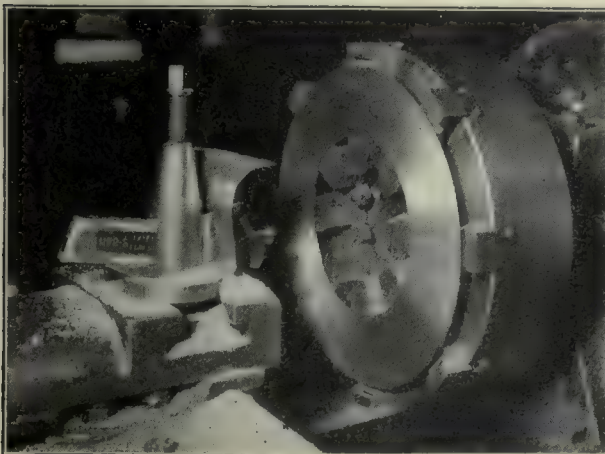


FIG. 8. TURNING BRONZE CLUTCH DISKS

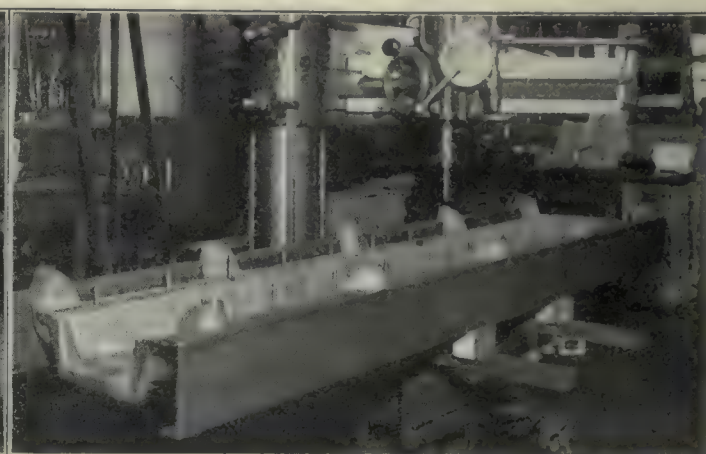
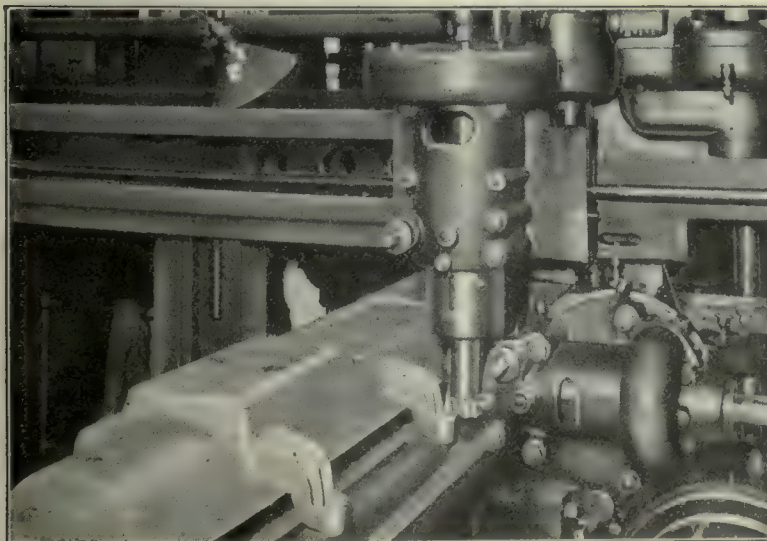


FIG. 9. DRILLING HOLDING-DOWN BOLT HOLES

FIG. 10. INGERSOLL MILLER FOR BASES AND CRANK CASES
USED FOR "PLANER" WORKFIG. 11. PORTABLE GRINDER IN THE CLEANING
DEPARTMENT

nate sides to prevent buckling, the disks are reduced to $\frac{1}{8}$ in. in thickness.

It will be observed that a special eight-jawed chuck is used to obviate distortion as much as possible. The

of the radial drilling machine are two tracks made of planed channel steel. Bosses that cannot be reached by swinging the arm are brought into range by sliding the bed on the rails. The holes for the holding-down

bolts do not require to be spaced accurately, so no jig is used. The holes for the studs that secure the crank case to the base must be accurate. They are drilled with the aid of a light steel jig, or perhaps more correctly a templet with drill bushings.

Practically all the "planer" work on the crank cases and bases is now done on the heavy Ingersoll miller, Fig. 10. With the adoption of the miller for this work the production has been more than doubled.

The electric portable grinder illustrated in Fig. 11 is used in the cleaning room. It hangs, as shown, from

which permits the boring operation to be practically continuous.

The cylinders shown in Fig. 12 are 5½ in. in diameter by 12⅞ in. deep when finished; ⅝ in. of metal is removed in two roughing cuts and one finishing cut. It takes about 14 min. for the cut. For the four-cylinder engines, in which the cylinders are cast *en bloc*, a four-spindle Baker cylinder-boring machine is used.

The pistons are at present turned on a Jones & Lamson flat-turret lathe. For the first operation the piston, shown at A in Fig. 13, is chucked in a four-jaw chuck

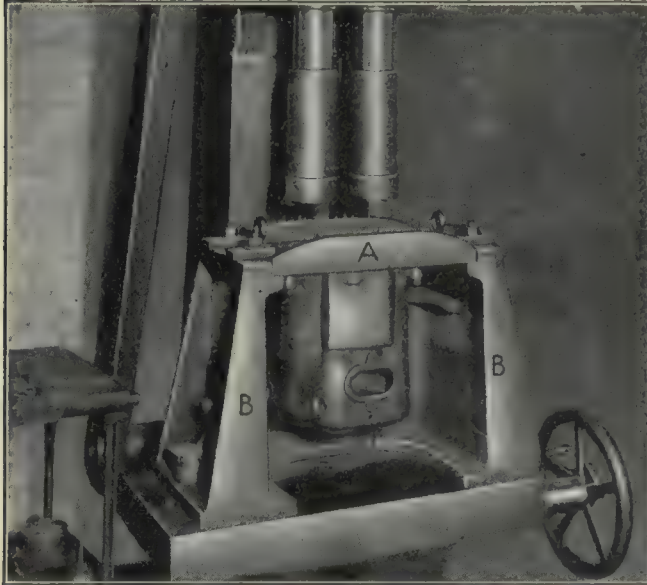


FIG. 12. BAKER CYLINDER-BORING MACHINE

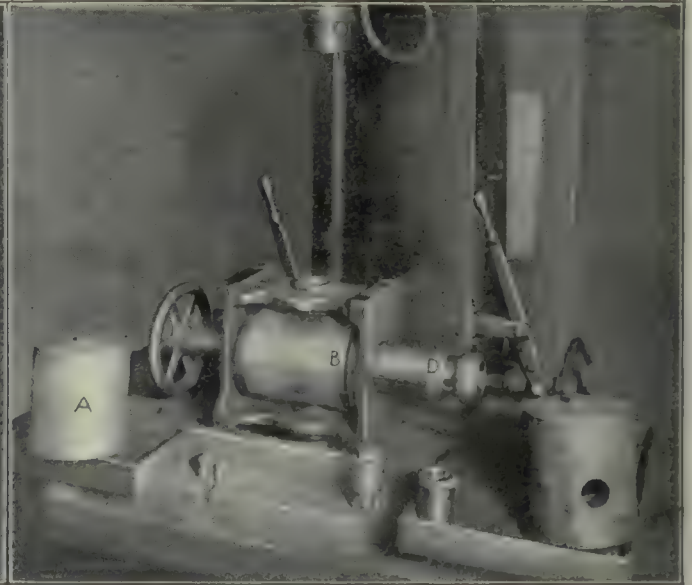


FIG. 13. DRILLING WRISTPIN HOLES IN PISTONS

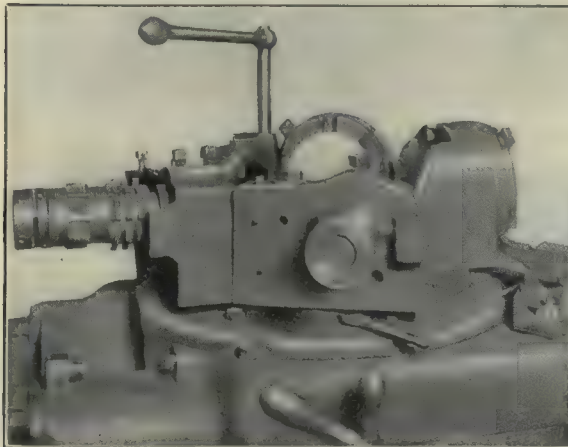


FIG. 14. ROUGH AND FINISH GROOVING TOOLS

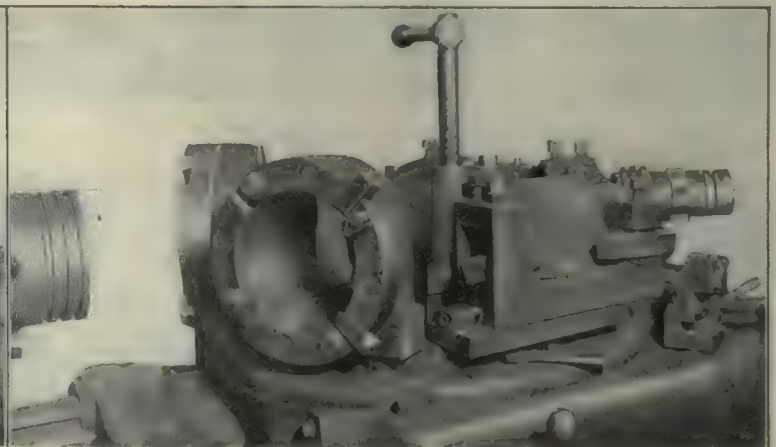


FIG. 15. TURNING AND FACING TOOLS FOR PISTONS

a swinging crane. The counterweight is padded with rags to soften the blow, should someone inadvertently bump into it. When the work is small and easy to manipulate, the grinder is clamped by the sleeve in the vise, as shown, and the operator takes the work to the grinder.

In Fig. 12 is shown a Baker double-spindle cylinder-boring machine. The surface of the cylinders, which bolts to the crank case, is milled in the first operation on a heavy Brown & Sharpe vertical miller. In the boring operation this surface is bolted to the boring-jig plate A, which slides against stops in the jig body B and is clamped in place, as shown. Two plates A are employed,

with the lower or open end outward. It is trued by the inside. The open end is faced and bored to a depth of about ⅜ in., a flange projecting inwardly being provided on the casting for this purpose. This operation takes about 5 min.

The wristpin hole is then bored on the Baker drilling machine, Fig. 13. The bored and faced end of the piston is centered on a seat at B, against which it is forced by the handwheel and screw C. The sliding plug D is provided with a wedgelike fork on its inner extremity. This fork squares up the bosses on the inside of the piston, bringing the piston in correct position so that the wristpin hole will pass through the center.

For burning, the pistons are chucked against a seat similar to that used in the drill jig in Fig. 13, with this exception: An eye-bolt passes through the hollow spindle of the Jones & Lamson lathe, and a pin passed through the wristpin hole enters this eye-bolt. At the rear end the eye-bolt is provided with a thread and handwheel to draw the piston to the seat.

The exterior is turned 0.010 in. oversize for grinding. The turning operation covers two roughing cuts on the

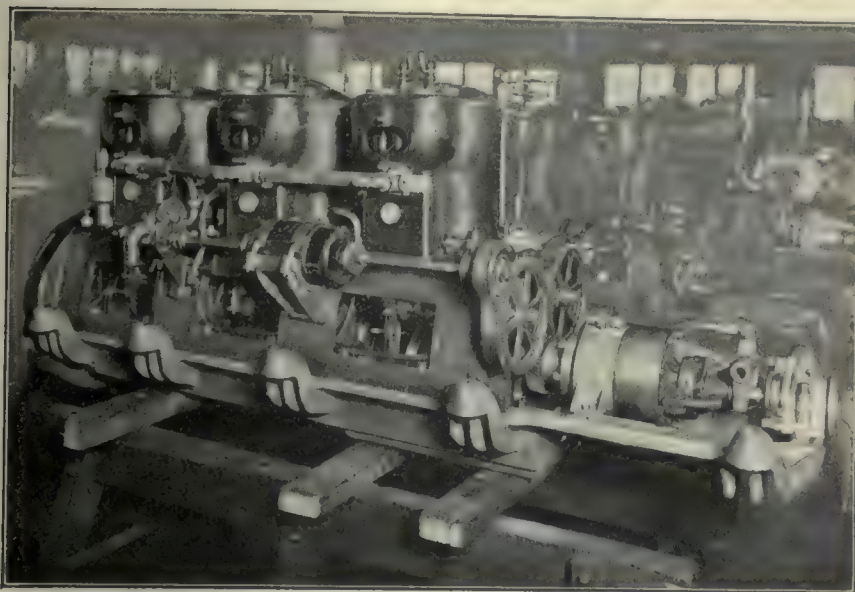


FIG. 16. PARTLY ASSEMBLED SIX-CYLINDER MARINE ENGINE

body, roughing the three ring grooves and the three oil grooves, finishing the three ring grooves, facing the end and centering the end for the grinding operation—all of which takes about 20 min. on a 6-in. piston.

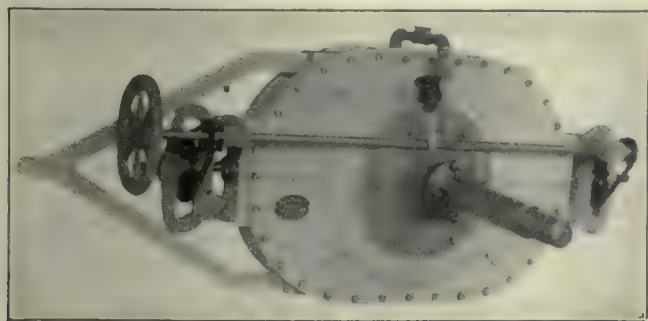


FIG. 17. STERLING WATER DYNAMOMETER

In Fig. 14 are shown the grooving tools. These are similar to milling cutters with coarse-pitch teeth. On the inside they are keyseated to prevent their turning on the bar. Collars space them the correct distance apart. It will be noticed that the oil grooving tools—that is, the broad one in the center and the two to the left—are of smaller diameter than the ring grooving tools.

In Fig. 15 the turning and facing tools are illustrated. In Fig. 16 is shown a partly assembled six-cylinder 110- to 140-hp. Sterling engine. This illustration gives some idea of the compact manner in which the mechanism is housed.

After assembling, all Sterling engines are given a running test from one to two days or longer, depending on circumstances. The testing department is in a separ-

ate building, and each testing base is provided with a water-brake dynamometer built by the company. An exterior view of this dynamometer is shown in Fig. 17.

Within the casing and secured to the central shaft is a rotor that is a circular casting with radial pockets on each side. On the periphery also there are pockets. The brake is supplied with water from any convenient source. The water is thrown from the side and face pockets of the rotor into corresponding reversed pockets in the casing and side plates. The force with which the water is thrown is in proportion to the speed of the rotor, and its impact tends to rotate the casing. Flat plates between the rotor and the end plates are adjustable to and from the center of the shaft and serve to cut off the amount of water thrown from the rotor, thus regulating the resistance, which can further be regulated by varying the amount of water admitted. The torque arm, at the left, is 31.152 in. long. It is attached to a weighing scale of any convenient type. The length of the torque arm simplifies the calculation of the power delivered by the engine, the formula being

$$\frac{\text{Pounds pull} \times \text{r.p.m.}}{2,000} = \text{hp.}$$

When the test has been satisfactorily concluded, the engine is disassembled, and examined to see the condition after test. The various parts are then cleaned, the engine reassembled, painted, bolted to skids and, if for foreign shipment, boxed.

Patterns for a Gas-Engine Cylinder and Head

By H. E. McCray

There are as many ways of making gas-engine cylinder and cylinder-head patterns and core boxes as there are engine builders in the country, and it is no extraordinary occurrence to see several kinds of patterns in one plant. The idea of this contribution is not to outline a standard method, for conditions differ widely, but to illustrate

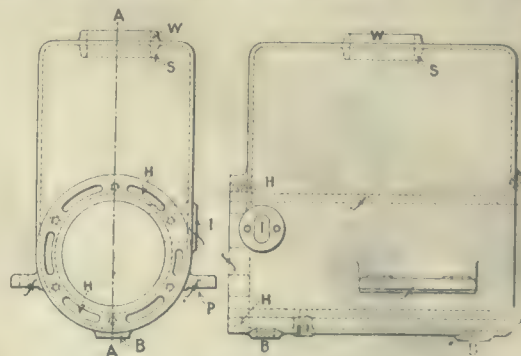


FIG. 1. THE CYLINDER CASTING

what we have found after considerable experience to be the best and cheapest way.

In Fig. 1 is shown an example of a common type of cylinder casting. It is cast separate from the engine bed. With a few variations in shape and ports, we find

it typical of "two-piece" engine construction. The pattern is parted along the center line *AA* and has six core prints. Two of these support the cylinder-barrel core, which is a straight round core. The igniter port core *I* is located, for convenience in setting, in the drag and is held down by the cylinder-barrel core, as it projects through the water-jacket core. It is also a straight core, but has one end rounded to conform to the

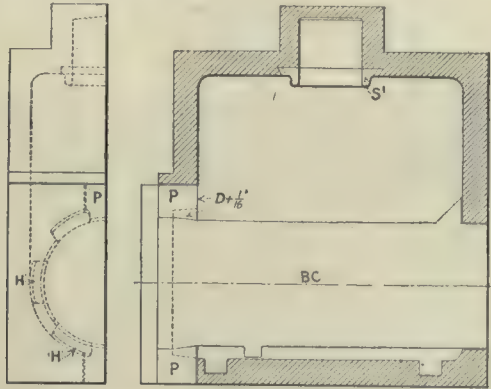


FIG. 2. THE WATER-JACKET CORE BOX

barrel core. The water-jacket core is made in halves and is supported at three points—the filler hole at *W* and the ports *BB*, later pipe tapped and plugged.

The cylinder head is held in place by six bolts, and between each pair of bolt lugs is a water core *H* to allow water to circulate around the cylinder head. The water-jacket core box is seen in Fig. 2, which shows how these cores are formed without loose pieces. The semicircular section *BC* forms the outside of the cylinder barrel and rests in each end of the box. It is of course removable to allow tucking and to draw the box off the core when completed. Before the core is rapped out of the box, however, a half-round cast-iron drier is inserted in place of *BC*, preventing any sag that might otherwise take place in baking.

The water-port cores *H* are formed by openings cut in the solid box and are arranged in such a way as to draw out with the main core. The pieces *P*, which would prevent drawing if solid with the box, are fastened to the plate at the end of *BC* and lift out with it. They

customary spacing—the core box is even simpler, as the pieces *P* do not interfere with drawing the core. The splash guard *S* is dovetailed into the box and draws out with the core, this being the only loose piece in the box. The illustration shows the cope half of the box; the ignited-core boss *I*, Fig. 1, is fastened in the other half.

The drag, or igniter-pad, half of the jacket core is set in the mold first, then the igniter core through its opening, followed by the barrel core and the cope half out of the jacket core. No chaplets are required.

The cylinder head is illustrated in Fig. 3. It will be noticed that the water circulates over the top of both inlet and exhaust ports and completely around the valve bosses. This construction was adopted for two reasons—the better cooling afforded the valve stems and the preservation of the paint over the exhaust port. The water-port cores are also marked *H*. They register with the cylinder water ports.

The cylinder-head pattern is parted at *AA*, the center line of the valve ports and pads. The cylinder step, or finished side, which is the drag half of the other half carrying the valve bosses, lifts with the cope and is drawn out of it. This arrangement is for convenience in core setting and closing the mold. The inlet- and exhaust-port cores are supported by two prints each—at *I* and *I'* and *E* and *E'* respectively. These are made in half boxes and pasted together before setting.

The water-jacket core is located by the print *H*. The core box, Fig. 4, is a solid box with open top, the blocks forming the ports, bolt lugs being glued in place. The radius over the top is formed by the cast-iron drier ring *R* set in place after the sand is well tucked. The section of the drier ring is approximately that of a fillet, as shown in Fig. 4. The core is struck off and slicked, then rapped out on the drier ring, which prevents any warping and permits easy handling of an otherwise delicate core.

The port cores are set into the drag first and the water-jacket core over them, with thin sheet-metal chaplets between. A height gage is provided so that the cores are not pressed too far into the mold. Four chaplets are then placed on the jacket core and the mold closed.

■

Chip Guard for Machine Tools

BY WILLIAM TORRAY

The accompanying illustration represents a guard for chips. It has been used successfully on lathes. The

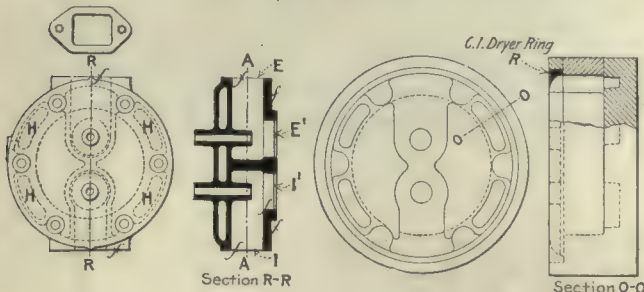
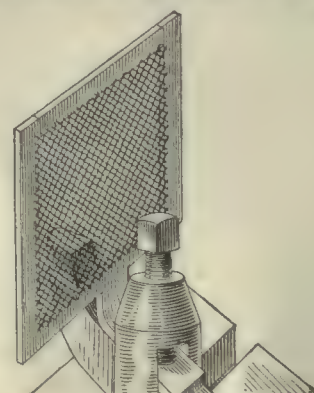


FIG. 3. THE CYLINDER-HEAD CASTING

Fig. 4. CYLINDER-HEAD CORE BOX

also act as squaring strips, to maintain the bosses solid with *BC* at the proper angles. The water cores *H* do not have prints on the pattern, nor do they touch the mold, as they project only $\frac{1}{16}$ in. beyond the finished dimension of the cylinder face. Even though filled over on the rough casting, the roughing cut over the face opens them up. With a four-bolt head, the bolt lugs located at 45 deg. from a vertical center line—the



A CHIP GUARD

device, which is clamped with the tool in the holder, hardly needs any explanation.

Caring for Small-Shop Bearings

By JOHN H. VAN DEVENTER

SYNOPSIS—This article takes up some of the practical points in connection with the construction and operation of shaft bearings and tells how to make simple tests of the quality of the lubricant.

"How are you getting on with that perpetual-motion machine, Uncle Billy?"

"There is only one thing now left to be overcome, and then the machine will go."

"And what's that, Uncle Billy?"

"Oh, just friction."

Friction is the curse of the perpetual-motion inventor, and it is indeed more or less of a nuisance in the shop

a case of three, or even two, bearings on a bedplate. Unless the section of this plate is extremely rigid, any mechanic will know that it can be easily sprung out of shape to suit the lack of level or flatness level of the floor on which it is placed. It is almost impossible to line up three bearings upon a single shaft without producing more or less of this binding, which is the reason that the sale of flexible couplings is on the increase. Even the use of self-aligning bearings does not do more than make it easier for the shaft to bend under these conditions. The remedy in a case of this kind is to use a flexible coupling and self-aligning bearings, dividing the work between two shafts, as shown at *C* in Fig. 1. This arrangement costs more than the arrangement shown at

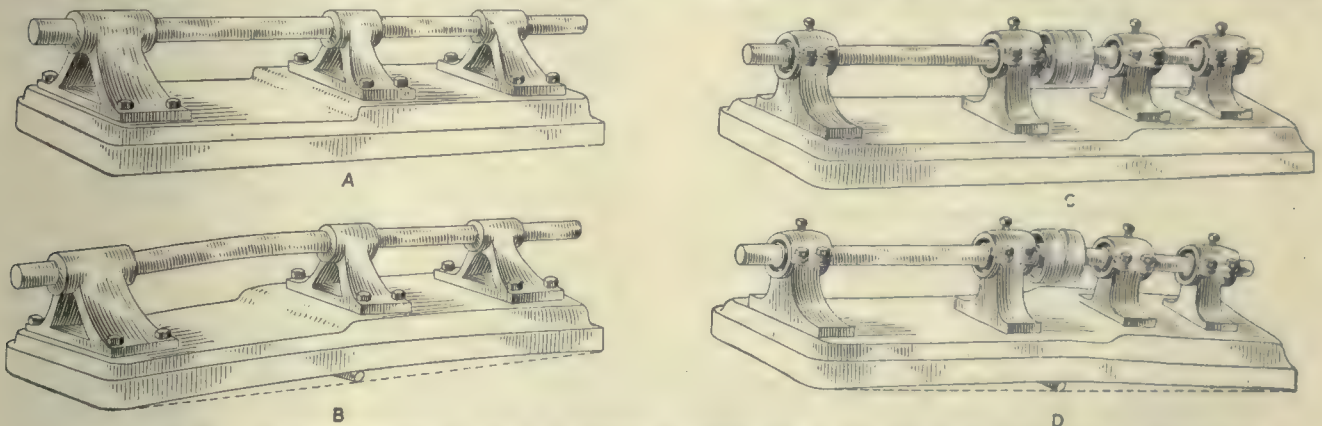


FIG. 1. SELF-ALIGNING BEARINGS AND A FLEXIBLE COUPLING MAKE BEARING FRICTION A MINIMUM

A and B—three rigid bearings on one shaft are certain to result in loss of power. C and D—four self-aligning bearings and a flexible coupling increase the first cost, but pay dividends

anyway, except in the case of pulleys and belts, where it is quite desirable to have a fair share of it. Like all other evils, it has its uses; but like most other evils, it is easier to make use of its advantages than it is to minimize its disadvantages. And then if it weren't for

A; but the man who is going to use this outfit will pay the difference, if its disadvantages are properly explained to him.

Friction is blamed for a lot of things of this kind that really should not be laid at its door. As a matter of fact,

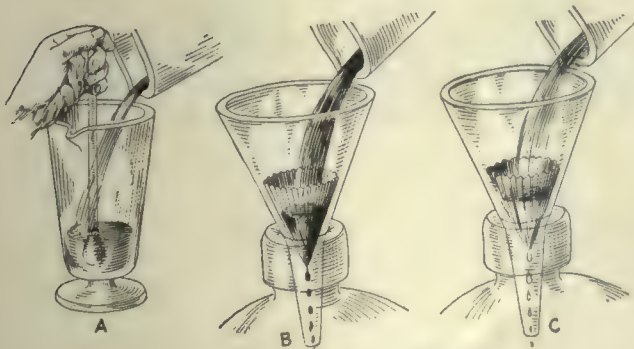


Fig. 2



D

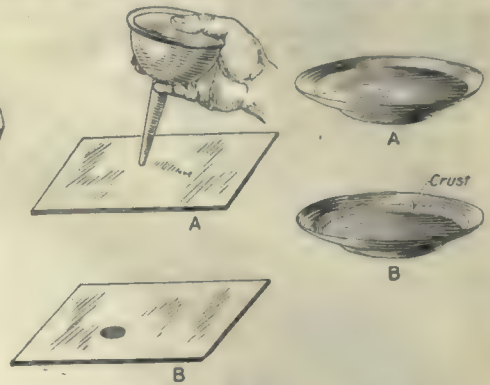


Fig. 3

Fig. 4

FIGS. 2 TO 4. VARIOUS TESTS OF OILS TO DETERMINE PRESENCE OF IMPURITIES

Fig. 2—Testing oil for solid impurities. A—Thin the oil with kerosene. B—Strain through filter paper. C—Wash the oil through with pure kerosene. D—Examine the filter paper for a residue of solid particles. Fig. 3—Testing oil for the presence of acid. A—Put a drop of oil on a polished brass sheet. B—A green spot on the brass after several days denotes acid in the oil. Fig. 4—Testing oil for the presence of resins. A—Put some oil in a saucer and leave in a warm place for several days. B—If a crust forms, it shows the presence of resins

friction, the oil dealers would lose their jobs and the price of gasoline would go up another notch to keep up the general average.

A good deal of the friction that is ordinarily attributed to bearings is in reality actual mechanical binding. Take

the reason that many shafts run at all is because they possess enough flexibility to let them turn the corners imposed upon them by bearings that are out of line.

When a bearing heats up because something of this kind is the matter with it, conditions are wrong and

should be changed, but the mere fact that a bearing gets hot does not indicate that anything serious is the matter. A modern theory has it that the hotter a bearing becomes the more efficiently it runs and the less power it wastes in friction. If made properly, bearings can be run hot enough to fry an egg upon their surface, and yet this heat need not be the cause of alarm. However, this is true of the fast-running shafts that rotate one or more thousands of revolutions per minute. When the slower-moving small-shop bearings get hot enough for culinary purposes, it is time, ordinarily, to do something with them.

A hot bearing may be caused by lack of proper lubrication or by lack of sufficiently good workmanship, and sometimes, not infrequently, it is due to a lack of knowl-

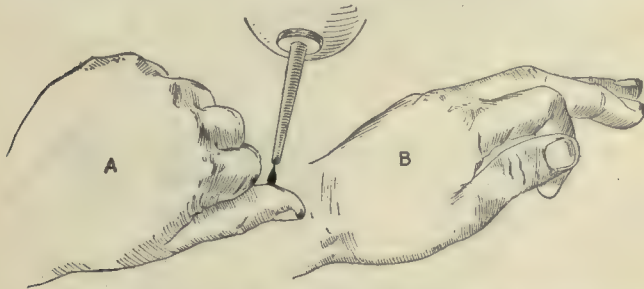


FIG. 5. A SIMPLE SHOP TEST FOR VISCOSITY

A—Place a drop of the oil on the ball of the thumb. B—If you can squeeze out the "slippery feel" by rubbing a short time, the oil lacks lubricating qualities

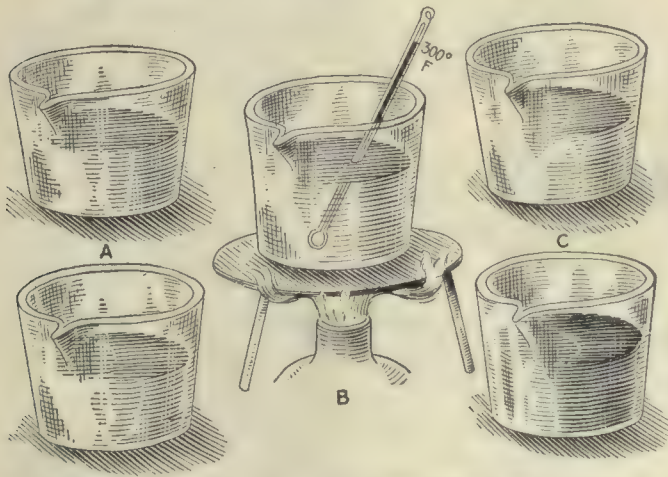


FIG. 6. TESTING OIL FOR THE PRESENCE OF SULPHUR

A—Put a quantity of oil into each of two glass vessels. B—Heat one of the samples to 300 deg. F. and maintain this temperature for 15 min. C—If the heated sample turns darker than the original, it indicates the presence of sulphur

edge on the part of the man who designed the bearing and who made it too small for the load. In the majority of cases, however, trouble is usually traced to a lack of proper lubrication.

Thus, the first and greatest rule in caring for small-shop bearings, and in fact any other, is to keep them lubricated with a lubricant of good quality, suitable for the work that they have to do.

Of course, there are people who simply will not oil a machine, out of general principles, I suppose, these people usually *not* being the ones who pay for the machines in the first place. Then there are others, and more of them, who do not neglect to oil machines on principle, but because of forgetfulness. The injury done by one of these fellows is as bad, however, and the aggregate damage is much greater. I have seen shops

(and big ones, too) where a machine that was in common use by a number of men went oilless because each one would look to the next fellow to oil it.

The crudest oiling device that exists is the "oil hole" to which oil is applied with a squirt can. The use of

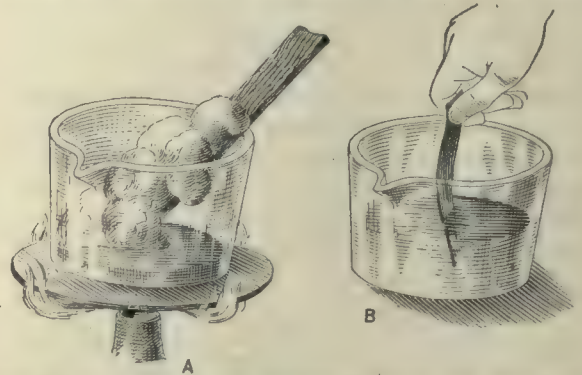


FIG. 7. TESTING THE "NEUTRALITY" OF GREASE

A—Melt a quantity of the grease. B—Test with litmus paper. If blue litmus paper turns red, it indicates acid; if red litmus paper turns blue, it indicates alkalies. A very slow change of color indicates a neutral grease

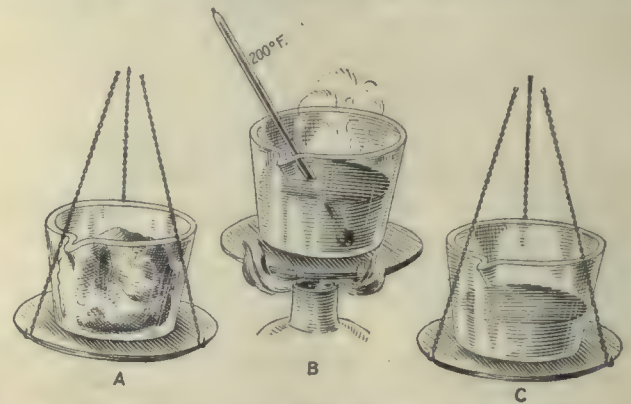


FIG. 8. TESTING GREASE FOR VOLATILE MATTER

A—Weigh a quantity of grease on a sensitive balance. B—Heat at 200 deg. F. for 2 hr. C—Weigh again. The difference in weight is an indication of the amount of volatile matter, such as benzine, naphtha, etc., in the grease

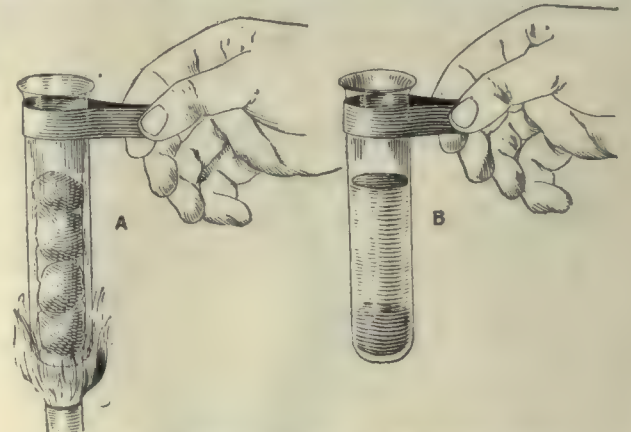


FIG. 9. TESTING A GREASE FOR "FILLING"

A—Melt some grease in a test tube. B—A cloudiness at the bottom of the tube indicates soap or other filling

the word "engine lathe" is almost a slander on the steam engine, for no matter how depraved and lost to hope be the designer of an engine he still retains a certain sense of shame that prevents him from teetotally ruining the design of his engine by providing for squirt-can lubrication. No, indeed, he puts on sight-feed oilers, even on farm engines in which the bearings are not scraped. What a pity to see excellent workmanship

wasted on hardened and ground spindles and high-grade bronze bushings such as we find in machine tools and then to think that the lubrication and like of these expensive bearings are left to the chance finding of a squirt-can hole! When you get a machine in which the important bearings have been mistreated in this way, do yourself a favor by tapping out the holes and adding

These gears made it possible for the table to run intermittently, slowly when milling the lugs and fast across the spaces.

It will be noticed that the teeth on the driver gear are cut on angles of 75 and 45 deg. with its axis, and the teeth on the driven gear are 15 and 45 deg. with its axis. When the 75-deg. teeth on the driver gear are in mesh with the 15-deg. teeth on the driven gear, the driven gear revolves slowly; but as soon as the 45-deg. teeth of the driver gear are in mesh with the 45-deg. teeth on the driven gear, the driven gear revolves fast.

It is understood that the driver gear revolves at a constant speed, only the driven gear changing speeds. The full lines show the gears complete; the dotted lines show the part of the teeth that must be removed with an end mill to allow freedom in turning.

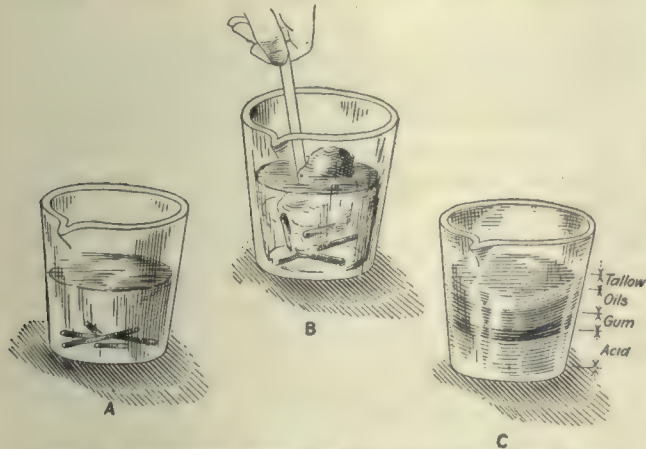


FIG. 10. TESTING GREASE FOR TALLOW AND GUMS

A—Place some pieces of copper wire in a concentrated solution of nitric acid. B—Add some grease and stir. C—After an hour the ingredients will arrange themselves as shown

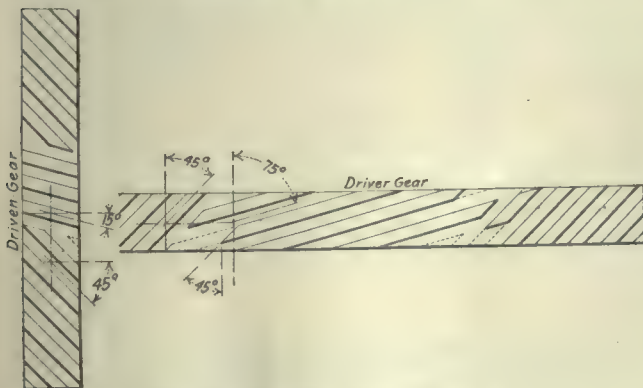
sight-feed oil cups, incidentally crediting yourself for this act by adding a couple of years to the probable life of the machine on your depreciation sheet.

An article of this length is a small place to cover the big subject of bearings, even for small shops. The man who is interested in the design and operation of bearings will find this subject fully covered in the "American Machinist Bearing Book." So I will use this space for pointing out certain simple tests for oils and greases—tests which need not be made in the laboratory, but which can be made in Mrs. Small-Shop Man's kitchen, if necessary.

Intermittent Spiral Gears

By D. WATSON

The illustration shows the developed layout of double-lead intermittent spiral gears on the pitch line. These double-lead spiral gears were used on a special machine



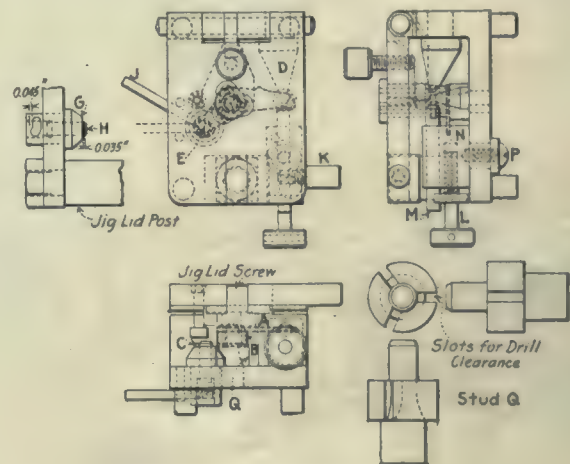
INTERMITTENT SPIRAL GEAR

for milling work that had 15 lugs about 2 in. apart in a straight line. They were too far apart to let the cutter run idle over the spaces at the regular cutting feeds.

Feather-Pinning Jig

By M. A. BOWYER

Fig. 1 shows what is known as a feather-pinning jig. Into the holes drilled in the pieces rivets are driven and riveted over. The work consists of three pieces—A, B and C. The piece B is made of $\frac{7}{16}$ -in. cold-rolled steel, with a $\frac{3}{16}$ -in. hole drilled and reamed in it and a hub $\frac{1}{4}$ in. in diameter on each end. These hubs are as long respectively as the thicknesses of the pieces A and C, which have a $\frac{1}{4}$ -in. hole reamed to fit over the hubs. The important stop-



FEATHER-PINNING JIG

ping point on the piece A is shown in contact with the stud D. The locating point of the piece C is the hole E.

This jig was first made with a solid stud at E, but the workmen had trouble getting the work off, owing to the extremely snug fit in the hole and also on account of the thin, springy material. These unsatisfactory conditions were improved upon, as shown.

The device now consists of a cam arrangement that allows the locating stud to drop out of the hole. The small hole of the part G is lapped to fit the locating stud H snugly. The lever J is shown by full lines in the position it has when the work is loaded and by the dashed line when the work is unloaded.

It is not good policy to use a screw against as thin a piece as A, so the clamping of this part on the stud D is done by the screw L acting on the pin M. The stud N has a tenon turned on one end, driven into the jig and held by the screw P. The handle K is used to raise the lid.

Tools Used in Machining a Turret-Lathe Head

By ROBERT MAWSON

SYNOPSIS—In this article are shown the tools for machining the head, tailstock and apron of a turret lathe. The fixtures used in boring the head and tailstock are provided with long guide bearings. Slip bushings are furnished to guide the bars during the rough- and finish-boring operations. The drilling jigs for the head are supplied with locating plugs so that the holes are machined in alignment. The apron jig locates the rough casting after the bar has been machined and is provided with a cover.

On page 1007, Vol. 44, is shown a turret lathe made for the Reed-Prentice Co. by the Blake & Knowles Steam Pump Works, East Cambridge, Mass. In this article are illustrated some of the tools for machining important

parts of these lathes. The fixture used in boring the head is designed with supports at each end and in the center. The planed base of the casting is located against pins and screw poppets tightened against bosses to hold the casting against strains. Straps hold the casting securely during the boring operation. In the jigs employed in drilling, plugs fit into the bored holes to produce the desired alignment.

The tailstock boring jig has straps and setscrews to hold it in the fixture after it has been located by pins. In this tool the same design of boring bearings to obtain good alignment is observed as was shown in the head-boring fixture. The jig for the apron is provided with a cover and, after the casting has been accurately placed and clamped in the tool, is held down with swinging bolts. It will be observed that this latter is provided with substantial legs forming an integral part of it.

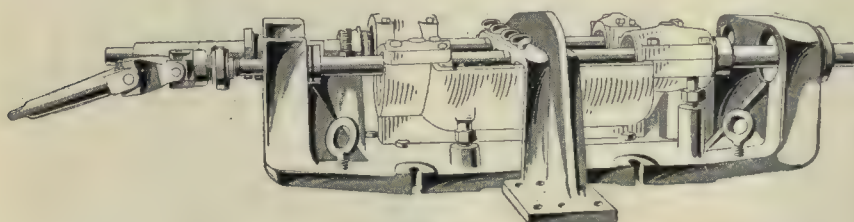


FIG. 2

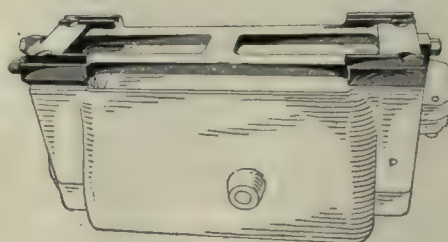


FIG. 3

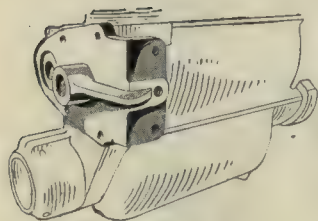


FIG. 4

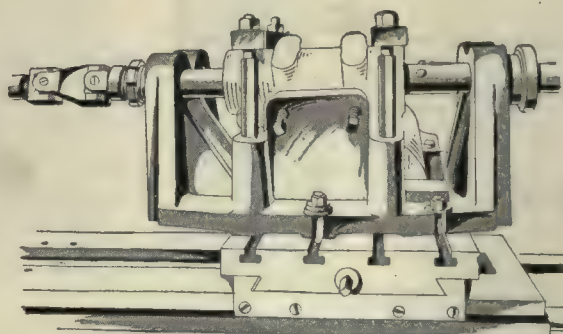


FIG. 6

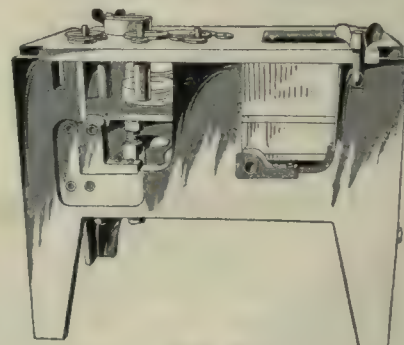


FIG. 8

JIGS AND FIXTURES USED IN MACHINING A TURRET-LATHE HEAD, WITH WORK SHOWN IN POSITION

FIGS. 2 AND 2-A

Operation—Boring the head, Fig. 1. The planed casting is located against pins and held down with straps. Screw poppets are then tightened against bosses to assist in holding the casting against the boring strains. The bars are guided at each end and through a bracket in the center.

Holes Machined—One 5-in., one 2½-in., one 4½-in. and one 5¾-in. bored.

FIGS. 3 AND 3-A

Operation—Drilling holes in base of head, Fig. 1. The jig is placed on the planed base of the casting and forced back against an adjustable stop with a setscrew.

Holes Machined—Four ¼-in. drilled.

FIGS. 4 AND 4-A

Operation—Drilling holes at end of head, Fig. 1. Jig is located by a 4.122-in. plug that fits into the 4½-in. bored hole. On the right-angle side of the jig a plate rests against the planed base, thus locating the jig.

Holes Machined—Four ⅜-in. drilled and one 1½-in. spot-drilled and reamed.

FIGS. 6 AND 6-A

Operation—Boring tailstock, Fig. 5. The machined casting is located by stops and held down by setscrews on the sides and straps on the upper surface. The boring bars are guided at both ends by boring tool-steel hardened bushings.

Holes Machined—One 4¾-in. bored and one 3¾-in. bored. The end of the latter hole is tapped for ¾ in. with a 4-in.-12 U.S.F. thread. The bars on this fixture are arranged with one-point cutters.

FIGS. 8 AND 8-A

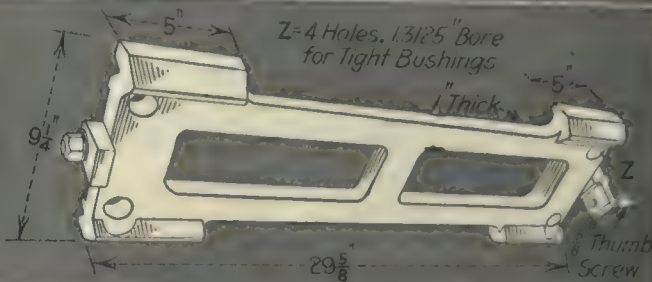
Operation—Drilling and reaming apron, Fig. 7. The milled casting is placed on adjustable screws and held down by straps. The cover of the jig is placed in position, being held with nuts on bolts fitting into slots.

Holes Machined—One 47/64-in. drilled, one ¾-in. spot-drilled and reamed. One 2¼-in. spot-drilled and reamed, one hole drilled for 1½-in.-14 U.S.F. threads, one 1½-in. spot drilled and reamed, two ½-in. drilled, four ⅝-in. drilled for ⅝-in. U.S.F. threads.



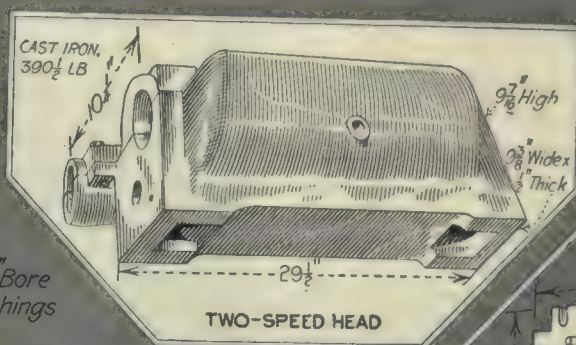
TIME OF OPERATION,
7 HOURS

FIG 2-A



TIME OF OPERATION,
6 MINUTES

FIG 3-A



TWO-SPEED HEAD

FIG 1

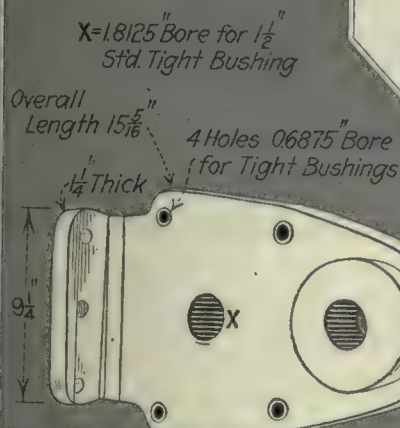
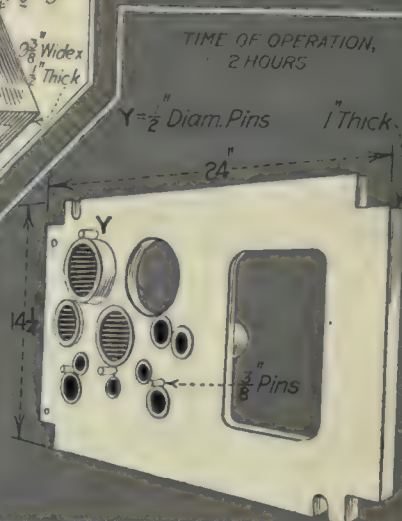


FIG 4-A



APRON

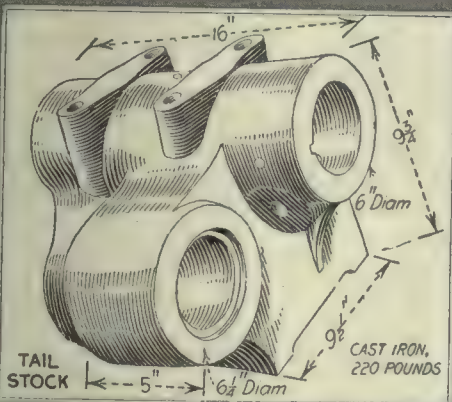


FIG 5

NOTE
ALL BUSHINGS USED FOR
GUIDING TOOLS ARE BLACK-
ENED OR HEAVILY RULED. ALL
JIG AND FIXTURE BODIES
ARE CAST IRON, STRAPS AND
FASTENINGS, MACHINERY
STEEL; GUIDE BUSHINGS
ARE TOOL STEEL, HARDENED
AND GROUND

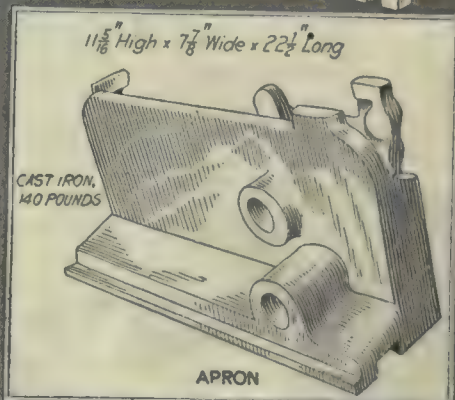


FIG 7

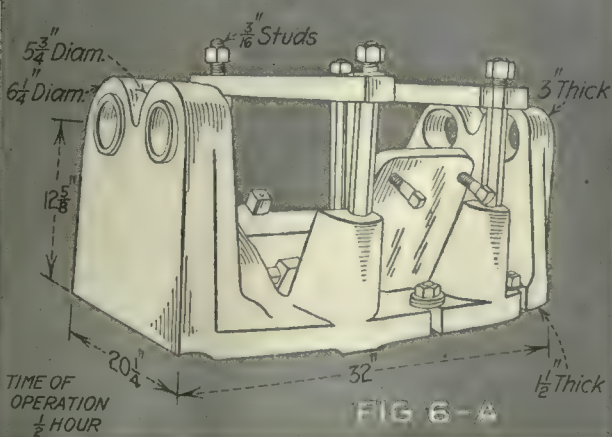


FIG 6-A

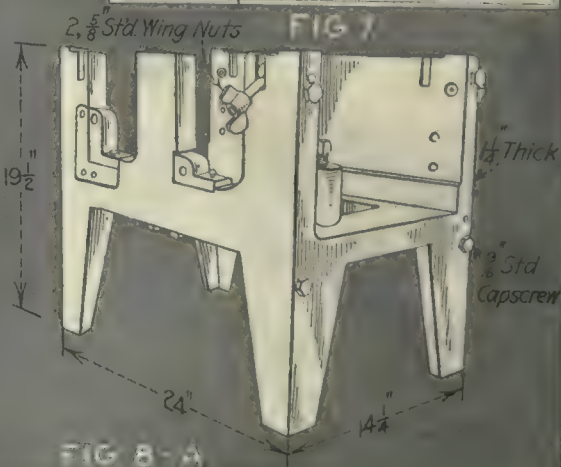


FIG 8-A

Interesting Hardening Plant

By A. TOWLER

The Gray & Davis Co., Boston, Mass., has recently designed and built an interesting hardening department in connection with its factory. In Fig. 1 is shown a plan of the department.

A noteworthy feature of the arrangement is the overhead trolley for conveying to the various furnaces and tanks the parts being hardened. The trolley is also useful for carrying the compound and bone to the hopper, from which they can be dropped down to the packing bench as required.

A view of the side of the department where the muffles, small crude-oil furnaces and lead pots are placed is shown in Fig. 2. In Fig. 3 are illustrated the cooling-oil tank, with cooling screen over it, also the motor-driven blower and air compressor. In front of the air compressor may be seen a number of tote boxes with parts ready for hardening or heat-treating. In front of the oil tank and screen may be observed the hot-potash tank; in one corner is the steam pipe for heating the liquid. This hardening department was designed after much investigation on the subject and is giving good satisfaction under regular commercial conditions.



FIG. 4. VIEW OF FURNACES

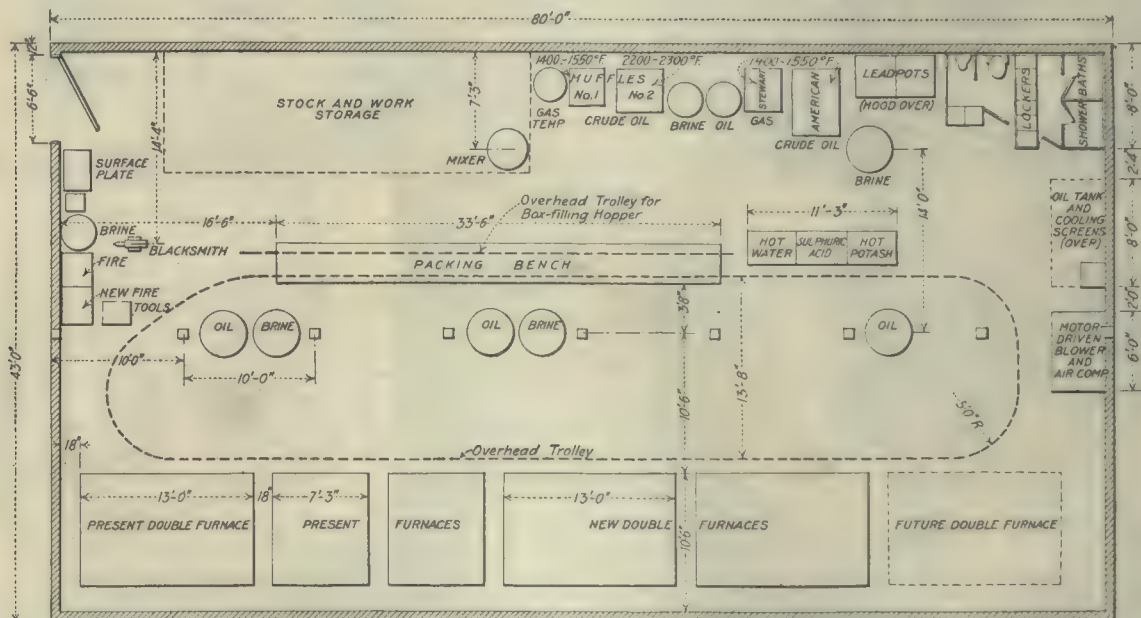


FIG. 1. LAYOUT OF THE HARDENING DEPARTMENT



FIG. 2. VIEW OF MUFFLERS AND LEAD POTS



FIG. 3. VIEW OF OIL TANK AND COOLING SCREEN

A 5,000-Hp. Silent-Chain Drive

By JOHN R. ALLEN*

SYNOPSIS—The waterwheels for this development were designed for a head of 42 ft. and a speed of 225 r.p.m. Owing to lack of head, their operating speed was 147 r.p.m. By connecting two wheels to the generator shaft through silent-chain and sprocket drive the speed of the generator was stepped up to 225 r.p.m.

At the time of the construction of the present temporary plant the Oxbow Bend power house of the Idaho-Oregon Light and Power Co. presented a peculiar engineering problem. The plant is located near Copperfield, Ore., at what is called the Oxbow Bend of the Snake River, about 60 mi. north of Huntington. It is $2\frac{1}{2}$ mi. around the bend of the river, and the distance

In the meantime the company was placed in the hands of a receiver, who found himself very much handicapped for lack of power. There was also a possibility that if this power house was not completed the company's water rights in the Snake River would be forfeited. It was desirable, then, that this construction work be made use of as far as possible in building a temporary plant. It was at this point that I was called on to advise the company in regard to what could be done to obtain power from the Oxbow plant without expending any large sum of money. The amount of money available made it impossible to build a dam, as originally planned, or to buy new machinery. The problem was to use the construction work, the waterwheels and the generator already owned by the company and to combine them into an operating power plant sufficient for the purpose.

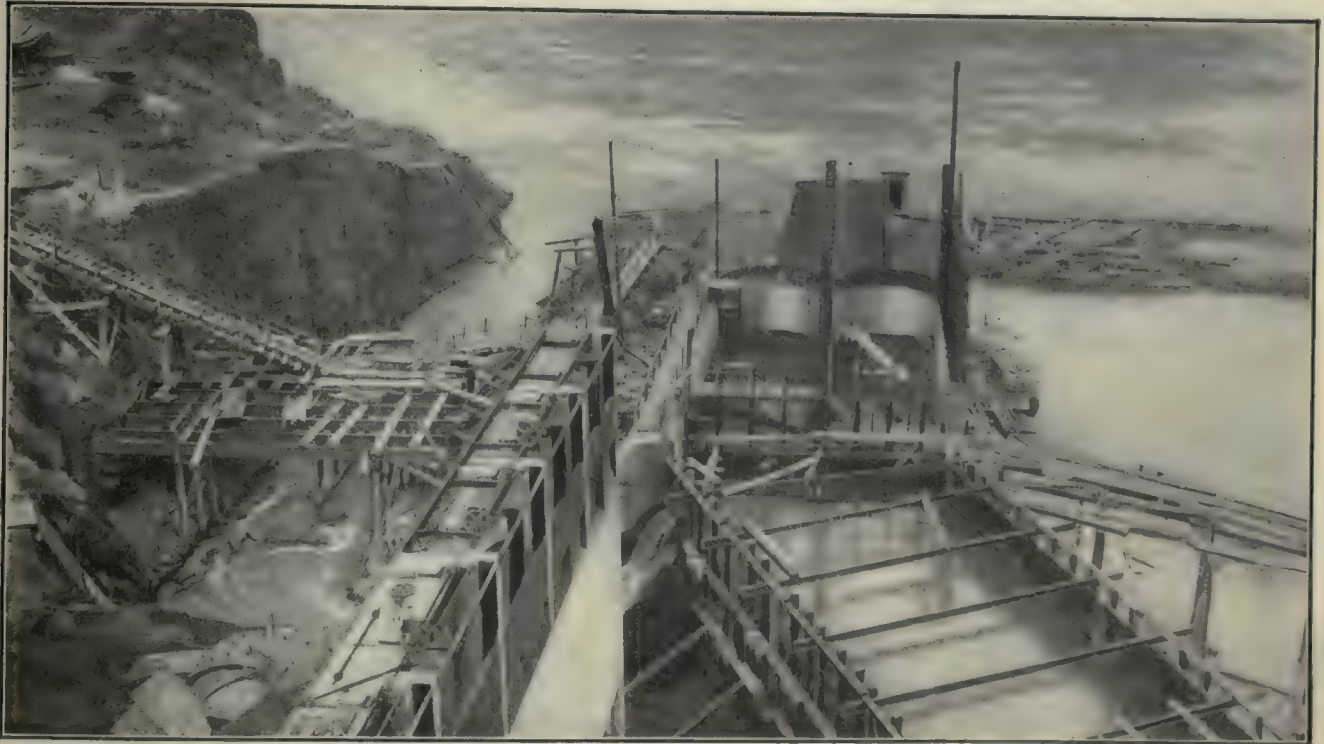


FIG. 1. A GENERAL VIEW OF THE PLANT

across the bend at the narrowest point is only 1,300 ft. The natural fall in the river in passing around the bend is 21 ft.

It was the original intention to build a dam across the Snake River, raising the water so as to give a head of 42 ft. at the power house. The tunnel across the bend was entirely completed, also the headgates at the entrance to the tunnel. The company having charge of the original construction had also purchased the waterwheels and two of the generators. The waterwheels had been purchased for a head of 42 ft., at which their speed would be 225 revolutions. At this point in the construction the company was forced to stop operations, owing to lack of funds, and the construction work was left for about three years.

One of the difficulties was in the fact that the generator was designed for 225 revolutions and must be operated at that speed. The waterwheels at 21-ft. head would have a normal speed of about 147 revolutions and at the lower head would develop less than one-half the horsepower required by the generator. It was decided that, if possible, the experiment would be tried of driving one generator from two waterwheels, provided some form of geared drive could be employed to give the proper speed ratio between the generator and the waterwheels.

The first consideration was the use of large miter gears. These were seriously studied, but were given up owing to the difficulty that would be encountered in the gears being so large as to cut into the tailrace and prevent a proper discharge of water from the wheels. In addition, the expense of very large gears, such as

*Professor of mechanical engineering, University of Michigan.

would be necessary in this case, the shafts being 10 ft. 9 in. on centers, would be excessive. There was also suggested the possibility of using a crank and connecting-rod drive. This, too, was rejected owing to the many difficult problems involved in construction of this kind.

the concrete-steel penstocks in which are located the waterwheels. The wheels consist of four 48-in. wheels on a single shaft, there being two such sets.

A general view of the plant is given in Fig. 1. One set of chains and the generator are shown in Fig. 2.

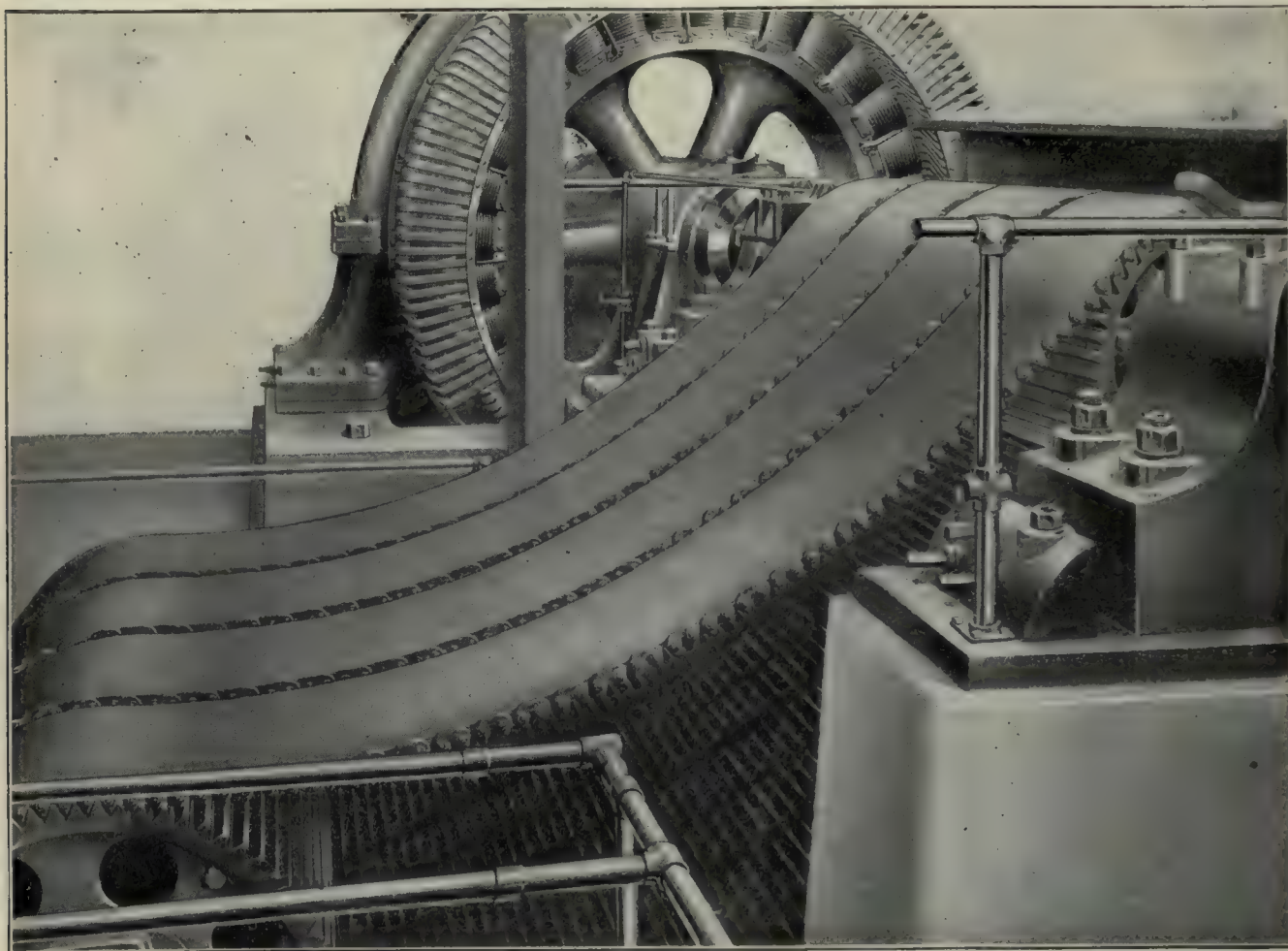


FIG. 2. ONE SET OF CHAINS AND THE GENERATOR

The third means considered was a silent-chain drive, which involved less expense and took up less space than any other form of drive proposed. In laying out the temporary plant it was found that it would be necessary to lower the wheels 5 ft. from their position as originally planned, in order to obtain a sufficient head of water over them in order not to draw air. The lowering of the wheels brought the waterwheel shaft very close to the floor of the power house, but by the use of a chain drive the sprocket wheels were reduced to so small a size that they did not cut into the engine-room floor to any depth. Previously to this time no silent-chain drive had been made for more than 1,250 hp., and it was with some misgivings that plans were made involving the transmission of 5,000 hp. The question of using so large a drive was taken up with firms making chains of this type and the contract was awarded to the Morse Chain Co., Ithaca, N. Y.

The hydraulic tunnel is 26 ft. wide, 26 ft. high and 1,300 ft. long. When the plant is in operation, the velocity of the water through the tunnel is about 7 ft. per sec., with a loss of head of about 1 ft.

A temporary tailrace of timber and steel was built to carry the water from the lower end of the tunnel to

Fig. 3 shows a layout of the shafts, sprockets and chains. The power house is built of monolithic concrete construction up to the roof. The entrance is through the roof. This construction was necessary, as at times of high water the power house may be submerged to a depth of 8 ft. above the operating floor. One peculiarity

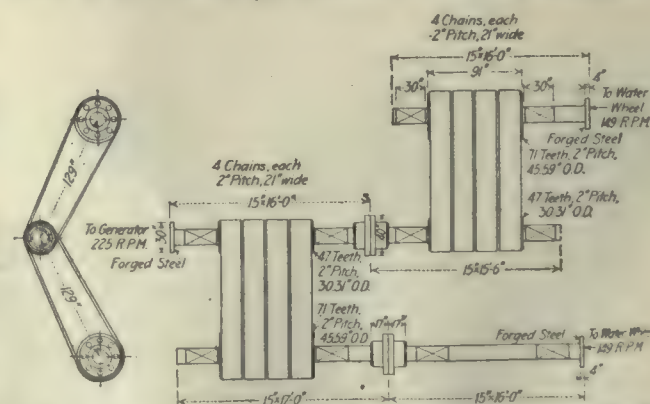


FIG. 3. LAYOUT OF SHAFTS, SPROCKETS AND CHAINS

of this plant, however, is the fact that during periods of high water the level of the headrace rises about as much as the level of the tailrace, so that an approxi-

mately uniform head of water can be obtained at the wheels at all times.

The plant has now been in operation since September, 1914, and the only shutdown that has occurred has been due to ice trouble. The chains have given satisfaction. The operation of the chains is almost noiseless, and the sound made by the revolving armature of the generator is much more noticeable than the sound of the chain. In the drive there are eight chains, each 21 in. in width with a 2-in. pitch. The driving sprockets have 71 teeth, and the driven sprockets 47 teeth. The distance from center to center of the shafts is 129 in. The linear speed of the chain is 1,765 ft. per min. The main shafts are 15 in., and the main bearings are 15x30 in. Each sprocket is supported with a ring-oiling main bearing close to the sprocket at each end. From the first day upon which the plant started, the chains and operating mechanism have run without difficulty of any kind.

Building a Large Marine Engine Crankshaft

By R. M. SHERMAN

Each builder of large marine engines has his own opinion as to how a crankshaft should be made. While it is by no means difficult to build crankshafts, it is quite a different matter to produce one that, when finished, will be of

and the exact source will be difficult to find. If the crankshaft does not run true and the pins are out of line with the shaft, it is almost impossible to line an engine up correctly, thus impairing the efficiency of the engine and increasing the fuel bill.

One of the many results of a faultily built and machined crankshaft will be hot bearings, which are a source of much annoyance to the engineer, besides interfering seriously with the performance of the engine, and which might result under certain circumstances in the loss of a ship. It is therefore of the utmost importance that the building and machining of a large marine-engine crankshaft should be intrusted only to mechanics who have had experience along this line.

Quite frequently the crank webs are delivered rough-forged in the machine shop. In such cases the first operation is to ascertain if there is sufficient stock left so that the webs will machine true to drawing size, which is determined by a sheet-steel templet. After this has been done, the crank webs are placed on a planer or miller and machined to the required thickness.

Since the web is a solid mass, as shown in Fig. 1, it would require considerable time to drill and bore it for the shaft and pins. To avoid this, two $\frac{3}{4}$ -in. holes are drilled for a starting point, and then, with an acetylene cutting outfit, holes are cut about 2 in. smaller in diameter than the given size, thus allowing ample stock for finishing on the boring mill and taking care of eccentric cuts.



FIG. 1

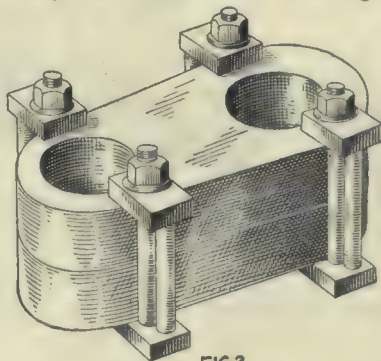


FIG. 2

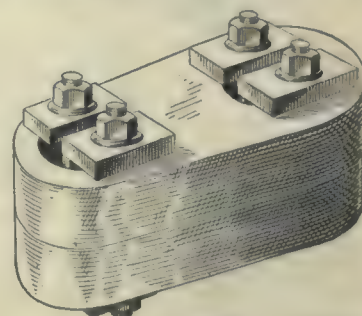


FIG. 3

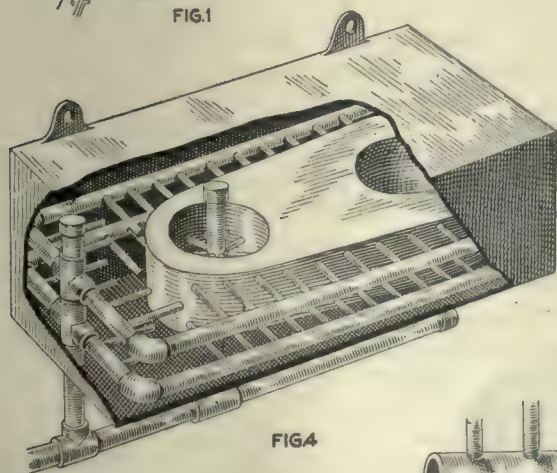


FIG. 4

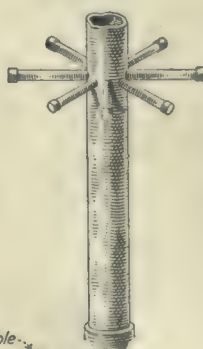


FIG. 5

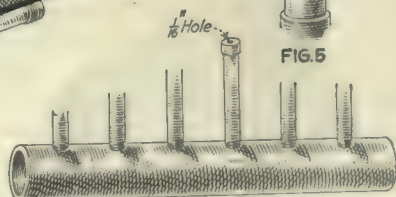


FIG. 7

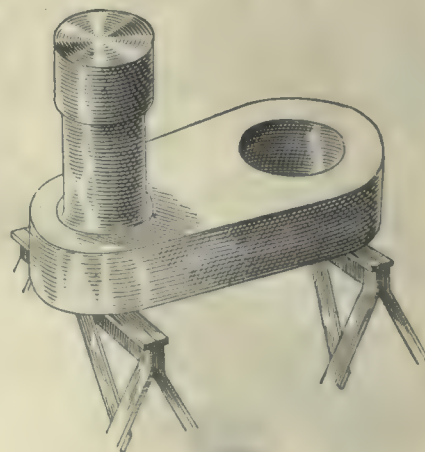


FIG. 6

FIGS. 1 TO 7. THE CRANK WEBS AND HEATING DEVICES

100 points excellence and that will render unfailing service. The heart of a ship is its propelling machinery; and if it has a reciprocating engine, the crankshaft is a basic factor of this heart. If the alignment of the finished crankshaft is poor, chronic trouble will soon develop

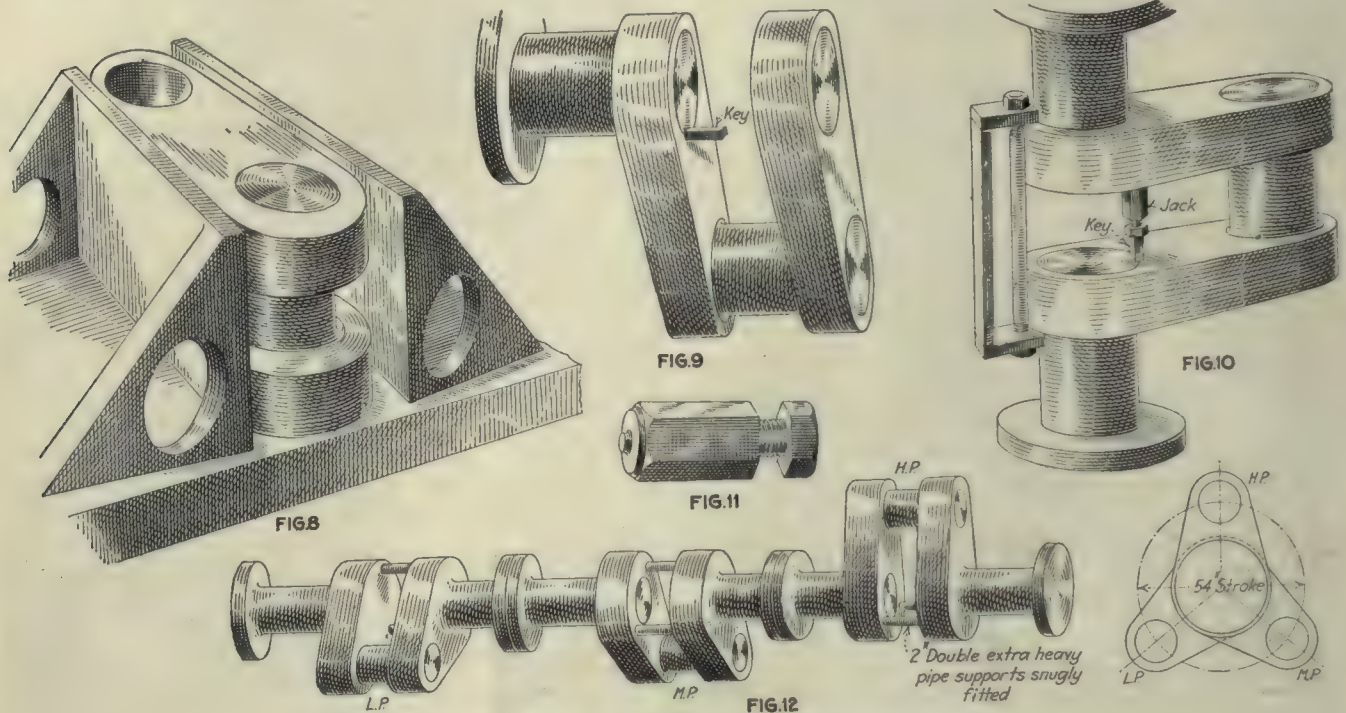
All burrs are removed, after which the crank webs are carefully laid out, assembled in pairs and clamped rigidly together, as in Fig. 2. They are placed on a vertical boring mill, where they are accurately set and bored. Keyways are cut and clamps changed to the inside of holes

without disturbing the position of the webs, as in Fig. 3. The next operation is to slot the ends and sides parallel with the bore, or at right angles with the face. To obtain good results after the shaft has been shrunk together, this work must be done accurately. The webs are then disassembled, outside corners well rounded and a guide block fitted to the keyways in both the webs and the shafts.

To produce a maximum grip of about 20,000 lb. per sq.in. on the crankshaft and pins, which from past experience has proved satisfactory, the pins and shaft are

Having shrunk a pin in each web, as shown in Fig. 6, two angle plates are set on a platen, Fig. 8, and the other web heated and shrunk on. This operation insures accurate alignment for the shaft and pins, if all previous operations have been skillfully executed. As there is a keyway in both the web and the shaft, a guide block that has been previously fitted to both is used to keep the keyways and the shaft holes in line.

As will be seen from Fig. 9, one shaft is shrunk in each web, after which the keys are accurately fitted and driven



FIGS. 8 TO 12. BUILDING UP THE COMPLETE CRANKSHAFT

turned, for each inch of diameter, 0.001 in. larger than the bore of the web. In this case the bore is 18 in. and the shaft is turned 18.018 in. This practice, of course, applies to solid-steel shafts and pins and to webs made of forged steel. Should the shafts and pins have an axial hole through them, the allowance should be slightly increased, owing to the fact that the hollow shaft is more compressible.

To insure an even temperature, which is of vital importance, the webs are placed in a sheet-steel box made expressly for this purpose. The arrangement may be seen in Fig. 4. Gas pipes fitted with burners about 2½ in. apart, to suit the shape and size of the piece to be expanded, are placed in the box and around the web, as shown. In the center of the bore is fixed a vertical pipe that has a number of burners diffusing heat in all directions. The pipes are connected to the gas main, and the flow is regulated by the valve, as the case may require. The construction of the burners, which are simple and inexpensive, is illustrated in Figs. 5 and 7. With an outfit of this kind the temperature of the webs is quickly and evenly raised to any reasonable point.

The temperature to which crank webs should be raised in a shrink fit for clearance in assembling should not exceed 600 deg. F. and should be slightly less when handling facilities are good. When the web has been expanded sufficiently, the crankpin is placed in position and the temperature of the web reduced by an even application of cold water.

home with a heavy maul. The other section is then shrunk in, and the open ends of the webs are clamped, as in Fig. 10. As there is no room to use a maul, a screw-jack, Figs. 10 and 11, made especially for driving these keys, is used.

The crankshaft is then assembled, and supports are fitted between the webs, as shown in Fig. 12, after which the shaft is put in the lathe and tested. If all previous operations have been carefully handled, the assembled shaft should not run out more than 1/64 in. The centers are drawn so that the alignment of the pins will be correct, and the shaft is turned to a snap gage.

The crankshaft shown is built so that each section is interchangeable. It weighs, when finished, 51,700 lb.



High-Grade Nonfluid Oils, it was pointed out in an article on good and bad lubrication presented in the "Journal" of the American Society of Naval Engineers, have all the advantages of soap lubricants but none of their disadvantages, and in addition they possess the property of adhering to metal surfaces with a force that is considerably above that possible with fluid oils. They are all of high viscosity and can only be fed drop by drop. In that they prove economical, as with ordinary oil a greaser can and frequently does squirt oil with a lavish liberality not only on the part needing it, but also on any parts adjacent. It is not to be supposed that this slow feeding is a disadvantage even where a bearing has run hot, as, owing to its clinging properties, it films immediately on reaching the moving part and so forms an ideal lubricant. Nonfluid oils, also, will not gum, and they can be used without risk of clogging in central distribution systems provided the oil tubes are of sufficiently large internal diameter to permit of the oil flowing.

Effect of Peace on the Demand for American Machine Tools

SPECIAL CORRESPONDENCE

SYNOPSIS—A study of the conditions in European markets, with an attempt to forecast the after-war demand for machine tools. It is estimated that some \$22,000,000 worth will be required at once.

While fighting is still going on in Europe the possibility of a return of peace already begins to influence commercial conditions, especially in the neutral markets. Exporters and importers are beginning to maneuver for position. The change from the conditions of war to those of peace will not be easy. It must be realized that the struggle has cut deeply into the economic life of all the nations involved, including the neutrals. It is therefore necessary to begin early, so as to shorten as much as possible the period between the end of war and the reestablishment of normal conditions.

It appears that the American machine-building industry, especially the machine-tool industry, will play a considerable part in the economic upbuilding of Europe after the war, and it therefore seems necessary that the representatives of that industry, both at home and abroad, should be fully conversant with all the preparations made in Europe with a view to coming peace, so as to be able to equip themselves for any emergency likely to arise.

The effects of the war on the European machine-tool industry have been of various kinds. In the countries of the Allies, where a large importation of American machines has taken place, conditions must be different from those in Germany, or again from those in neutral markets. Consequently, in each case different steps will have to be taken, both to reestablish connections and to select the machines to be supplied.

THE CONDITIONS IN GERMANY

To start with Germany, the effects of the war on the machine-building industries in that country have already been explained in the *American Machinist*. It seems only necessary to say a few words about those points that will interest the importer of American machine tools. Germany was a very good customer for American machine tools before the war. Her engineers realized early the advantages offered by American machines and have made good use of such machines. American machine tools were imported into Germany to the value of about \$2,000,000 a year; the exact figure for the year before the war being \$2,167,240. Allowing a depreciation of about 10 per cent. on such machines, one would estimate a total value of American machine tools existing in Germany before the war at about \$11,000,000, or even more. There is, furthermore, no doubt that Germany has been able to secure American machine tools from other sources than America since the outbreak of the war, which may have raised the American machine-tool equipment in Germany to a value of about \$14,000,000. Probably for the years of the war a much higher depreciation of machine tools will have to be accounted for than the

usual 10 or 15 per cent., and 25 per cent. is possibly not too high. Thus the book-value of the American machine tools installed in German plants at the end of the second year of the war would be about \$10,500,000.

A number of the older machines may have become entirely unsuitable for use and will go to the scrap heap after the war. This, however, may not impair the usefulness of the great majority in a time like the present, where every machine is used to its utmost capacity. Depreciation and new demand resulting from depreciation and ultimate destruction, however, can have only a comparative meaning if applied to foreign trade. Even during the war American machine builders have seen new competition growing up in Germany. It is said that several firms have taken up the manufacture of machine tools that formerly had to be imported. While the manufacture of these tools was unprofitable as long as they could be imported, it became profitable, however, the moment there was no other way of getting them than by making them at home. This competition may impair the probable demand for American machine tools after the war as far as Germany is concerned.

On the other hand, there are a number of reasons that speak for an increase in the demand. First, there is the fact that Germany has been accustomed to the buying of machine tools from American makers at a fairly high rate and that she has been unable to buy for nearly two years. Second, there is the certain lack of machine tools of all kinds imported or built at home which will become more and more pronounced when the war is over and normal conditions begin to rule again. Germany, like all the other countries, has gone through a period of national economy; and while saving may still be a virtue after the war, there are certain things that cannot be left undone. German manufacturers may think it wise to buy from abroad, in this case from this country, rather than to wait until the needful supply can be covered by the manufacturer at home. All of which would mean not only a return to the former import figures, but possibly an increase in the demand.

Finally, there is the influence of all who are interested in a speedy reopening of trade relations between this country and Germany after the war, which should not be underestimated as a powerful factor in bringing about a reestablishment of the foreign trading connection. It appears, therefore, that the sales of American machine tools in Germany after the war may be very heavy.

CONDITIONS IN AUSTRIA-HUNGARY

Austria-Hungary, to continue with the Central powers, has not been a very large customer for American machine tools, buying on the average only about \$250,000 worth a year. Part of the machines sold to Germany may have found its way to that country. The economic conditions of Austria-Hungary, since the outbreak of the war, however, have been about the same as those of Germany. And even if Germany should have been able to secure American machine tools in small number it seems practicable

ally impossible that Austria should have been able to do so. Moreover, the country has been in the habit of buying large numbers of German machines every year, a field of supply that must have been fairly limited during the last two years. In 1913 alone Austria bought \$3,110,000 worth of German machine tools. Austria herself is building certain classes of machine tools, but the figure given above shows how largely she has been depending on her neighbor. It is doubtful whether Germany will, after the war, be able to take care of all the business of her present ally, and Austria may be compelled to go for her supply to other markets.

Both countries are making extensive preparations for the coming of peace. One of the most difficult problems to be faced is the reëntering of the small artisan, who has been serving as a soldier, into the economic life of the community. He will need capital, and the large number of invalids will have to be supplied with suitable machines for carrying on their trades. This will affect the small machine-building industries and may bring about a large demand for small machine tools and even automatic machines. The extent of this cannot be foreseen now. The fact in itself, however, should be noted. Municipal money will be used for the purposes of reëstablishing these artisans.

CONDITIONS IN THE BALKAN STATES

Bulgaria, the third in the number of the Central powers, has never been a large customer for American machine tools and most likely will not be so after the war. Austria, Germany, and to some extent Italy, have taken care of the requirements of that market and most likely will continue to do so. The same may be said for Turkey.

Servia, Montenegro and Greece have also shown a decided favor for machine tools from Germany, Austria and Italy. The continuation of that business will depend entirely upon the peace that will be made. Greece may continue to buy from Germany and Austria, while a change is predicted in the attitude of Servia and Montenegro. The conclusion of the treaty between Germany and Rumania seems to indicate a continuation of the commercial relations between these countries that will assure to Germany a sale of machine tools to Rumania of about \$140,000 a year.

CONDITIONS IN GREAT BRITAIN AND FRANCE

Turning to the group of powers commonly called the Allies, England has been by far the largest customer for American machine tools since the outbreak of the war. She bought from this country in the year before the war \$3,178,000 worth of machine tools, roughly \$1,000,000 more than Germany. England has had the advantage of being able to secure as many machines as she wanted, and it would not be astonishing if more had been bought than were actually needed. It may be that after the war England will not only quickly return to her peace requirements, but may even buy less until the machines bought during the last two years have been assimilated by her industry under peace conditions. The probable decline, therefore, in the imports of machine tools coming into England from Germany and averaging yearly a value of \$1,500,000 before the war most likely will not have any material effect on the English orders from American makers, at least for the first two or three years.

France has also been buying on a considerable scale in this country since the outbreak of the war. The condi-

tion of France, however, is different from that of England. While England in increasing her equipment has used existing possibilities, France had to create a new industry, necessitating machine tools to a value of about \$10,000,000 and more a year. France has always been an enormous importer of machine tools even under normal conditions. Germany alone used to supply her with \$3,000,000 worth a year while this country sold her \$1,771,000 worth the year before the war. All in all, France imported yearly about \$10,000,000 worth of metal-working machine tools. Considering this figure, and that she has had possibly very few machines from England since the outbreak of the war, and none from Belgium and Germany, the present requirements cannot be called at all excessive. In fact, it is astonishing that France should have been able to get along with so small a supply.

Further, one will have to keep in mind that the main districts of the French machine industry are at present in German hands and that according to reports the machine-building plants have been depleted of their stock both by the retiring French and the in-coming Germans. Therefore there is every possibility that France after the war not only will continue to buy machine tools at the present rate, but even may increase her orders until her machine-building industry has completed its equipment.

Belgium, another of the Allied nations, has been practically in the hands of the invading armies and has ceased to be a buyer of machine tools since the beginning of hostilities. The little country has been a very good customer for American machine tools for many years and it looked very much as if the imports would reach the \$1,000,000 mark during the year before the war. The record was suddenly interrupted during August of 1914. Belgium has imported about \$2,500,000 worth of machine tools every year, the majority coming from Germany. In addition, she has been a manufacturer of such tools herself. As it is said that the country is practically emptied of metal-working machines, her requirements for such machines may be considerable after the war. It is certain that America will have a large part of the orders. The likely demand for machine tools of the character of those as a rule exported by America should be somewhere around \$15,000,000, or even more.

CONDITIONS IN ITALY AND RUSSIA

The conditions in Italy are complicated, seeing that the country while having war with Austria-Hungary, is technically at peace with Germany, even to the point of occasional commercial intercourse. With an open sea, she has been able to buy as many machine tools as she wanted, and considering that the industrial expansion of the country after the war most likely will go forward on the same scale as before, there is very little reason why the demand should become larger than it has been. About two-thirds of the machine tools imported into Italy came from Germany.

Russia also has been able to buy all the machine tools she required. It is said, however, that the ports of Russia are full of goods and that it is extremely difficult to move them to their destinations. Russia takes an exceptional position among the Allied nations. She has always been a large importer of industrial products and will continue to be so after the war. This tendency will be counterbalanced by the desire of her rulers to create a Russian industry, independent from foreign imports. So, what-

ever the outcome of the present war, Russia will drive slowly in the direction of closing her frontiers against foreign trade. She will attempt to make many things she is buying now, including many of those supplied at present by America and even her present allies. The building up of an industry cannot be accomplished without the assistance of machine tools of all kinds, and in whatever she may contemplate for the future there will be an accompanying policy of encouragement of the importation of first-class machine tools. Those tools may still come from Germany, but they will come as well in increasing number from America. It is almost certain that the demand will set in right after the declaration of peace. The \$1,369,000 worth of American machine tools imported into Russia in the year before the war will easily be doubled when normal conditions prevail.

CONDITIONS IN THE NEUTRAL NATIONS OF EUROPE

The few remaining neutral nations of Europe have played a peculiar part during the war. Unable to keep themselves entirely out of the struggle, suspected by all belligerents and compelled to spend fairly large amounts for military purposes, they have nevertheless been able to pile up a comfortable fortune. The available figures show that they have been able to secure about one-half of their actual needs of machine tools, and the business was practically left to American exporters. To take the case of Holland, that country has bought more machines from America since the outbreak of the war than in normal times; on the other hand, the cessation of imports from Germany must have left the country with a deficiency over former years. Holland used to buy machine tools at the rate of \$800,000 a year from Germany. Sweden, which bought about \$500,000 worth, Norway with an importation of \$215,000 and Denmark with imports of about \$250,000 worth of machine tools from Germany during one year, have also been left with a deficiency, notwithstanding increased imports from America. To supply this need Germany alone would have to take over orders amounting to about \$3,000,000 for immediate delivery, which most likely she will not be able to do. To those four nations should be added also Switzerland, which received machine tools from Germany before the war at the rate of about \$750,000 worth each year.

Spain and Portugal both have increased their American orders during the last months; Spain especially has been a good buyer. With the return of peace this tendency

should become more pronounced. During the year before the war the American exports of machine tools into Spain were valued at \$110,000.

Provided that no great changes take place in Europe until peace comes, and all indications point to the contrary, this will be about the situation in the machine-tool business. Changes will be more pronounced after the war and it will take some time before the market has settled down to new permanent conditions. Should the war end before the New Year this might mean a likely immediate demand for machine tools that can be supplied by America of a value of about \$22,000,000. American machine-tool manufacturers have little to fear from a sudden break in the market owing to an unexpected peace, at least as far as European exports are concerned.

As the European manufacturers, especially those in England and Germany, will have plenty to do for at least two or three years, a theory that seems to be accepted by all conversant with economic conditions in Europe, there is also little danger that European machine-tool builders will feel inclined to cheapen their goods. It is said that the higher costs of producing, made up of higher wages, higher cost of materials and higher general expenses, as taxes, etc., will even compel manufacturers to keep up a higher standard of prices than existed before the war.

Taper Attachments for Use on Turret Lathes

By WILLIAM BAUMBECK

When one observes in descriptions and illustrations of shrapnel manufacture, which are now appearing in most mechanical papers, the accuracy obtained on turret lathes, one wonders why machine shops have not long before this used turret lathes for finished and accurate work on large and complicated pieces. Most shops have employed turret lathes as roughing machines for their more intricate work, such as bevel gears, cylinders, pistons, etc., doing only one or two operations and finishing the pieces on engine lathes and grinders.

No doubt, a good many shops have had the same reason for this practice as was given by a large Western factory; that is, the work required very close tolerances, special tapers and shapes beyond the capacity of any turret lathe, therefore making it impossible to machine successfully.

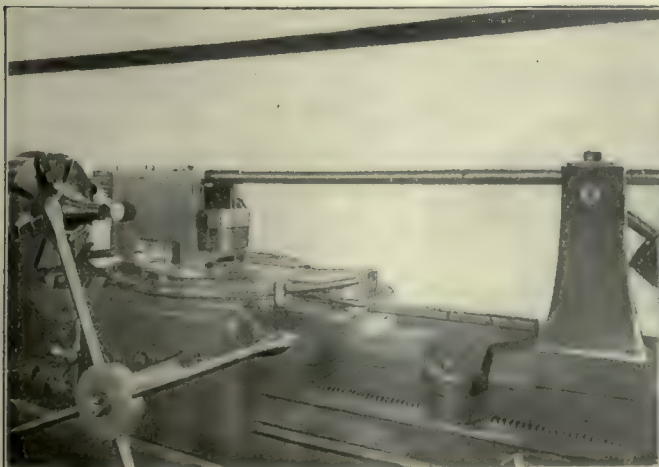


FIG. 1. TAPER-TURNING ATTACHMENT AT WORK

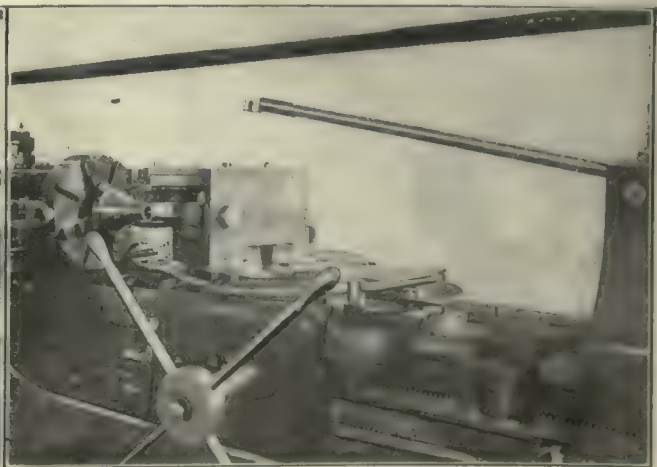
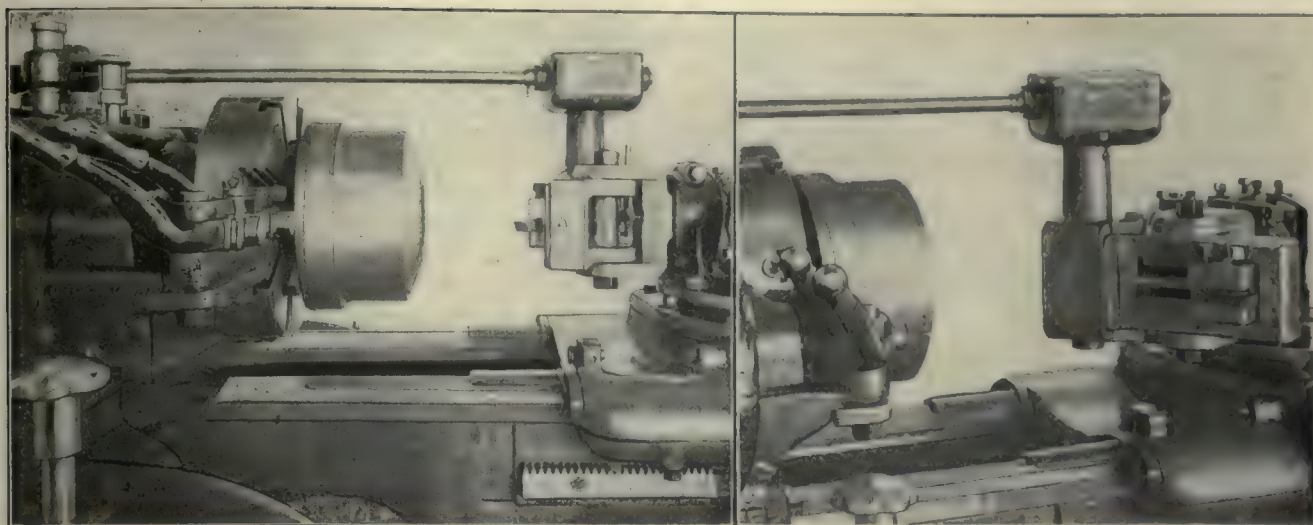


FIG. 2. DISCONNECTED AND TURRET SWUNG



FIGS. 4 AND 5. TWO VIEWS OF THE ANGULAR TURNING

the same accurate results are obtained as in doing taper work with this tool.

Turning or boring to 25-deg. taper and 12 in. long can be done with a taper bar 14 in. long; and a taper up to

40 deg. and 5 in. long can be secured by making a shorter bar as *N*, to work inside of the base.

Figs. 4 and 5 show a tool for facing operations that formerly had to be performed with a compound rest and

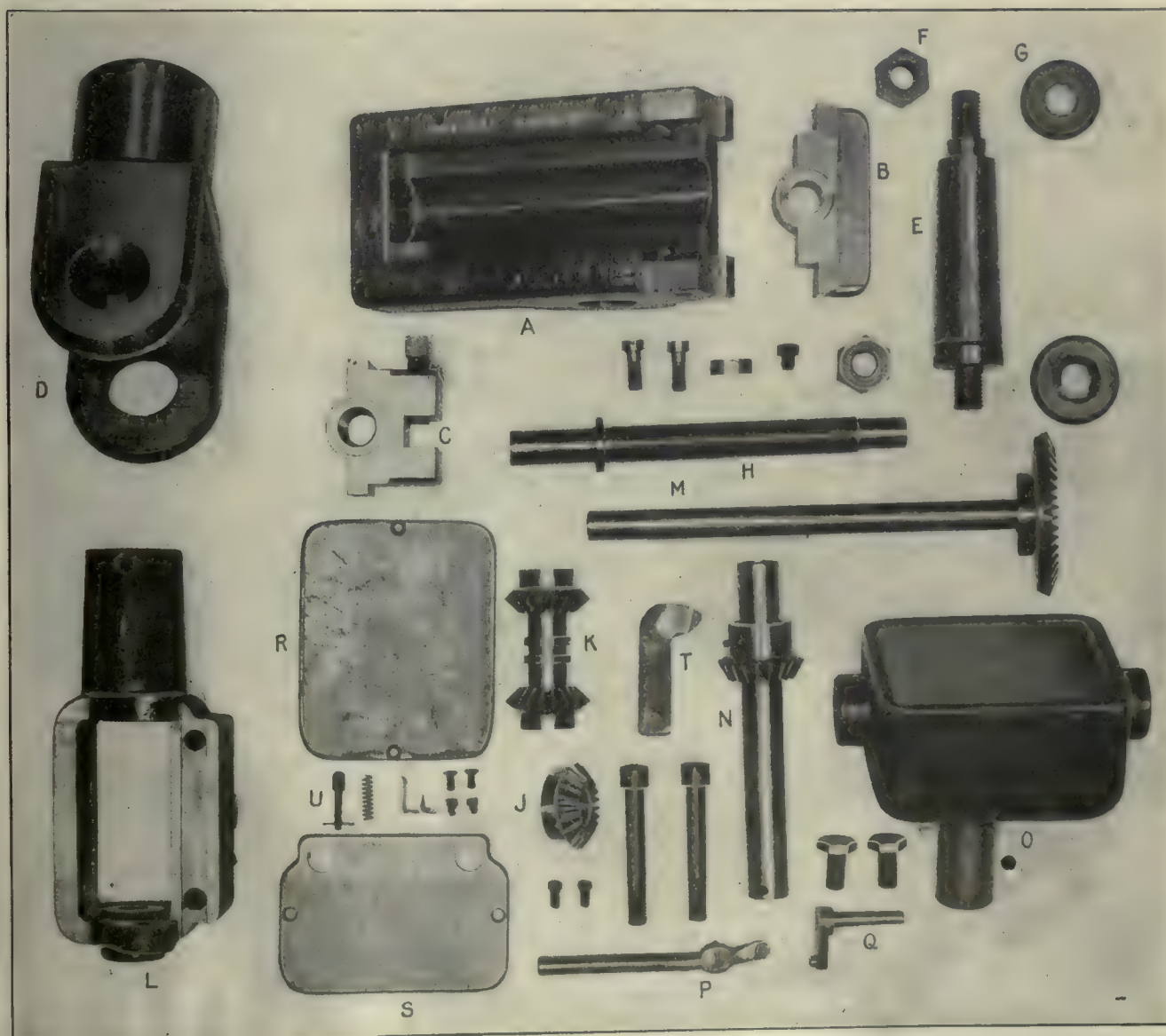


FIG. 6. HOW THE ANGULAR TURNING TOOL IS MADE

could not be done on any turret lathe except with broad facing tools. This tool is more complicated in design, but a wider range of angle work can be obtained, as the tool can be swung to a 45-deg. position. It is driven by the driving bar attached to Jones & Lamson turret lathes with their threading attachment. The parts of the tool are shown in Fig. 6.

The tool-carriage swivel *D* is clamped in the round-hole holder of the turret lathe. The tool carriage *A* is attached to the swivel *D*, clamped tightly in any position by the clamping stud *E* and locked by nuts and washers *F* and *G*. The upper ear of the swivel is graduated in degrees up to 45 each way from the center. A small indicator point fastened to the tool carriage will show at a glance the angle that the tool has been moved.

The tool-holder slide *C* is fitted into a T-slot of the tool carriage *A*. The feed screw *H* is held by two bronze bearings *B* screwed to the tool carriage. The bevel pinion *J* is attached to the feed screw with a taper pin. The sliding-gear case *L* is bolted to the end of the tool carriage. The driving shaft and bevel gear *M* are attached to the bevel-gear case box *O* and then passed through the top of the sliding-gear case into the sliding gear *K* to the bottom bearing in the case. The sliding gear *K* is driven by a key in the driving shaft. The bevel-gear case box *O* is held to the sliding-gear case by a circular gib and lock-screw. *R* is the cover plate and *T* the tool used.

The sliding gear *K* can be moved to three different positions (forward, neutral and backward) by the bell crank *Q* the handle *P* and the plungers *U*. These plungers are located on the side of the sliding-gear case *L* and hold the handle *P* in the desired position by spring action. An indicator point is fastened to the tool-holder slide *C*, with danger-mark lines on top of the tool carriage, so that the operator will not let the tool holder jam against the bearings.

To indicate the powerful cutting strength and easy working of this tool, a 1/4-in. wood pin can be used for driving. It is used on a driving shaft for a 3/8-in. deep cut, 3 1/2-in. feed, 4 in. long, on hard cast iron. The tool cuts in either direction.

The work, as shown at *P*, Fig. 3, is completed in one set-up in the lathe—finishing outside turning and finishing inside boring. The advantage of such a tool on operations of this kind can easily be appreciated.

Boring circular holes, as shown on the piece at *O*, Fig. 3, may not be needed in many manufacturing operations. However, where similar or formed surfaces are required, a tool like the one illustrated would pay for itself in a short time, as the slight cost of making a forming plate *S* would only be necessary for a new job.

mental, university and private, with the object of encouraging the application of scientific principles to American industries and the employment of science in the national defense."

It has been decided to spend from \$8,000 to \$15,000 per year on a competent executive secretary to assist in the above organization. An important addition to the financial resources of the Foundation has been made by Mr. Swasey.

Machine-Tool Shipments from Port of New York

	First Quarter	1916	
		April	May
Argentina.....	\$36,527	\$10,103	\$3,990
Australia.....	131,290	54,365	93,148
Australia and Tasmania.....	213,891		
Barbados.....	26		255
Bermuda.....	64		56
Bolivia.....			10,253
Brazil.....	6,389	212	
British East Africa.....	61		67
British South Africa.....	19,564		
British West Africa.....	3,894		
British Honduras.....			
British East Indies, other.....			4,990
British West Indies, other.....	4		
British India.....	10,013	11,941	3,404
British Guiana.....	6		234
Canada.....			
Chile.....	5,542	13,313	12,876
China.....	2,729	2,787	2,425
Colombia.....	832	1,135	1,164
Costa Rica.....	1,395	711	146
Cuba.....	20,284	18,962	18,199
Danish West Indies.....	8		1
Denmark.....	26,254	1,604	18,328
Dutch East Indies.....	2,769		
Dutch West Indies.....	2,702		
Dutch Guiana.....			
Ecuador.....	591	202	1,343
Egypt.....	178		
England.....	4,471,340	1,482,903	2,067,289
Finland.....	11,133	2,442	306
France.....	3,108,251	1,699,746	1,720,112
French Azores.....		55	
French China.....			
French Oceania.....	3,061		
French West Indies.....			
Gibraltar.....	1,015		
Guatemala.....	425	64	182
Greece.....	544	580	6,317
Haiti.....		24	737
Honduras.....	729	1	279
Hongkong.....	47		
Ireland.....	552		
Italy.....	1,539,410	605,291	797,572
Jamaica.....	72		
Japan.....	98,839	5,617	35,785
Mexico.....	12,117	58,485	13,999
Newfoundland and Labrador.....	3,196	125	28
Netherlands.....	65,146	30,428	28,293
New Zealand.....	39,804	1,711	7,229
Nicaragua.....	36		22
Norway.....	89,898	19,170	25,812
Panama.....	20,211	15,688	8,011
Peru.....	7,130	289	20,555
Philippine Islands.....	934	47	17
Portugal.....	482	267	13,635
Portuguese Africa.....	1,397		
Russia in Asia.....	30,174	23,636	1,851
Russia in Europe.....	671,986	81,177	3,307,800
Salvador.....	71	1,072	65
Santo Domingo.....	749	129	1,219
Scotland.....	108,558	51,446	90,913
Spain.....	337,155	17,851	71,776
Straits Settlements.....	1,787		66
Sweden.....	29,852	452	28,135
Switzerland.....	9,938		2,114
Trinidad and Tobago.....	500		42
Uruguay.....	1,434	144	551
Venezuela.....	3,083	446	470
Total.....	\$11,156,916	\$4,214,621	\$8,422,613

Engineering Foundation Plans Research Federation

The Engineering Foundation (the initial endowment of which was received last year from Ambrose Swasey of Cleveland and is administered "in the interest of scientific research and the good of mankind" through the engineering profession by trustees from the national Societies of Civil, Mining, Mechanical and Electrical Engineers) has decided to offer its services to the National Academy of Sciences of the United States "to accomplish the federation of all the research agencies of the nation, govern-

Testing Metals Through the X-Ray was made the subject of a paper read recently before the British Institute of Metals. This application was thought to possess interesting and practical possibilities, particularly in the case of copper castings, since pure copper, when at a high temperature, absorbs gases from the air, thereby rendering likely the formation of blowholes. When making these castings a small quantity of phosphorus, tin or zinc is usually added as a deoxidizer. Blowholes, however, are always to be guarded against, and in order to study their occurrence the author made some X-ray experiments upon a thin casting of pure copper, using a Gundelach X-ray tube. The blowholes were readily discerned by faint spots, but had there been employed a more powerful source than the ordinary strength X-ray used, such as the Coolidge tube, it is thought certain the radiographs would have been sufficiently distinct for precise deductions.

Making the 4.5-In. Howitzer Cartridge Case--II*

By ROBERT MAWSON

SYNOPSIS—In this section the operations are continued from the final drawing to the machining of the case. The various machines used are shown by illustrations, and the special attachments, gages and similar small tools are presented in detailed drawings.

After the final drawing operation the cartridge cases are taken to the lathe, Fig. 28, and trimmed to 4 in. in length. The same tools are again used, as shown in detail in Fig. 29, with the exception that there is an-

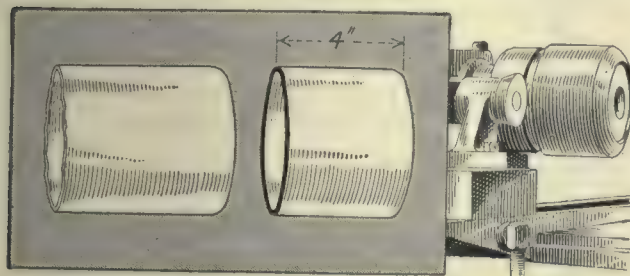


FIG. 36. OPERATION 17: TRIMMING

Machining Used—Special high-speed lathe with chuck and trimming attachment.
Production—270 per hr.
References—Figs. 28, 29 and 30.

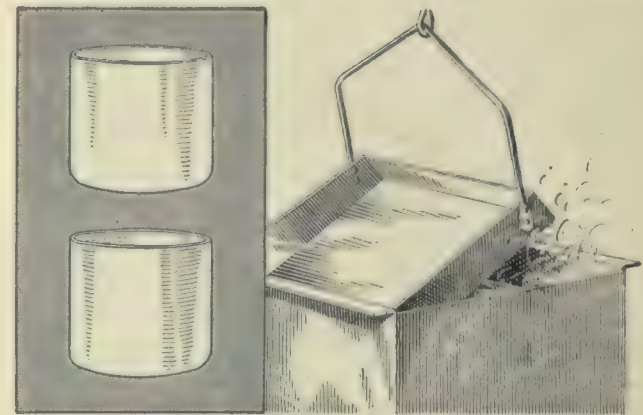


FIG. 38. WASHING OPERATION



FIG. 37. TRAY WITH CASES FOR WASHING

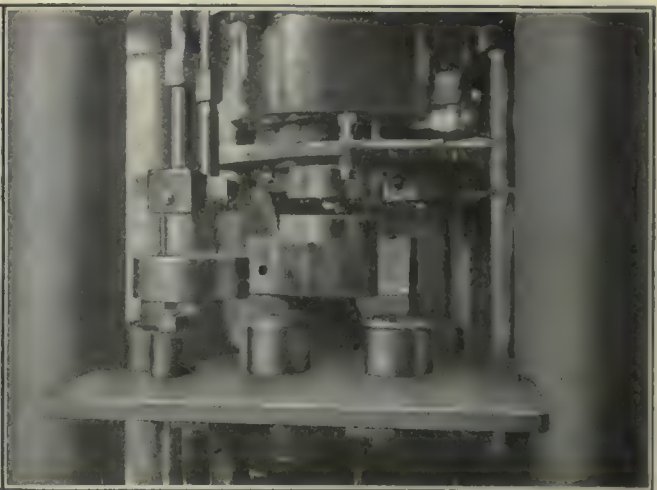


FIG. 39. HYDRAULIC HEADING PRESS

other guide chuck to suit the diameter of the case and the length it is to be trimmed. The rate of production for the operation is 270 per hour. This operation is shown in diagrammatical form in Fig. 36. The cartridge cases are washed for about 1 min. in a solution of hot water and caustic soda, to clean them. A view of the tank, with tray holding 16 cases, is given in Fig. 37. The tank held in position ready for receiving shells to be dipped in the solution of hot water and caustic soda is shown in diagrammatical form in Fig. 38.

in the hydraulic is shown in Fig. 45 and that for the power press in Fig. 46. For the second heading the same tools are employed, with the exception of the punch, which is illustrated in Fig. 47. The first and second heading operations are given in diagrammatical form in Fig. 48.

The cases are then trimmed to 3½-in. length in a manner similar to that previously described. This operation is performed on the machine seen in Fig. 28, with the same tools, substituting a chuck to suit the length of the case being trimmed. The rate of production for this operation is approximately the same as

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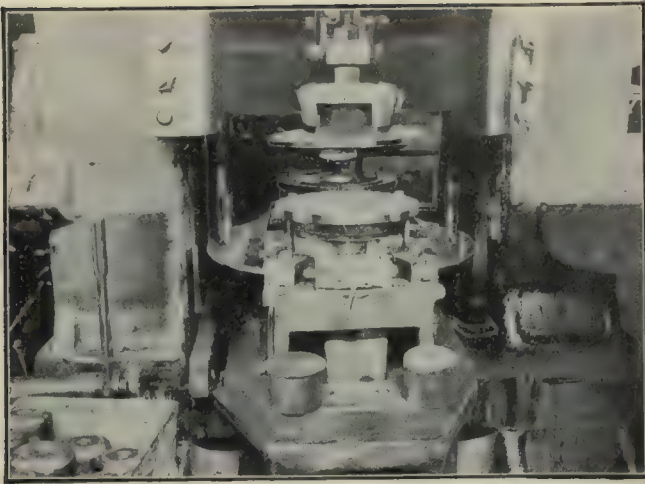


FIG. 40. POWER HEADING PRESS

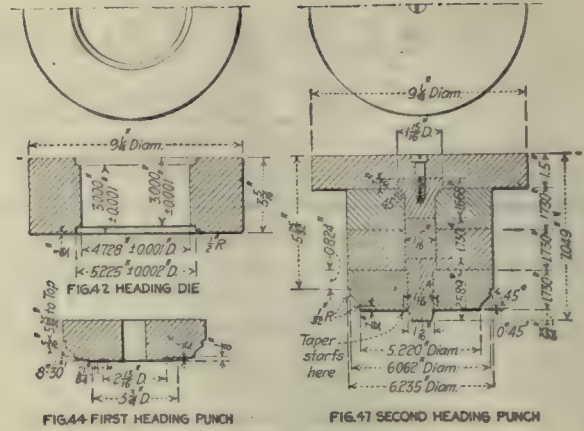


FIG. 44 FIRST HEADING PUNCH

FIG. 47 SECOND HEADING PUNCH

HEADING PUNCHES

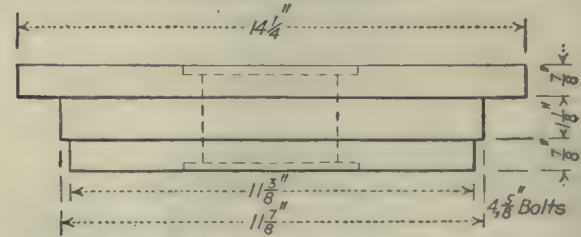


FIG. 43. DIE FOR POWER PRESS

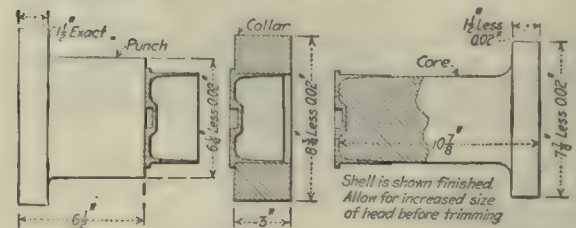


FIG. 45. KNOCK-OUT FOR HYDRAULIC PRESS

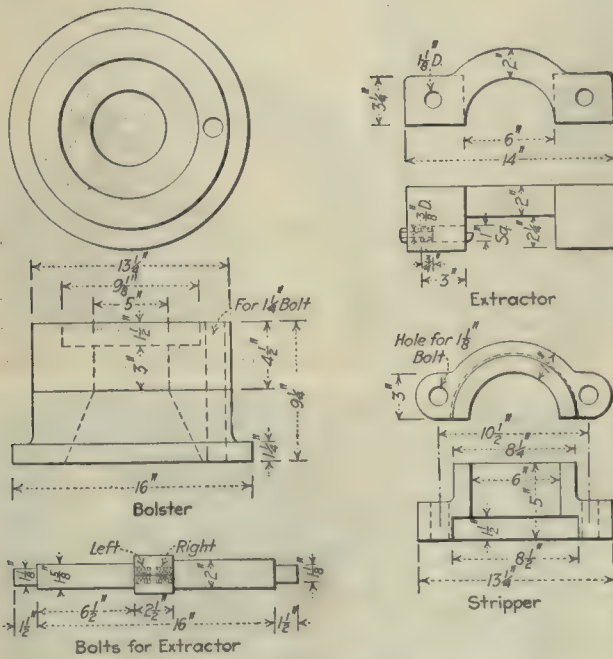


FIG. 41. DETAILS FOR HYDRAULIC PRESS

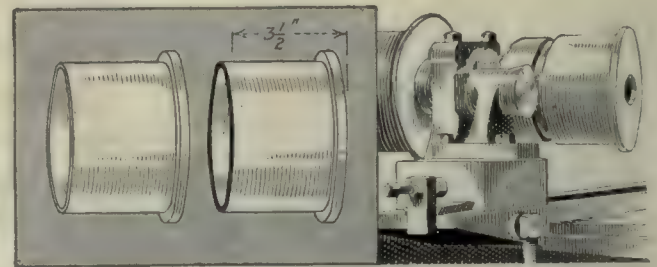


FIG. 49. OPERATION 21: FINAL TRIMMING

Machine Used—Special high-speed lathe with chuck and trimming attachment.
Production—270 per hr.
References—Figs. 28, 29 and 30.

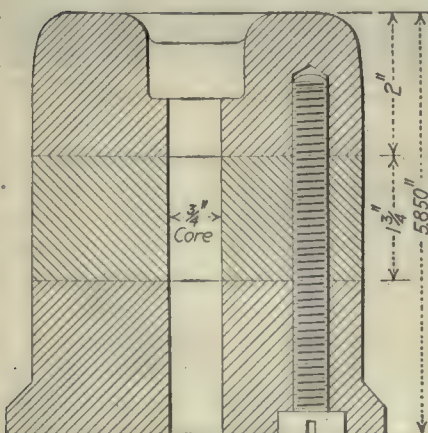


FIG. 46. KNOCK-OUT FOR POWER PRESS

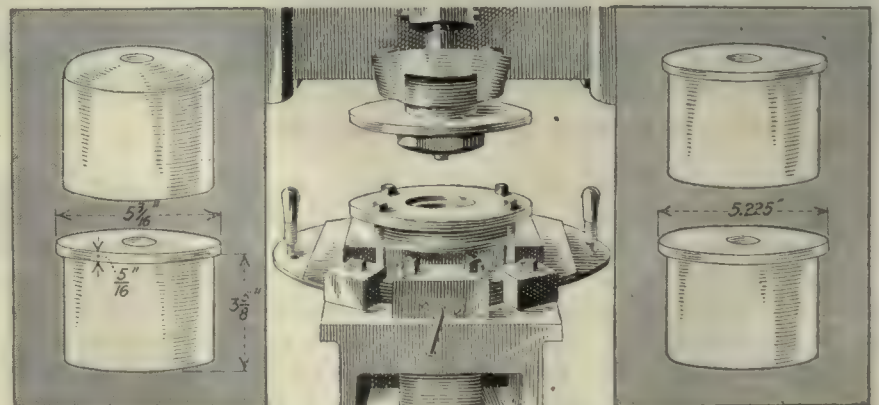


FIG. 48. OPERATIONS 19 AND 20: FIRST AND SECOND HEADING

Machines Used—Waterbury Farrell foundry (hydraulic) 6-in. stroke press; Toledo 2 1/2-in. stroke press.
Production—260 per hr.
References—Figs. 39, 40, 41, 42, 43, 44, 45 and 46 for first heading; Figs. 39, 40, 41, 42, 43, 45, 46 and 47 for second heading.

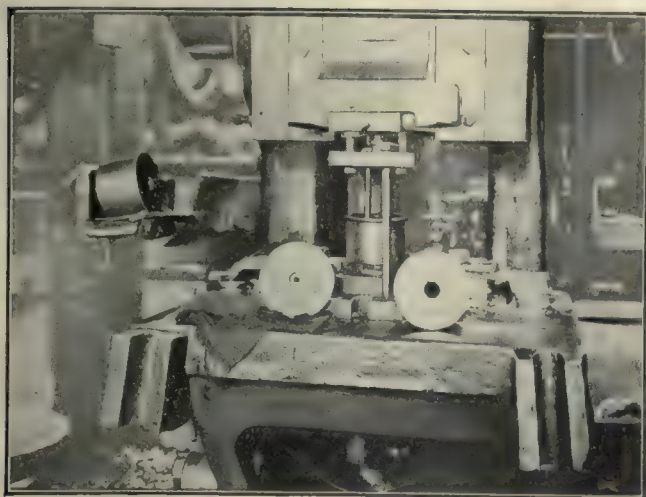


FIG. 50. PIERCING THE CASE

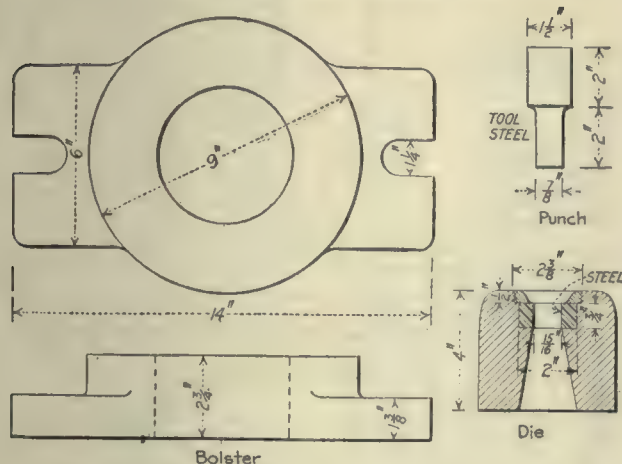


FIG. 51. TOOLS FOR PIERCING OPERATION

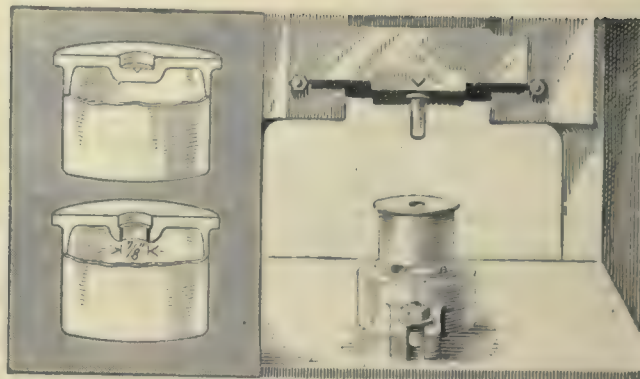


FIG. 52. OPERATION 22: PIERCING

Machine Used—Toledo 5-in. stroke press.
Production—500 per hr.
Pressure—5 tons.
References—Figs. 50 and 51.

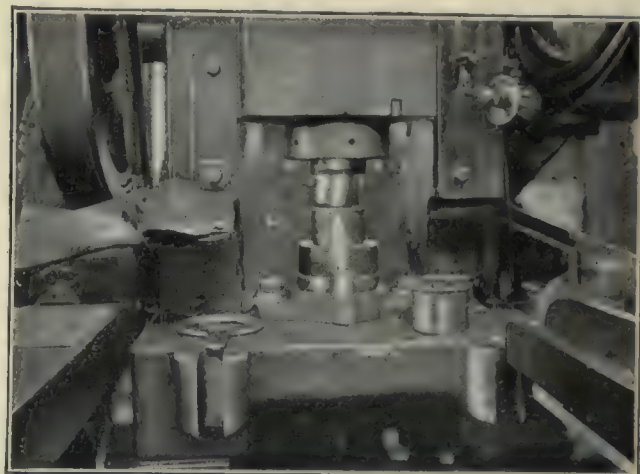


FIG. 53. TAPERING THE CASE

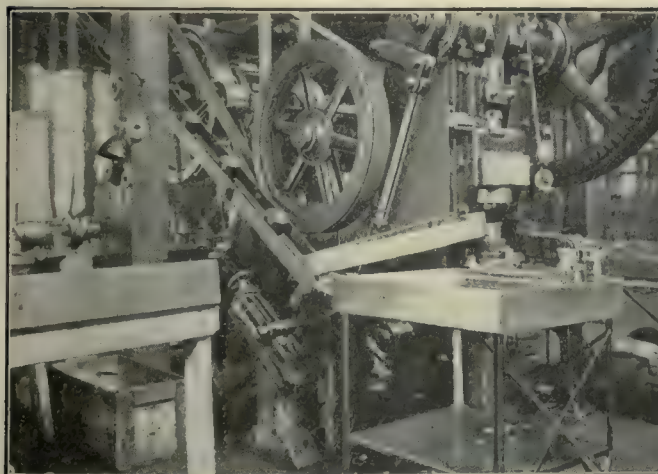


FIG. 58. CONVEYOR FOR CASES

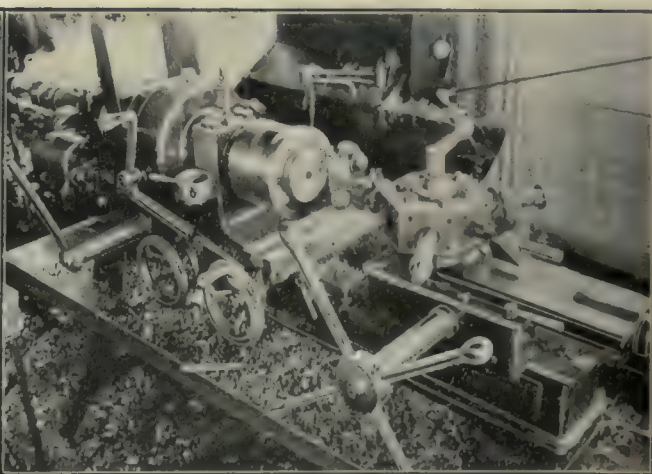


FIG. 59. MACHINING THE CASE

for operation 17. This operation is shown in diagrammatical form in Fig. 49.

The next operation is piercing for the primer hole. The punch press for this operation is illustrated in Fig. 50. The punch, die and bolster for the piercing operation are shown in Fig. 51, and the operation is illustrated in diagrammatical form in Fig. 52. The cases are then ready for the tapering operation. The machine used on this work is seen in Fig. 53. The punch, Fig. 54, ejector, Fig. 55, die, Fig. 56, and bolster, Fig.

17, are employed for the tapering operation, which is also given in diagrammatical form in Fig. 57.

Fig. 58 shows the method of transferring the cases from the trimming machine to the piercing and, finally, the tapering presses. A wooden trough is used, as may be observed at the right of the illustration. The case, after it has been tapered with the machine seen in the foreground, is slid down the chute shown, whence it drops on the chain conveyor. Protruding plates carry along the cartridge cases to the upper floor, where the

subsequent operations are performed. The cartridge cases are then given a shop inspection. The gages will be illustrated in detail in a later portion of the article.

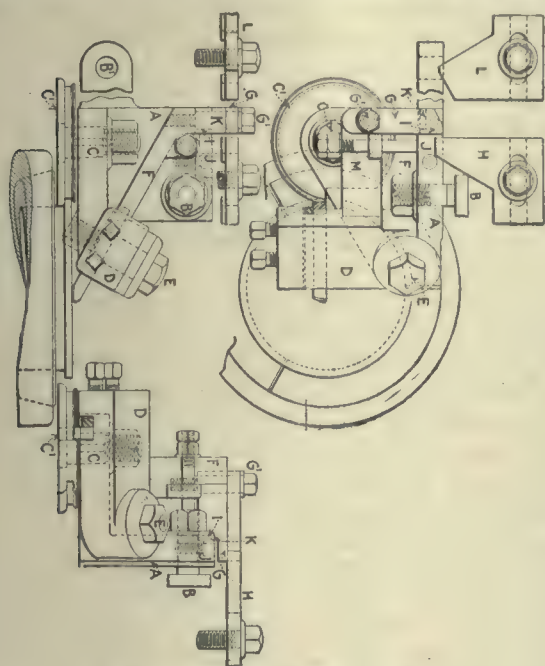


FIG. 60. SET UP OF TOOLS

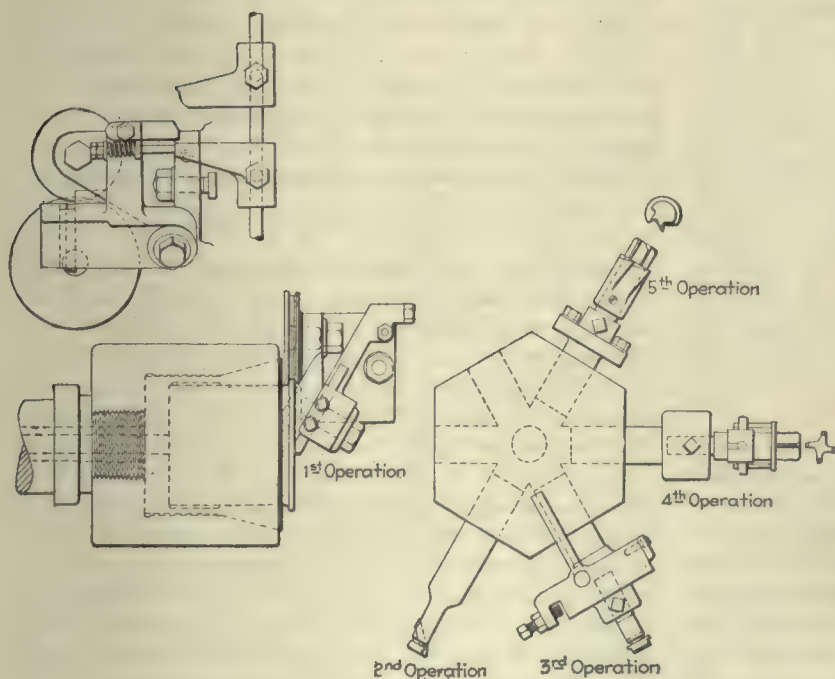


FIG. 61. LAYOUT OF TURRET TOOLS

The next operation is facing, squaring to length, rough-threading and counterboring for the primer. The machine for this operation may be seen in Fig. 59. Details of the tools are given in Figs. 60 and 61. The operation is also shown in diagrammatical form in Fig. 62. A detail of the shape required on the head is presented in Fig. 63.

Attention should be called to the interesting method shown in Fig. 58 of conveying the cases from the tapering press to the upper floor where the machining operations are performed. By this means much handling is avoided as the operator merely allows the case after it has been

headed to slide down the chute shown when it drops onto the conveyor. One of the plates which is inserted in the chain of the traveling conveyor coming against the case raises it to the floor above when the machining operations on the head of the cartridge case are performed.

As the case reaches the upper floor it falls into another chute down which it slides to the lathes performing the machining operations. It will be seen by reference to the layout of the tools used in the turret that the face of the case is first machined, the primer hole is next bored, the recess in them formed at the rear of the primer hole. The tapping of the hole is next done and last the facing and counterboring operation. During the facing of the head the flange is machining to the correct contour and

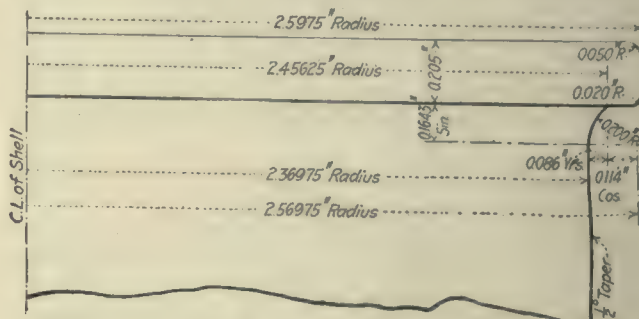


FIG. 63. DETAIL OF HEAD OF CASE

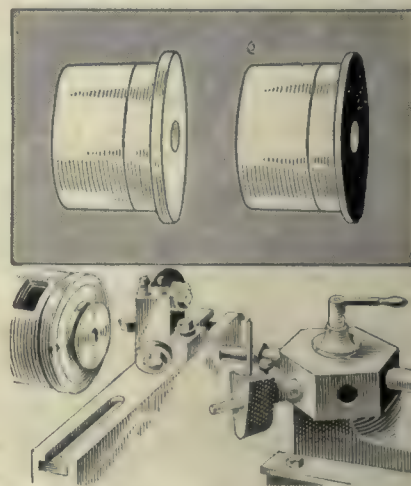


FIG. 62. OPERATION 25: FACE, SQUARE TO LENGTH, ROUGH-THREAD AND COUNTERBORE FOR PRIMER

Machine Used—Warner & Swasey turret lathe.
Production—70 per hr.
Lubricant—All surfaces machined dry except threading, on which lard oil is used.
References—Figs. 59, 60 and 61.

thickness with a circular forming tool carried at the rear in the cross-slide.

Between other machines are placed wooden chutes so that the cases may be slid between each operation when manufacturing the cartridge case.

This system of transferring work during the various operations to the several machines is well worth adopting both on press operations as here described and also on other machining work. The cartridge case is then ready for the operations that follow after machining the primer hole.

(To be continued)

Purchase and Inspection of Leather Belting

SPECIAL CORRESPONDENCE

The numerous forms of belting on the market may be divided roughly into three groups—first-quality oak-tanned leather, second-grade oak-tanned leather and novelties. In the latter group are fabrics, special tannages of leather and various combinations of these with one another and with oak-tanned leather. In price the range is from a fraction of the price of first-quality leather to about three times its cost. Each is particularly adapted to a certain narrow field of application, but is apt to be recommended by its maker for all purposes. As a whole, belts in this class show a high ultimate cost, since the cheap ones give poor service and the expensive ones do not last long enough to justify their high initial cost. Such belts should be used only where they have demonstrated their superiority in competition with oak-tanned leather.

Cheap grades of leather may be made to look as well as that of highest quality, and the temptation is strong to save the difference in first cost. Purchasers should remember, however, that belting of this kind is either poorly made or consists of stock rejected in the making of the first-grade belting. By the time it has been discarded the belt will have proved very expensive. The legitimate field for belting in this class is on agricultural machinery and similar service, where the conditions are such that no belt, however good, will last long.

First-quality oak-tanned leather belting, represented by the best brands of the leading manufacturers, shows the lowest cost per belt per year, provided it is properly installed and well cared for. For 30 per cent. more than the price of the cheaper grades the best that the market affords may be obtained, and it is obvious that not much gain is required from lessened upkeep, decreased idle machine time or longer life to make the extra investment a profitable one. Ample evidence is available to justify the use of the best oak leather for general machine-shop and similar service.

WHERE TO BUY BELTING

In belting, as in all other forms of leather goods, substitution and deception are easy. No matter how carefully specifications are drawn or inspection enforced, it is important to deal only with responsible and reliable houses. The volume and variety of their output should also be considered, since these factors give the ability to supply any requirements promptly and satisfactorily. For this reason and others it is better to deal direct with the manufacturer rather than through a jobber. A much discussed question is whether it is best to deal with a manufacturer who also tans his leather or with one who buys his raw material in the open market. There is much to be said on both sides, but it should be borne in mind that the ownership of a tannery is not *prima facie* evidence of ability to deliver a better belt. No tannery can produce uniformly good leather.

Large users would do well to divide their orders between two sources of supply as a protection against the failure of one to make deliveries and to get the benefit of healthful rivalry. Location is also an important feature. Better results will be obtained when either the factory or a branch warehouse is near-by, not only for quick service

when necessary, but especially because it means accessibility to, and better cooperation with, responsible representatives of the manufacturer.

Having chosen one or two sources of supply and found them satisfactory, every endeavor should be made to avoid frequent changes. Once a manufacturer has become accustomed to the particular needs of his customer, it is greatly to the advantage of both parties to retain the connection. Cooperation is essential to best results.

When belting is being bought or contracted for, it is always well to keep in mind that it may not prove satisfactory. This suggests at once that the kind of material desired should be specified definitely in writing and provision made for its rejection, if defective. On page 683, Vol. 44, a detailed discussion of this subject was presented. Small consumers should order by brand from a reliable house, trusting to its fairness to make good any shortcomings in its product. Large buyers have an opportunity to specify more definitely what they require to meet their special needs and to safeguard themselves against the acceptance of poor material.

Specifications having been determined upon, bids should be invited from five or six of the leading manufacturers for the ensuing six months or a year. The leather market is always a very uncertain factor, especially at this time, and most manufacturers do not look with favor on long-time contracts. Six months is probably a fair period to all concerned.

There are decided advantages in keeping a good stock on hand. Rush orders are thereby obviated, ample time for inspection is available, and most important of all, the manufacturer is able to accumulate from stock in progress the kind best suited to the needs of the customer. The value of such selection cannot be over-estimated.

IMPORTANCE OF CAREFUL INSPECTION

It is a long road from the cattle range to the pulleys of the manufacturing plant, and many operations are necessary to transform a steer hide into a leather belt. At almost every one of these stages the value of the product to the consumer can be influenced for better or for worse. The skill and knowledge of the workman, the condition of his equipment and the kind of supervision under which he works—all combine at each operation to determine whether the belt shall finally be a powerful aid to successful factory operation or the source of endless trouble. Unfortunately, the conditions under which his product is sold and consumed do not give the belt manufacturer much incentive to keep all his processes at high efficiency. Most of his product goes to jobbers and supply houses, from which it is passed on in small quantities to the consumer, generally with price as the incentive rather than quality. Under these conditions a good appearance is often considered more important than invisible quality. This situation leads to practices akin to the coloring of butter, bleaching of flour and polishing of rice, largely practiced by manufacturers of foodstuffs. Only by constant and vigilant inspection can such practices be eliminated and defective material or workmanship discovered. The mere fact that delinquencies are promptly detected and reported to the manufacturer is sufficient to minimize their occurrence.

Where purchases are being made from more than one source, detailed inspection will soon point out their relative merits and the causes. It has the further advantage

also, that defects discovered before installation save the time and money involved in repairs, replacement and loss of production. A large user can well afford to assign a high-grade man to this duty, preferably one who is in close touch with operating conditions throughout the factory.

PRELIMINARY EXAMINATION OF BELTING

Two inspection tables with rotating tops should be provided and set a convenient distance apart in a good light. When a shipment is received, each roll should be placed on one table and wound onto the other. The entire length of the roll is thus exposed for inspection, and the rewound roll is left ready for storage or use. While the belt is passing before the inspector, he can readily check up the length, width, uniformity of thickness, 'shimming, excessive evening and other external characteristics. The most important points to watch are:

Injurious Blemishes—All surface markings should be opened up, if possible, by bending the belt, grain side out. Any defect that extends through the outer layer, or "grain," weakens the belt, is apt to become larger in service and readily admits to the interior of the fiber injurious substances such as lubricating oil, dust and metallic particles. On the other hand, surface markings that do not open up on bending cannot be regarded as objectionable. Blemishes likely to cause belt failures can be avoided by careful selection and should not be present in first-quality belting.

Piping—Single belts should be bent through 180 deg. over a $\frac{1}{2}$ -in. diameter rod, grain side in, and double belts over a 1-in. rod. Since the inner surface is strongly compressed by this treatment, a wrinkling will be developed. If this is deep enough to extend to the fibrous body under the grain layer, it is known as "piping" and indicates that the leather has been cut from an undesirable part of the hide. Such material will give unsatisfactory service and should not be present in the best belting.

Cracking—When treated in the manner described under piping, but grain side out, no cracking should be developed. This would indicate poorly tanned leather or the shirking of some process that should during manufacture have made the fibers soft and pliable.

Length of Sections—The overall length of the individual sections of which the belt is composed should not exceed 54 in., nor should many of them be less than 42 in. Longer lengths have been cut into the shoulder area, the least desirable part of the hide for belting, while shorter sections, even if of good material, introduce too many cemented joints, each of which is a potential trouble maker in service.

Another point to be watched is uniformity of character, especially as to pliability. Color, however, has no significance if the material is otherwise satisfactory. The manufacturer's name, brand and date should be plainly stamped every 10 ft. as a means of identification in case the service rendered should later prove unsatisfactory.

It is well, also, to unroll a length of about 50 ft. on the floor, noticing whether the belting remains flat at all points without pressure and shows straight laps. A little curvature will be observed, but it should not exceed a foot or two, should be all in the same direction and fairly uniform throughout the entire length. Such belting will run true on the pulleys under a slight tension.

All but the largest consumers can safely conclude their examination at this point, with the assurance that they are getting a very good belt. The process sounds elaborate; but as a matter of fact, when the proper facilities are provided and the inspector has become accustomed to his duties, a speed of 1,000 ft. per hr. can easily be attained. All the foregoing tests need not be applied to each roll, but the most important tests should be applied to every foot of belting purchased.

PHYSICAL AND CHEMICAL TESTS

Purchasers whose investment for belting in service totals hundreds of thousands of dollars can well afford to look a little deeper into the chemical and physical properties of their purchases. Samples should be taken at random from part of each shipment and subjected to the laboratory tests to be described.

Tensile Strength and Elongation—A specimen cut with a die lengthwise of the belt may readily be tested to destruction in any standard testing machine. A length of 12 in. and a width of $1\frac{1}{2}$ in. is very satisfactory. To insure rupture near the center, the specimen should be necked down to a width of 1 in. for a length of at least 2 in. Before the specimen is mounted in the machine, a length of exactly 2 in. should be marked off on the center line in the necked portion. The elongation at rupture or any intermediate point can easily be read off in per cent. with a scale graduated to hundredths of an inch. The ordinary flat clamps commonly used in testing metals are apt to give erroneous results by allowing the specimen to slip more on one side than the other, causing rupture before the full strength of the material has been developed. A better method is to use a fixture consisting of a cylinder held in each head of the machine. The ends of the specimen are passed over the cylinders and clamped on the opposite side. This allows any unevenness of stress to distribute itself before reaching the neck. The speed with which the machine is operated makes a material difference in the results, and a belt or motor drive is preferable. Elongation should be measured at the prescribed tensile strength, since it is obviously unfair to charge an unusually strong specimen with the total elongation at rupture or to credit a weak one with a low value.

Cemented Joints—A similar procedure should be followed in determining the strength of cemented joints, except that elongation need not be observed. The progress of elongation should be noticed, however, and the point where serious distress becomes evident. This should not be less than 90 per cent. of the specified tensile strength. All tensile tests should be recorded in pounds per inch of width, not in pounds per square inch.

Occasional tests should be made to determine the percentage of greases introduced during manufacture to promote pliability and to protect the belt from absorption of foreign matter such as lubricating oil, water, fumes, etc. This examination should be made in accordance with the standard practice of the American Association of Leather Chemists.

The presence of mineral oils, inorganic acids or anything detrimental to the strength, pliability or durability of the leather should be detected by suitable tests. Likewise, loading for artificial weight by means of white lead or other foreign matter can be detected by burning a sample and weighing the ash.

Reliable manufacturers are always willing to stand behind their goods in service. Poor material or workmanship will occasionally evade the most vigilant inspection—hence, the importance of the branding previously mentioned. The most frequently occurring defects after installation are excessive stretching, uneven stretching, cracking and poor joints. For any of these defects a good maker will cheerfully make adjustment if notified promptly, provided the belt has been properly installed and not abused. Before making claims, however, it is wise to make certain that these conditions have been fulfilled. Few failures will be found if the pulleys are in line, parallel and large enough for the kind of belt used; if the belt is not allowed to rub against bearings, hangers, posts or shifters; if lubricating oil and other destructive agents are kept away; if proper tension is maintained and if the belt is not overloaded.

Really first-class belting, properly applied and cared for, will give splendid service and a surprisingly long life.



Special Operations in a Textile Machine Shop

EDITORIAL CORRESPONDENCE

For manufacturing hosiery machines Scott & Williams, Inc., Laconia, N. H., employ some interesting tools and methods. In Fig. 1 is illustrated the fixture used in drilling pattern drums. The casting *A* is located by the shaft *B*, which is supported in a bracket at each end, as shown. The locating of the various holes is obtained with the index drum *C*. As the pointer *D* is dropped into the indexing hole of the drum *C*, the casting *A* is in the correct position for drilling. In this pattern drum, 158 No. 37 holes are drilled. The time required is 15 min.

The way in which the flutes are milled in the rolls may be seen in Fig. 2. After the roll has been turned to the correct diameter, it is placed between centers in the lathe and driven by a dog at the head end. The knurl holder is fitted with three knurls, and the shank is attached in the tool post, as shown. With the shaft revolving, the knurl holder is caused to travel along the shaft, and a good form of knurl is produced. One of the holders is illustrated at *A*, and the design may be easily observed.

In Fig. 3 is shown the attachment used in milling the segment gears. The casting is located on a stud and held in position with a nut and washer. It is located by stops

at *A* and *B*. The gang cutters consist of two 3x $\frac{3}{4}$ -in. and one 2x $\frac{5}{8}$ -in. between them. Motion to revolve the casting and fixture is obtained through the worm and wormwheel *C*, spiral gears *D* and wormwheels *E*. The driving worm-wheel of the pair of gears *E* is attached and driven by the

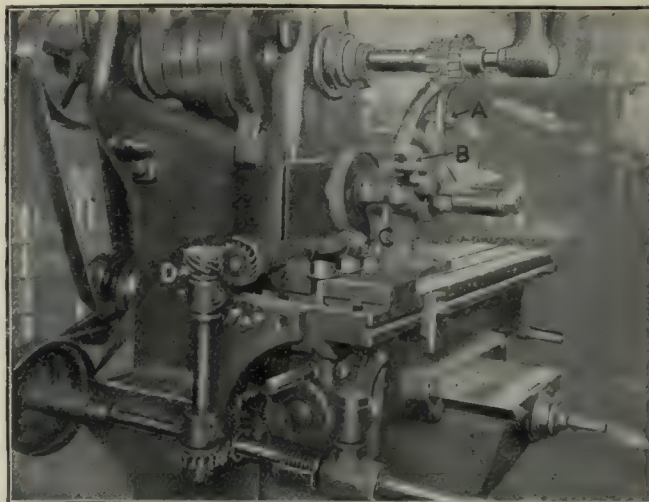


FIG. 3. ATTACHMENT FOR MACHINING A SEGMENT GEAR ON THE MILLER

driving belt of the miller, as shown at the left of the illustration. This method of machining the circular surface on the gear is proving successful, and the surface produced is all that could be desired.

These three special methods are being used with great success in the manufacture of hosiery machine parts and as will be noted good results so far as time is concerned are obtained. When drilling other pattern drums than that shown in the illustration, a different indexing cylinder is placed on the arbor of jig, Fig. 1; thus this jig may be applied for a variety of different designs of pattern drums which are machined in the manner shown. The method shown of milling the segment gear is also interesting as it will be observed that the cutters are machining surface at all times, which would not be possible if the part was rotated on an arbor and the surface machined in a lathe, without some oscillating device being used. A good surface is also produced.

The method used when milling the flutes on the rods is interesting. The tool is held in the tool post and fed along the rotating bar. Three knurls are held in contact with the rod by means of a clamp bolt at the rear.

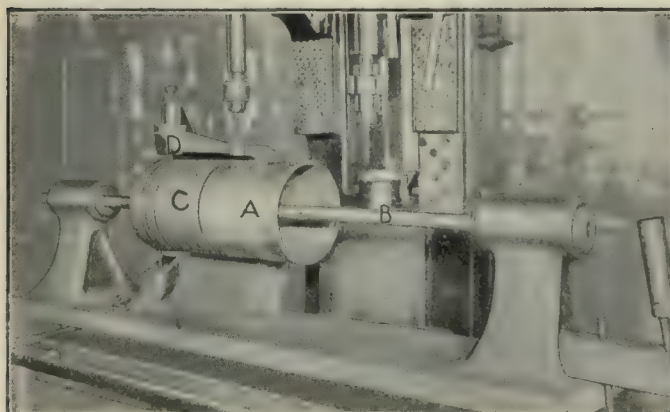


FIG. 1. DRILLING PATTERN DRUM WITH A SPECIAL INDEXING FIXTURE

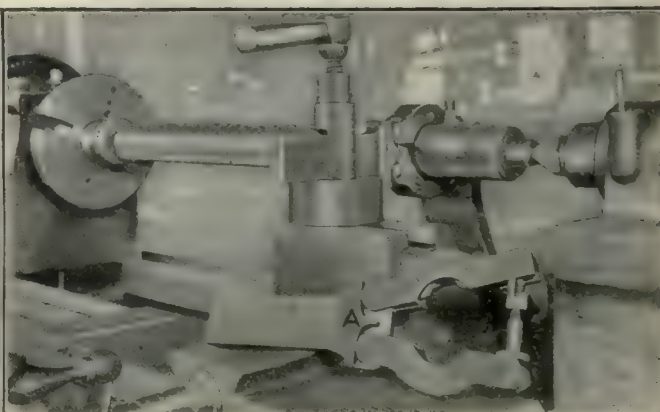


FIG. 2. MILLING FLUTES ON ROLLS IN THE LATHE WITH A THREE-KNURL TOOL

Letters from Practical Men

Combined Table of Drill Sizes of A. S. M. E. Screws

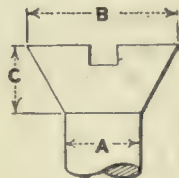
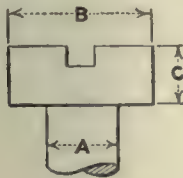
In order to save time and trouble in referring back and forth to tables to find either a tap or a body drill size for a certain size of screw I have compiled the accompanying table, together with the drill sizes for flat and fillister-head screws. These are American Society of Mechanical Engineers standards.

We do not always realize the time lost in referring from one table to another. By combining tables in this way we can also eliminate one chance of error that creeps in whenever we copy a value or try to remember it, as we turn to look it up in another place.

I believe a good many of your readers will appreciate a table of this kind and find it a great convenience, as I have.

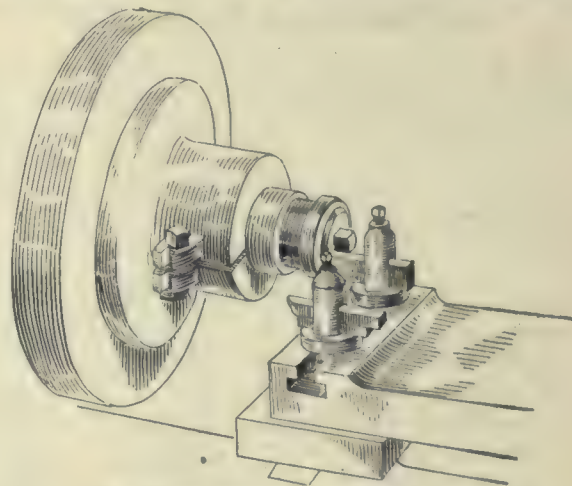
A. ELTING.

New York City.



Trimming Off the Base Plugs of Shells

The sketch herewith shows the equipment used by the writer for cutting of the square tit and facing off the surplus metal of the base plug after it has been riveted into the shell. It is easily applied to the lathe.



TRIMMING BASE PLUGS OF SHELLS

DRILL SIZES FOR A. S. M. E. MACHINE SCREWS

No. of Screw	No. of Threads	Diameter of Screw "A"	No. of Tap Drill or Letter	Tap-Drill Diameter	No. or Letter of Body Drill	Body-Drill Diameter	B	C	No. or Letter of Drill	Diameter of Drill	B	C	No. or Letter of Drill	Diameter of Drill
0	80	0.060	55	0.0465	52	0.0635	0.0894	0.0376	43	0.089	0.112	0.029	33	0.113
1	72	0.073	53	0.0595	45	0.073	0.1107	0.0461	34	0.111	0.138	0.037	28	0.1405
2	64	0.073	54	0.055	45	0.073	0.1107	0.0461	34	0.111	0.138	0.037	28	0.1405
3	64	0.086	50	0.070	44	0.086	0.132	0.0548	29	0.136	0.164	0.045	19	0.166
4	56	0.086	51	0.067	44	0.086	0.132	0.0548	29	0.136	0.164	0.045	19	0.166
5	56	0.099	46	0.081	35	0.0995	0.153	0.0633	23	0.154	0.190	0.052	11	0.191
6	48	0.099	47	0.0785	35	0.0995	0.153	0.0633	23	0.154	0.190	0.052	11	0.191
7	48	0.112	43	0.089	33	0.113	0.1747	0.0719	16	0.177	0.216	0.060	2	0.221
8	40	0.112	44	0.086	33	0.113	0.1747	0.0719	16	0.177	0.216	0.060	2	0.221
9	36	0.112	45	0.082	33	0.113	0.1747	0.0719	16	0.177	0.216	0.060	2	0.221
10	44	0.125	38	0.1015	30	0.1235	0.196	0.0805	9	0.196	0.242	0.067	2	0.221
11	40	0.125	39	0.0995	30	0.1235	0.196	0.0805	9	0.196	0.242	0.067	2	0.221
12	36	0.125	40	0.098	30	0.1235	0.196	0.0805	9	0.196	0.242	0.067	2	0.221
13	40	0.138	33	0.113	28	0.1405	0.217	0.089	2	0.221	0.262	0.075	2	0.221
14	36	0.138	34	0.111	28	0.1405	0.217	0.089	2	0.221	0.262	0.075	2	0.221
15	32	0.138	36	0.1065	23	0.1405	0.217	0.089	2	0.221	0.262	0.075	2	0.221
16	36	0.151	31	0.120	24	0.152	0.2386	0.0976	B	0.238	0.294	0.082	M	0.295
17	32	0.151	31	0.120	24	0.152	0.2386	0.0976	B	0.238	0.294	0.082	M	0.295
18	30	0.151	32	0.116	24	0.152	0.2386	0.0976	B	0.238	0.294	0.082	M	0.295
19	36	0.164	29	0.136	19	0.166	0.2599	0.1062	G	0.261	0.320	0.090	P	0.323
20	32	0.164	30	0.1285	19	0.166	0.2599	0.1062	G	0.261	0.320	0.090	P	0.323
21	30	0.164	30	0.1285	19	0.166	0.2599	0.1062	G	0.261	0.320	0.090	P	0.323
22	32	0.177	26	0.147	16	0.177	0.2813	0.1148	K	0.281	0.346	0.097	S	0.348
23	30	0.177	27	0.144	16	0.177	0.2813	0.1148	K	0.281	0.346	0.097	S	0.348
24	24	0.177	29	0.136	16	0.177	0.2813	0.1148	K	0.281	0.346	0.097	S	0.348
25	30	0.190	22	0.157	11	0.191	0.3026	0.1234	N	0.302	0.372	0.105	V	0.372
26	32	0.190	21	0.159	11	0.191	0.3026	0.1234	N	0.302	0.372	0.105	V	0.372
27	24	0.190	26	0.147	11	0.191	0.3026	0.1234	N	0.302	0.372	0.105	V	0.372
28	28	0.216	15	0.180	2	0.221	0.3452	0.1405	S	0.348	0.424	0.120	7/16	0.437
29	24	0.216	17	0.173	2	0.221	0.3452	0.1405	S	0.348	0.424	0.120	7/16	0.437
30	20	0.242	7	0.201	2	0.221	0.3879	0.1577	X	0.397	0.472	0.135	31/64	0.484
31	20	0.242	11	0.191	2	0.221	0.3879	0.1577	X	0.397	0.472	0.135	31/64	0.484
32	22	0.268	2	0.221	2	0.221	0.4305	0.1748	7/16	0.437	0.528	0.150	17/32	0.531
33	20	0.268	3	0.213	2	0.221	0.4305	0.1748	7/16	0.437	0.528	0.150	17/32	0.531
34	20	0.294	C	0.242	2	0.221	0.4731	0.1920	31/64	0.484	0.580	0.164	19/32	0.593
35	18	0.294	B	0.238	2	0.221	0.4731	0.1920	31/64	0.484	0.580	0.164	19/32	0.593
36	20	0.320	H	0.266	2	0.221	0.5158	0.2092	33/64	0.515	0.632	0.179	41/64	0.640
37	18	0.320	H	0.266	2	0.221	0.5158	0.2092	33/64	0.515	0.632	0.179	41/64	0.640
38	22	0.346	L	0.290	2	0.221	0.5584	0.2263	9/16	0.562	0.682	0.194	11/16	0.687
39	16	0.346	K	0.281	2	0.221	0.5584	0.2263	9/16	0.562	0.682	0.194	11/16	0.687
40	24	0.372	N	0.302	2	0.221	0.6010	0.2435	39/64	0.609	0.732	0.209	47/64	0.734
41	18	0.372	O	0.316	2	0.221	0.6010	0.2435	39/64	0.609	0.732	0.209	47/64	0.734
42	16	0.398	Q	0.332	2	0.221	0.6437	0.2606	21/32	0.656	0.788	0.224	51/64	0.796
43	14	0.398	P	0.323	2	0.221	0.6437	0.2606	21/32	0.656	0.788	0.224	51/64	0.796
44	14	0.424	S	0.348	2	0.221	0.6863	0.2178	11/16	0.687	0.840	0.239	27/32	0.843
45	16	0.424	T	0.358	2	0.221	0.6863	0.2178	11/16	0.687	0.840	0.239	27/32	0.843
46	14	0.450	V	0.377	2	0.221	0.7270	0.2950	47/64	0.734	0.892	0.254	29/32	0.906
47	30	0.450	W	0.386	2	0.221	0.7270	0.2950	47/64	0.734	0.892	0.254	29/32	0.906

*Special sizes of A. S. M. E. machine screws.

The machine is a plain 20-in. American engine lathe that is nearly old enough to vote. It is fitted with a home-made split chuck and an extra tool holder. One tool holder takes a parting tool for cutting off the square end, and the other tool holder carries an ordinary round-nose tool for squaring up the base of the shell and plug. The shell forgings are about 50 carbon, but much harder to cut than the carbon content would lead one to expect.

With this equipment we can do 168 British 4.5-in. shells every 10 hr., the lathe running at 130 r.p.m. Tool feed is by hand for parting and $\frac{1}{48}$ -in. feed per revolution for facing.

JOHN S. WATTS.

New Glasgow, Nova Scotia.

Adjustable Drill Jig

Many a man has been troubled time and again by the loss involved in the laying out of holes in instances where a job consisted of "just not enough" pieces to make profitable a special drill jig. In fact, the laying out of holes often amounts to the same as the drilling itself, which depends of course greatly on the pay of the man who scribes off and of the boy who runs the drill press.

To eliminate the expense of scribing, the use of a double-gage drill jig, as shown in the accompanying illustration, not only proves to be a paying investment, but pleases the men, and there is no wear to it.

The bedplate *A* is provided with two lugs to clamp it to the table of the drill press. Bearings *B* and *BI* on the ends of the bedplate carry a right- and left-handed screw *C*. By means of this screw the vise jaws *D* and *DI* can be moved. They always remain equally distant from the center of the jig and automatically center any piece gripped between them, as can be easily understood. The jaws of the vise run in T-slots in the bedplate. Between and above the jaws a drill bushing is fastened in a holder *E*, which is split at the end so that the proper bushing can be inserted. The holder is slotted at the other end, which enables it to move parallel to the right- and left-hand screw. It runs in the recess in a projection on the bedplate. Pointer and gage indicate directly how much the bushing is off center. When in the right place, the holder is firmly clamped down by the screw *F*.

In the center of the jig, the stop *G* can move at right angles to the right- and left-hand screw. The pointer and the gage on the tail of the bedplate indicate the distance between the end of the stop and the center of the bushing. The stop is fastened by a wing nut and screw *H* in a machined slot.

As only one hole at a time can be drilled in each piece, the jig requires some extra handling of material, but this is fairly well balanced by the consideration that an ordinary jig has to be moved for each hole.

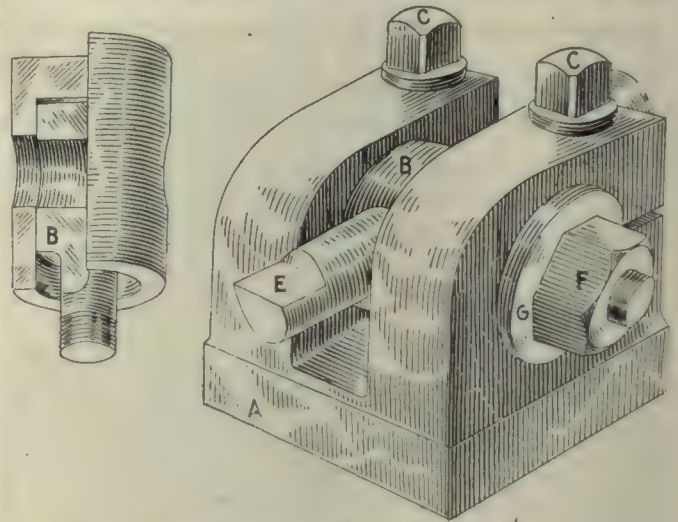
In case the jig is subject to heavy use, the wearing surfaces of the vise and the stop have to be hardened.

Brooklyn, N. Y.

JAN SPAANDER.

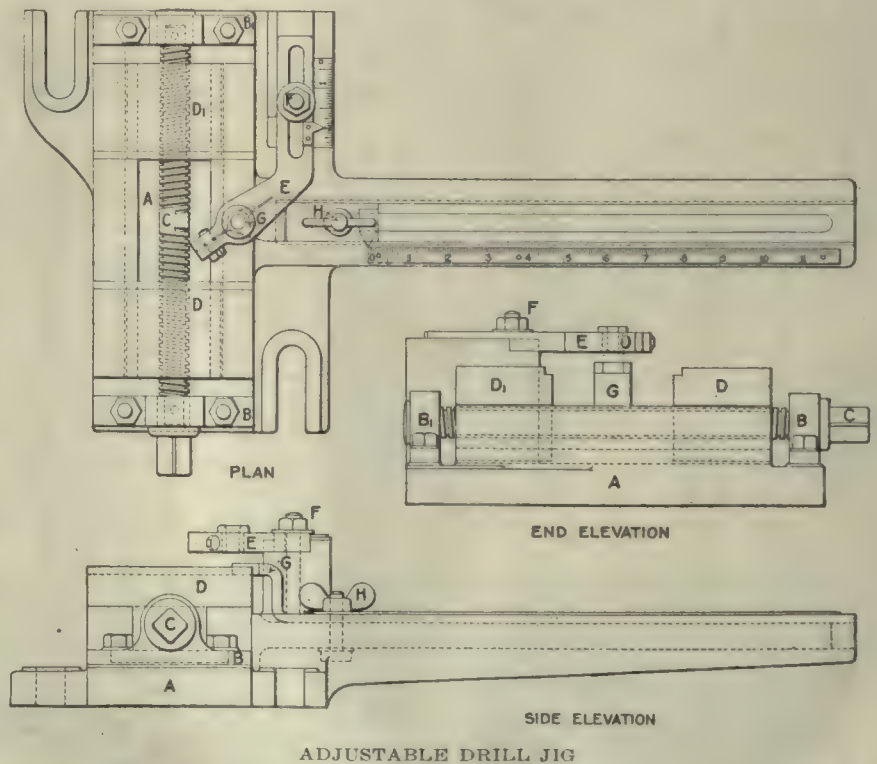
Round-Bar Tool Holder

Herewith is shown a rugged tool holder for tools of the round-bar type. This holder may be used almost anywhere, as on a lathe turret, a carriage, etc. It con-



ROUND-BAR TOOL HOLDER

sists of a heavy base *A*, either a good casting or forging, in which the tool block *B* is free to rotate when released by the clamping screw *C*. These screws serve to clamp the two binder bushings together, thus locking the tool block in any position. The tool *E* is locked in



ADJUSTABLE DRILL JIG

the block by means of the nut *F*, which tightens against the washer *G*.

W. BURR BENNETT.

Bridgeport, Conn.

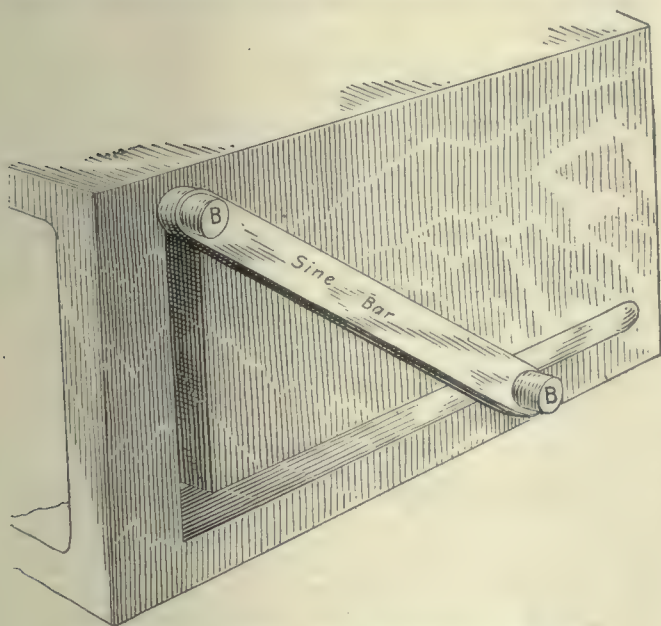
Exports of Ingots, Billets and Blooms, according to figures compiled by the Bureau of Statistics have grown at such a rate that 1,000,000 tons per year have been reached. With an increase from 50,942 tons per month in the last quarter of 1915 to 84,770 tons per month for the first four months of 1916, the outgo has reached the record rate of 1,017,240 tons per year.

Discussion of Previous Question

Improved Type of Sine Bar

The sine bar is undoubtedly a most useful tool. Its usefulness is so well known among tool makers that it has received probably more than its share of space in past numbers of the *American Machinist*. On page 820, Vol. 44, the subject was again raised by Wesley E. McArdeU in an article discussing the merits of an "improved type of sine bar."

A somewhat extended experience with angular work has convinced me that the sine bar without some ready means of support is a most efficient time waster. Before it can be used, it must be clamped to an angle plate. Then it must be tapped to the correct setting. Quite possibly, before the correct setting is obtained the clamps



SINE BAR HOLDING AND SETTING FIXTURE

must be moved. Further, during the progress of the work the setting of the bar must be tested. Since it is held only by clamps, there is a possibility of its moving. All this is well known to its users, and the improved type suggested by Mr. McArdeU does nothing to provide a remedy.

A device designed by the writer to save time in setting the sine bar makes the setting positive for any angle desired. This contrivance is shown in the illustration. It is merely a special form of box angle plate having a right-angle slot parallel to two of its sides. The buttons *B* pass through the sine bar and are, on their reduced diameter, a good fit in the slot. A nut and washer on each button secure the sine bar at the necessary inclination.

To simplify the calculations, the center of the slot should be a definite distance from the edge of the box. It saves time to engrave this distance on the face of the plate. In setting the bar with the height gage, if

the center of the slot is $1\frac{1}{2}$ in. from the edge and the diameter of the buttons 1 in., then 2 in. is added to the calculated height when gaging from the top of the button.

The great advantage of this fixture comes in when we have an angle that may be repeated. It is also valuable in those cases, and they are many, where we have to do work on the bar and require a positive support. In such instances a slip gage of the necessary length, made from, say, $\frac{1}{2}$ square material, is put into the vertical slot. The button pins resting on this gage give the desired angle in minimum time, and work can be performed on the sine bar without any danger of moving. It is convenient to mark the slip gages in angles as well as lengths.

For use with a 10-in. sine bar having buttons 1 in. in diameter, the stems of which are of $\frac{3}{4}$ -in. diameter, the slots in the box should be about 11 in. and 8 in. long respectively. Then for angles up to 45 deg. the short slot is vertical. For the larger angles the long slot is in the vertical position. Both sine bar and buttons should be hardened and ground. A series of tapped holes in the box angle will assist in securing work in position on the bar, if necessary.

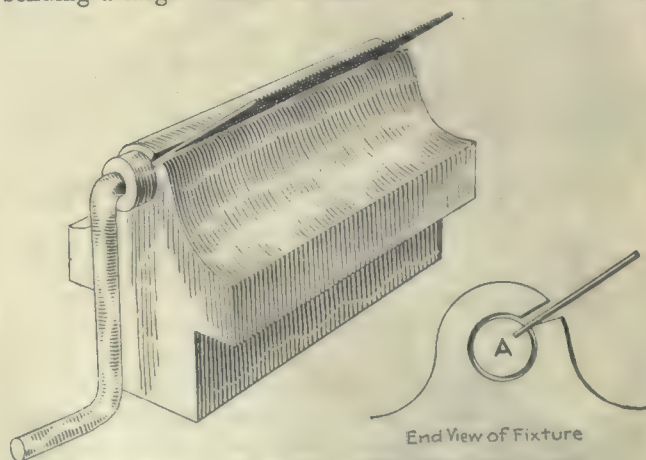
Surrey, England.

WALTER G. GROOCKOCK.

✻

A Simple Hand-Operated Bending Tool

After reading the article about a hand-operated bending fixture, page 513, Vol. 44, I am prompted to write a description of a simple tool that I recently made for bending a large number of small thin steel tubes. They



A SIMPLE HAND-OPERATED BENDING TOOL

were required for the short pieces of black-lead pencils and were termed "pencil economizers." These tubes were made of No. 32 B. G. (0.0098-in.) planished steel, the material having a highly finished blue surface. In making the tubes pieces of the metal were cut $\frac{1}{16} \times 4\frac{1}{2}$ in., which gave the required dimensions— $\frac{19}{64}$ in. in diameter by $4\frac{1}{2}$ in. in length.

In the illustration is shown the bending appliance. It is used in a bench vise and is made of cast iron, with the exception of the roller and handle, which consist of a piece of $\frac{9}{32}$ -in. diameter steel rod bent to the shape shown. Before turning the handle the edge of the sheet metal is placed in a narrow groove that will be observed in the roller at A. To use this bending tool, the piece of sheet metal is pressed evenly with the left hand in the groove in the roller, and the handle is turned with the right hand. The output of tubes by this simple appliance was at the rate of 700 per hr., which was considered satisfactory.

A. EYLES.

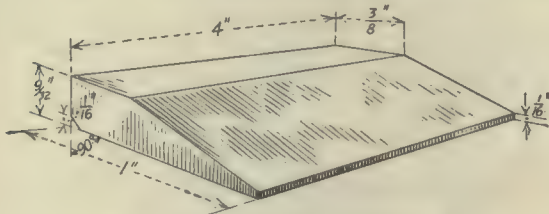
Manchester, England.



Design of Holding Jaws

On page 1002, Vol. 44, Robert J. Beuter indicates that any information on the subject of "hold-downs" would be appreciated. For the benefit of those contemplating making a set of these useful tools, I herewith submit a sketch of a pair of "hold-downs" that I made three years ago. They have never failed me, even under the most trying circumstances.

I have held down a 60-point carbon die block for drop-forge dies while taking a $\frac{1}{8}$ -in. cut in a shaper, with never a fear of my "hold-downs" jumping. For thin



A SATISFACTORY HOLD-DOWN

stock they are almost indispensable. They are made of Ketos steel, hardened and ground parallel on the edges, which contact with the vise jaw and the work. The edges are also ground 90 deg. to the bottom.

All that is necessary to make this kind of "hold-down" work like a charm is to grind on the bottom corner of the wider edge a bevel equaling the width of the narrow edge.

Dayton, Ohio.

HUGO F. PUSEP.



Metric System in Export Trade

I have read with interest the editorials in the *American Machinist*, also the contribution of Henry R. Towne, on page 825, of Vol. 44.

The revival, or perhaps we may say, the ever-recurring epidemic of the metric system may be said to be one of the little things sent along to try us and raise our ire.

It is many years since I had the audacity to question the statement of a well-known professor who informed me, among others, that all go-ahead countries were adopting the metric system. I put the question, "What are the most prominent countries, and how many of them use the metric system?" He did not think an answer necessary.

Many firms, British and American, use inches and meters as a business necessity, as Mr. Towne shows. This evidences no particular favor for the metric system. Many of us are in the position of the ambidextrous individual, only with a bias on the right. To sum up the matter, we are politely asked to tie up our right and give the

other fellow full freedom to attack us with both hands.

I know of some British firms that have given the metric system an out-and-out trial. All may be described as failures. Messrs. Willans & Robinson, mentioned in your editorial, gave up the system because "their designers thought in inches and then wrote millimeters." The man who designs a crowbar about 5 ft. long and then thinks it out in millimeters does not benefit by the system; he is only wasting time.

Aside from the financial aspect (which means that should we adopt the metric system millions of dollars worth of tools must be scrapped), the question of thought must be considered.

We and our children have been trained to think in inches and yards, some of us even in thousandths of an inch. It is not important whether the rule in our hand be metric or foot, but what we "think with," or what our brains are familiar with, that is the important thing. Are we to throw overboard our brains, "tie up our right," and adopt a system doubtful as to its advantages, though certain to cause endless confusion until a new race trained in our schools to think in these particular units can be produced?

Of course, we all think ourselves quite as good as the other fellow, but at the same time fail to see why we should deliberately handicap ourselves by adopting a Will-you-walk-into-my-parlor policy, and make his foreign trade a home trade and our home trade all foreign.

In conclusion, I remember discussing the metric system some years ago with a canny old Scotch engineer. On my asking what were its advantages, he replied: "Well, ye see it's this way: When ye dee, they usually pit ye awa' in a sax-foot plot, but under this new-fangled system ye get two meters instead. Ye have the advantages of anither sax an' three-quarter inches or thereabouts."

Belfast, Ireland.

F. P. TERRY.



Promoting the Right Man

While reading Mr. Stuart's article under the above title on page 1041, Vol. 44, many readers will remark that no man is able to be his own critic, and the Hartfordian writer has not proved to be an exception. The fact that he reads the *American Machinist* and that he is interested enough in the welfare of the trade to write for "our" paper brand him as a man above the average. How many of his former coworkers have read a technical paper? How few of them have ever attempted to write for one? How many stupids spend three nickels a week on Sunday papers to find a better job, while seven and a half cents a week for the *American Machinist* would teach them how to fill it? This is not the only thing that demonstrates that Mr. Stuart is above the average. The special job that gave him his chance could have been done by "any good toolmaker." The italics are mine. Whenever a man ceases to admire his work after it is finished, he is on the track to better results.

Mr. Stuart's superintendent was aware of the fact that the man on the special job was above the average, and he singled him out long before he ever had any need for him in another capacity. A "super" has no time to learn all the good and bad points of all his men, and he has to put them down as average till they prove to be otherwise. The few to whom are given the opportunity to prove their superiority are chosen, and no superintendent can be

blamed for picking the man who demonstrated his value. Mr. Stuart's rapid rise from the ranks proves that he was hand-picked and disproves his argument.

A third party will also regard the case of friend Tom from quite a different angle. Tom is described as a man who knew his business; a man ten years the senior of Stuart; a quiet man, a man with fully developed self-respect. The offer to take a foreman's position was welcome enough, but to work under an old friend, young in years and experience, went against the grain. The offer, however, was Tom's first trump card. His employers may have had the old-fashioned idea never to promote a man unless forced by circumstances. In all probability they knew Tom's value thoroughly and friend Stuart's offer put Tom in his right place.

There certainly are foolish promotions. A good man is often passed by because he is valuable at the work he is doing. These cases are rather numerous and such men are in an unfortunate position, as they pay the price of another man's egotism. But the moment they have sized up the situation, they are able to command much better remuneration than their coworkers. Several promotions which are regarded by the men as foolish appear otherwise if looked at from the employer's viewpoint. There usually is some method in his madness. The best proof of this was given me last winter, when in charge of a gang on some outside jobs in New England. In rapid succession we met the heads of departments of about a dozen firms. It was impossible for my men to know all their names in the short time they came in contact with them, but they always could tell to which firm any *outstanding* man belonged as long as all the "higher-ups" of a firm showed the same main traits of character. These characteristics were often pronounced and showed that each firm had a decided preference as to the qualities it wanted its men to possess.

At least two-thirds of the American firms have theories about hiring or promoting men, although their executives may not be aware of it. Some of the executives avoid friction in the shop by filling the vacancies higher up with outsiders, and discharging them if they do not come up to standard. This system has many advantages, but in northern continental countries, where this system was formerly practiced, laws have been passed making it impossible to lay a man off without one week's notice for the ordinary mechanic, one month for foremen and often several months for men in more important positions. This was to give a man a chance to keep on the level he had reached.

Hiring and promoting in the old country has to be done with great skill, as hiring a man or promoting a man to the wrong position might entail several months' loss of salary to a firm. Large concerns promote their men and shift them to other departments to escape jealousy; smaller companies suggest to the climber that he get out, gain more experience and then return. Often a man is sent out as a "volunteer" to a friendly firm abroad, his own firm defraying his expenses and "after having finished his education," the erstwhile Jack returns as Mr. So and So. His absence also has possibly broken up chummy relationships.

Such methods have proved to be of great advantage to all parties concerned and recently they have found their way to America. A large utility company that gives the utmost care to the hiring, promotion, education and finan-

cial welfare of its employees, has been one of America's greatest successes of the last six years.

Some readers of the *Machinist* will not be able to see the logic of Mr. Stuart's article, still he deserves a lot of credit for having started a discussion that can have only a good influence on those possessing the power to promote efficient workmen.

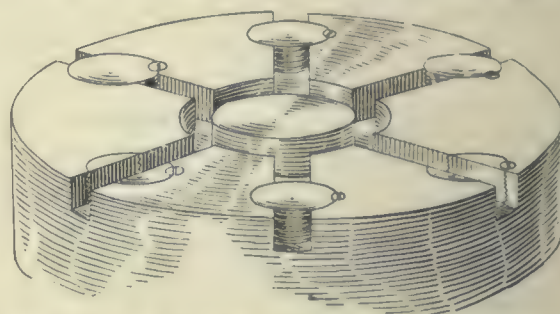
JAN SPAANDER.

Brooklyn, N. Y.

Repairing Tool-Holder Slots in a Turret-Lathe Tool Head

The article on repairing tool-holder slots, on page 1002, Vol. 44, reminds me of a repair recently done on a Jones & Lamson turret. The $\frac{5}{8}$ -in. 11-thread tapped holes in the turret were stripped. The illustration shows the way the job was done. The machine was out of service only 6 hr.

We made six threaded machine-steel plugs $2\frac{1}{4}$ in. in diameter, 16 threads, 2 in. long. These were made on a Jones & Lamson machine in 1 hr. We put the turret



THE REPAIR ON THE JONES & LAMSON TURRET

plate on the miller and bored and tapped the six $2\frac{1}{4}$ -in. 16-thread holes for the plugs in about 2 hr., which left us 3 hr. to shape the slot, drill and tap the $\frac{1}{4}$ -in. 20-thread holes so the bushings cannot turn, and put the turret on again.

I think this will make a stiffer job than the one submitted by F. W. Snyder, and it is certainly much cheaper.

N. W. WOLLUMS.

Columbus, Ohio.

Avoiding Costly Errors in Indexing Work

The editorial on page 785, Vol. 44, on the subject of errors in indexing work, recalls to mind a former experience. The conclusions then arrived at may be helpful to others.

The job itself was one of division and internal milling. Only what was absolutely necessary to get out the work was done. No trouble was anticipated, as it was proposed that, until the job had passed the experimental stage, the work should be handled in the toolroom, where only experienced men were employed.

For a time all went well; everything was as expected. Then trouble developed. Some difficulty was experienced in tracing its cause, which was found to be the shifting of the sector without the operator's noticing it. Some work also came out that was at once seen to be a "mis-divide"—that is, the operator had forgotten the number of turns he had to make for each division and had given

one too many or one too few. The remedy at the time and on that particular job was quickly decided upon. The work in question was held for milling in a pot chuck mounted on the dividing head, the outer end of the chuck being carried in a "steady" mounted on the platen of the machine. As soon as the defective work was found, the front of the chuck was graduated with the correct divisions. An index line was marked on the steady to match. This effectually prevented any further bad work. The operator, after indexing, had only to see that index and graduation were in alignment to be quite sure that all was well.

The question as to what should be done when the job had passed the experimental stage and was ready to be handed over to the regular production staff was then considered. It was decided that with proper jigs the work could be placed upon the plain millers. The matter of simple accurate division was next studied. Direct indexing was ruled out because the number of divisions was large in relation to the diameter, the work with the chuck was heavy and would have to be moved through a small arc, the holes or notches would need to be small and so would not withstand the wear incidental to correct alignment. As it was hardly to be expected that the operator would move the work the correct amount, the wear would of necessity fall upon the plunger and the notch or hole. Universal dividing heads were not admissible with the class of labor employed upon the plain millers. The tool-room operator had made mistakes; they would naturally make more.

The solution decided upon was the construction of dividing jigs in which were embodied a worm and wormwheel. The end of the wormshaft was provided with a spring plunger that entered a hole in a disk. All the operator had to do was to withdraw the plunger, give one turn and again insert the plunger in the hole. Thus there could not be any mistakes.

That was in our case quite satisfactory. In other cases and for finer divisions it would be quite practical to design a worm and wormwheel and provide an index plate in conjunction. The essential feature is that the operator has only to withdraw the indexing plunger from one hole and insert it in the next. This is too obviously simple for anyone to make mistakes. Even if the operator should by any chance miss a hole, the omission can be rectified without error in the result by simply coming round to the missed place as soon as convenient. It will be noticed that this oversight is all that could happen. There could not be a larger or a smaller division. F. R. MANN.

Bournbrook, England.

Attitude of Employers Toward Military Training

Your article on page 956, Vol. 44, recalls to mind the letters which were written some months ago regarding the attitude of employers toward military training, and I refer especially to Percy E. Barbour's reply to Mr. Murphy on the above subject. I also refer to James Vose's recent letter on page 1003, Vol. 44. As an ex-1st Sergeant of a militia company I naturally argue in favor of military training. Few employers realize that the National Guard is one of the greatest aids to discipline in the shops today.

The young man who is enlisted as a private in the ranks soon learns that he has *got to do as he is told* and no ques-

tions asked. By faithful duty he is promoted to a corporalship. At this point, it is his first experience as a (to use a shop term) "gangboss." He is in charge of 7 men and each of these men must go to his "boss" for orders. He is accountable for general discipline and personal appearance of his gang and cleanliness around their quarters. As he improves in his ability to handle his "gang," he is promoted to sergeant, which rank compares with that of a section foreman in the shops, because he commands a "platoon," or in other words, a number of "gangs." He finally is appointed a 1st Sergeant, whose rank compares with a shop department foreman.

The "Top" Sergeant is responsible for the discipline of his company, settles all disputes, lays out his "details" (assigns work to the men), and is the one man between the commissioned officers and the enlisted men.

A good commissioned officer, who acts the same as a shop superintendent, will never command an enlisted man to do certain things until he has first spoken to the 1st Sergeant (foreman). By this training he is unknowingly fitting himself for executive positions in the factories. It has been my experience as a foreman in dealing with military trained men that they are the last to ask the "whys" and "wherefores," but on the contrary are most likely to say, "Yes, sir, I'll do it right away."

Foremen, who may read this article, recall to mind men who with military training have worked for you. Does not your experience favorably compare with mine?

The largest electrical manufacturing concern in the world has recognized the National Guard, to the extent of paying their employees who are affiliated with the militia at the rate of \$1.50 a day, including Sundays, for all ordered tours of duty. The company commander notifies the manager when these tours of duty will take place, thereby giving the department foreman a chance to lay out his work accordingly.

THOMAS PRENTICE, JR.

Pittsfield, Mass.

Two Thread-Cutting Wrinkles

The two wrinkles described by O. F. Philler, under the above heading on page 601, Vol. 44, are not practical. I don't suppose any of us will sell our calipers in our enthusiasm for the first "stunt," even though it is "no cut-and-try method" and there are "no calipers required." As for the second, the odds are 100 to 1 that the next multiple thread the operator cut he would revert to the old and certain method of counting the gear teeth rather than advancing his compound rest in preferring to be sure instead of sorry.

Here's an old timer's thread-cutting stunt that has advantages. A left-hand multiple thread nut was required. After chucking, boring, opening out for about a sixteenth to correct depth, setting up gears, etc., he proceeded to reverse the cone belt (the lathe not being equipped with a reverse), ground up a screw-cutting tool opposite hand to the boring tool. Then, feeding inward for depth of cut and traversing toward the headstock as in a right-hand thread, he cut the threads, dividing up gear teeth, faced out depth cut and the job was completely finished.

This method eliminates guessing for depth, awkward set up in case of tool breaking, and, lastly—the dreaded stiff neck!

JOHN C. WELLS.

Dumfries, Scotland.

Editorials

Index

The index for Volume 44, January to June, 1916, is now ready.

Those desiring a copy should make prompt request.

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Anti-Efficiency Legislation

The record of the present Congress in regard to anti-efficiency legislation stands as follows at the time of this writing (July 7):

1. Tavenner Bill, H. R. 8,665. This bill prohibits time study, premium or bonus in all Government work. It has been reported favorably to the House, accompanied by minority views showing its vicious nature. It is not likely to be acted upon at this session.

2. Van Dyke Bill, H. R. 8,677. This bill prohibits time study, premium or bonus in the Post Office Department. It is still in the House Committee on Post Office and Post Roads. It may be reported out at any time if the desired ends are not gained by a rider on the Post Office appropriation bill.

3. Post Office Appropriation Bill, H. R. 10,484. This bill is now being considered on the floor of the Senate. Anti-efficiency rider is likely to be offered when the committee amendments are disposed of.

4. Naval Appropriation Bill, H. R. 15,947. This bill has been passed by the House and has been reported to the Senate by the subcommittee of the Senate Naval Affairs Committee. It carries in unchanged form the rider as passed by the House.

5. Fortifications Appropriation Bill, H. R. 14,303. This was passed by the House, June 22. The anti-efficiency rider was passed by a roll call, the vote being 197 to 117. It is now in the hands of the Senate Committee on Appropriations and, so far as the rider is concerned, will probably pass in its present form.

6. Army Appropriation Bill, H. R. 16,460. This was passed by the House on June 26 and carries the Tavenner amendment. It was introduced in the Senate on the same day. It will probably pass with the amendment unchanged.

The prospect staring American manufacturers in the face is that the four great appropriation bills will each carry a rider prohibiting the expenditure of any of the moneys there appropriated for time study, premium or bonus payment on any Government work. In principle and result these laws are just the same as those which might prohibit the use of rules, scales, micrometers or any other measuring tool commonly used in doing work. They are exactly parallel in purpose to the weavers' riots in England some 170 years ago. It is an attempt to abolish by law the use of labor-saving devices.

A brief study of the line-up in the House indicates that those who have voted for the amendment believe they are some kind of friend of the "plain people." On the other hand, those who have voted for the exclusion of these provisions are being classed as friends of the "employers' interests."

By the time these comments are in print, it will probably be too late to object to a part of the riders. However, those that have not actually passed into law should be vigorously protested by every manufacturer in the United States. And beyond and perhaps more important than all this, an active propaganda of education should be started at once to forestall similar legislation next year.

Any movement of this kind is insidious. It is easy enough to forecast the next step. It will be to prohibit the use of such improved methods on all work done by private manufacturers for the Government. Such a situation is intolerable, although not unthinkable. It is high time that the campaign of education should be started to prevent the throttling of improvement in shop conditions through such pernicious legislation.

❖

Mobilization of American Research Agencies

The Engineering Foundation has determined to offer its services to the National Academy of Sciences of the United States, "to accomplish the federation of all the research agencies of the nation—governmental, university and private—with the object of encouraging the application of scientific principles to American industries and the employment of science in the national defense." This plan really calls for the mobilization for the good of the country of all the research laboratories and their personnel throughout the United States. The project was taken up and planned by the National Academy. On behalf of the engineering societies the Engineering Foundation now comes forward and offers to assist by providing a competent executive secretary at a salary of some \$12,000 a year.

This movement is one of the earnest attempts at preparedness that are now being made throughout the country. Beyond this broad plan is still another that has for its aim the bringing about of coöperation between men of pure science and men of applied science. The secretary to be appointed by the Engineering Foundation may be the means of inaugurating this coöperation as well as assisting in the work of mobilizing the research agencies.

Both movements hold forth promise of good to American engineering and industry. In the past the man of pure science has been far too apt to hold himself aloof and consider that his interest lay in abstract problems, and too often he did not deign to consider those that had a more practical application unless his aid was specifically sought. It is probable that this attitude will break down when this work of mobilization and coöperation is under way. Once this is done the Engineering Foundation will indeed have accomplished a most worthy piece of work as its initial venture.

It is also hoped that the appointment of an executive secretary capable of handling these big movements will assist in further building up the Engineering Foundation itself. It will be recalled that Ambrose Swasey, of

Cleveland, established this Foundation to be administered "in the interests of scientific research and the good of mankind." The trustees are drawn from members of the four great national engineering societies—the Mechanical, Mining, Electrical, and Civil Engineers. Mr. Swasey's hope in establishing this Foundation was to see it grow and develop somewhat like the great foundation in his home city, known as the "Cleveland Foundation." This was started some four or five years ago by a gift of \$200,000 to be administered in studying the needs of the city of Cleveland. The initial gift has been added to time and again until the foundation now has an endowment of \$26,000,000.

It is earnestly hoped that other engineers will follow the example and wish of Mr. Swasey, and add to the Engineering Foundation until it reaches a large sum and produces an income capable of bringing great results in the field of engineering research and for the good of mankind. An excellent beginning has been made, for nothing but commendation can be said of the initial move of the trustees in seeking to bring about closer relations between the pure and applied sciences.

Keeping the Workers Cool in Summer

The season is fast approaching when those who labor in factories veritably earn their bread by the sweat of their brows. Warm weather, which was delayed beyond its usual time of appearance, has now arrived.

While investigations have shown that human energy and vitality are not by any means at their lowest ebb during the hot months, still it is an undeniable fact observed by anyone who has labored under these conditions that excessively hot weather has a diminishing effect upon shop production.

There are a number of ways to partly overcome this drawback, one of the remedies being the installation of ventilating systems. Some of the most advanced of these maintain the air at a temperature several degrees lower than that outside. Under these conditions, however, the circulation of air is restricted to certain definite passages, and openings such as windows and doors are kept rigorously closed. Imagination goes a long way in the matter of sense of comfort; and when the worker is confined in an atmosphere of this kind, even though it may be cooler than that outside, he misses the stirring of the air or breeze which through years of habit instinctively spells comfort.

A psychological method of increasing the comfort of the workers under such conditions is the installation of fans that produce an actual breeze. The ordinary electric fan in office or smoking car gives one an instinctive sense of comfort, although, as a matter of fact, it merely handles the same air over and over again, in reality raising its temperature through friction.

Another and more logical remedy for the individual worker is the adoption of a proper summer diet. A sense of high temperature is much more easily brought about by over-indulgence in meat or food of high caloric value during the summer months than through ordinary exercise. A glass of beer at noon may look and taste refreshing, but is far from comfortable in its after-effects. There is an opening for organized effort along these lines

on the part of progressive manufacturing companies. It very likely might pay some of them to furnish their employees with meals of proper caloric values even at less than cost.

What Is a Hand Screw Machine?

He who asks for a definition should always remember that peace flees when definitions are being framed. Every attempt to limit accurately the meaning of a word or name, or to distinguish between one machine or tool and others that are similar, brings forth controversy. If any worth-while result is finally obtained it must be through compromises. In spite of these truths a request has come to define a hand screw machine, or at least point out the differences between a hand screw machine and a turret lathe.

The name "turret lathe" is undoubtedly very old. It is descriptive in itself, is comprehensive and seemingly was originally and perhaps even today is properly applied to any type of lathe or turning machine that is provided with a turret to hold a series of cutting tools. Thus it properly seems to include chucking lathes, hand screw machines, automatic screw machines and the so-called semiautomatic lathes used largely for machining castings and forgings.

If this view is right, "turret lathe" is the comprehensive class name and "hand screw machine" the special type name of a certain kind of machine in the broad turret-lathe class. Once we accept this view, we can then try to define or state the features that separate hand screw machines from chucking lathes, automatic screw machines and the various other types in the same general class.

The four principal features that a hand screw machine seems to possess are a hand-operated turret, a hand-operated cross-slide, a hand-operated chuck and a hand-operated wire feed. The hand-operated mechanisms distinguish it from the automatic screw machine and semiautomatic turret lathe, on the one hand, and the possession of the wire feed from the chucking lathe, on the other.

This attempt at definition comes from the thought that the mechanism and possible functions of a machine determine its type rather than the particular work for which it may be used. This viewpoint forestalls any objections to the definition as just written, on the score that hand screw machines when used for second operations do not employ the wire feed and so in operation are like chucking lathes.

The confusion in mechanical terms has often been pointed out. It is a pity that such names are not better fixed, and it is particularly unfortunate that the term "turret lathe" is loosely employed without qualification for so many different kinds of machines. In mentioning them in print, in letters and conversation it is far better to use one of the names of a type, as chucking machine, or hand screw machine, or automatic screw machine, or semiautomatic turret lathe, than to refer to them merely as turret lathes.

The man who never makes a mistake is sleeping under six feet of Mother Earth with unheeding, purposeless winds blowing over him.

Shop Equipment News

Gage-Grinding Machine

For some time the Gem City Machine Co., Dayton, Ohio, has been handling large orders for punches, dies, fine tools, and snap, plug, limit or other gages. For its snap or other gages of that character, it designed and built a special grinder that has been in use in its shop for some

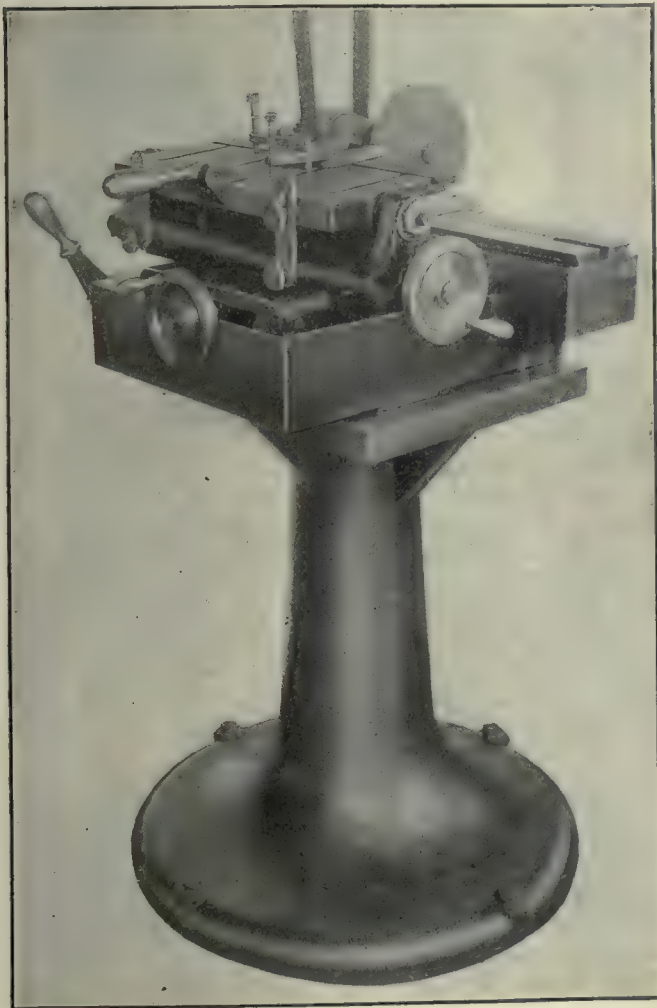


FIG. 1. GAGE-GRINDING MACHINE

Table, $6\frac{1}{2} \times 14$ in.; table swivels an included angle of 20 deg.; table traverse, screw movement, $\frac{1}{4}$ in.; grinding head traverse adjustment, 12 in.; cross-feed handle movement, 3 in.; size of pulley, $2\frac{3}{4}$ in.; speed, 2,800 r.p.m.; size of wheel taken, $6 \times \frac{1}{4}$ in., $\frac{1}{2}$ -in. hole; diameter of base, 22 in.; height overall, 33 in.; weight about 700 lb.

time, and which it has now decided to put on the market for use on similar work.

A feature of the machine shown in Fig. 1 is that the stand is made low enough so that an operator can sit on a stool and both manipulate the machine and watch the work to the best advantage. The table is of ample size to take all classes of gages and is equipped with T-slots, bolts and clamps. A setting gage is also used on the table for duplicate work. The table is made to swivel up or down to allow the grinding of thick or thin

gages and still keep the center of the work on a line with the center of the wheel.

The machine has a traverse screw feed operated by means of a large handwheel graduated to read to thousandths. The graduations on the rim of this wheel are about $\frac{1}{8}$ in. apart, making them very easy to read or to estimate in less than thousandths. The table may be traversed $4\frac{1}{4}$ in. by means of the handwheel, but if a longer or wider gage is to be ground the head gives an adjustment, in the same direction, of 12 in. The ways on which the head slides are accurately scraped and the head is shifted by means of a rack and pinion movement and securely locked wherever desired. The grinding spindle is made of hardened and ground steel and runs in bronze taper bearings that permit close adjustment. End

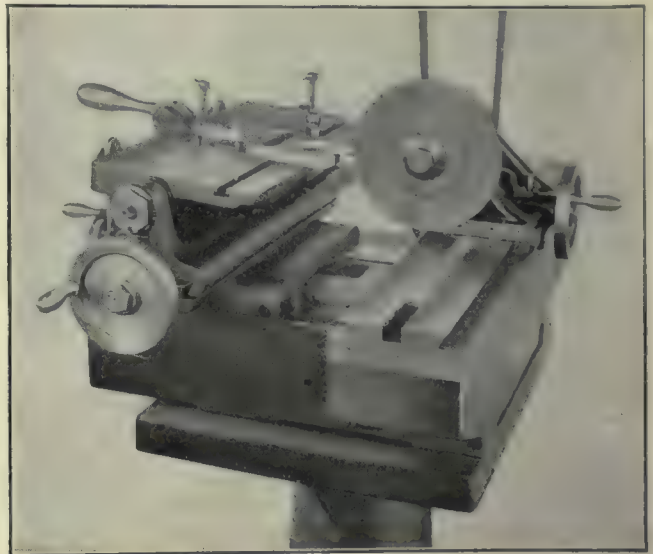


FIG. 2. ANOTHER VIEW WITH GAGE IN GRINDING POSITION

play is taken up by means of a very sensitive adjustment regulated by one small screw.

The spindle drive is of the floating type in which the drive pulley runs on a separate sleeve. This eliminates all marks made by the jump of the belt. The spindle is self-oiling, the oil supply being drawn from a reservoir inside the pulley from which it runs to both the thrust and circular bearings. This reservoir is inclosed with felt oil retainers that prevent leakage when running at high speeds.

The ways on which the head and carriage slide are covered with telescoping brass dustguards, which have been removed for photographing purposes. These guards are lined with felt and are so made as to be absolutely dust-proof. The crossfeed is operated by means of a hand lever and rack and pinion. This gives a quick movement for working purposes. Combined with this is an additional movement by means of a fine pitch screw and hand-wheel. The hand lever is used for removing most of the excess metal, and then the screw feed is used to obtain

a fine smooth finish and straight face. In actual practice it has been found possible to grind snap gages to within two or three tenths of the given dimensions, and then finish by stoning.

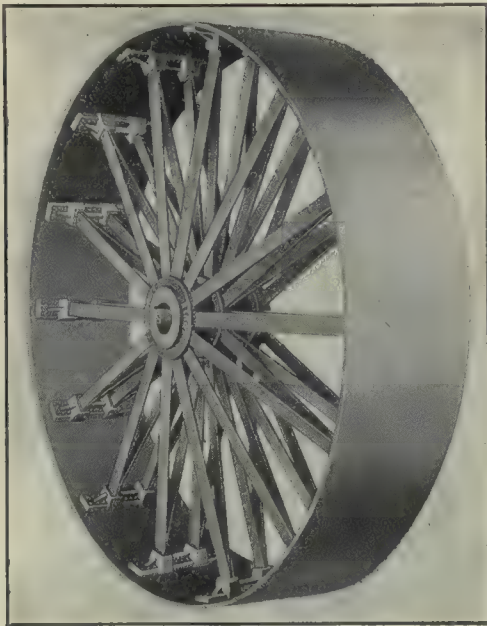
Another view of the machine, with a limit snap gage in place, is shown in Fig. 2. This gives a good idea of the entire mechanism of the head and table.

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Heavy-Duty Pulley

In the design of the type of pulley illustrated the aim was to provide for heavy duty and at the same time keep the pulley light.

The arms are made of flat wrought steel. The hubs and rim lugs are of semisteel and are cast onto ends of



HEAVY-DUTY PULLEY

Diameters, 3 to 15 ft.; face width, up to 50 in.

arms that are of a shape designed to provide a solid anchorage.

This form of pulley is made by the Medart Patent Pulley Co., St. Louis, Mo., in three styles—namely, single- and double-arm whole type and double-arm split type.

❧

Universal Grinder

While built along the same general lines as this firm's former machines, the latest type of universal grinder made by the Thompson Grinder Co., Springfield, Ohio, has been changed and improved in numerous ways. Most of the changes are for the purpose of making easier the work of the operator or to meet special shop conditions as demonstrated by use during the last two or three years of actual practice.

In the first place this grinder was designed to combine in a single machine efficient means for the rapid and accurate production of the varied grinding required in a machine shop. The grinding wheel is maintained in a fixed position at all times, and the table carrying the work is adjustable to any desired position relative to the wheel.

The principle of carrying the grinding-wheel head rigidly mounted on a central column solidly attached to

the base, around which a heavy bracket mechanism revolves, makes an unusual form of design for a heavy grinder. The revolving bracket moves on a bearing on the base and carries the elevating knee, carriage and table. This arrangement allows the table to be adjusted to a position at right angles to the wheel spindle at either end, parallel with it or at any intermediate position. Accordingly, the machine can be converted

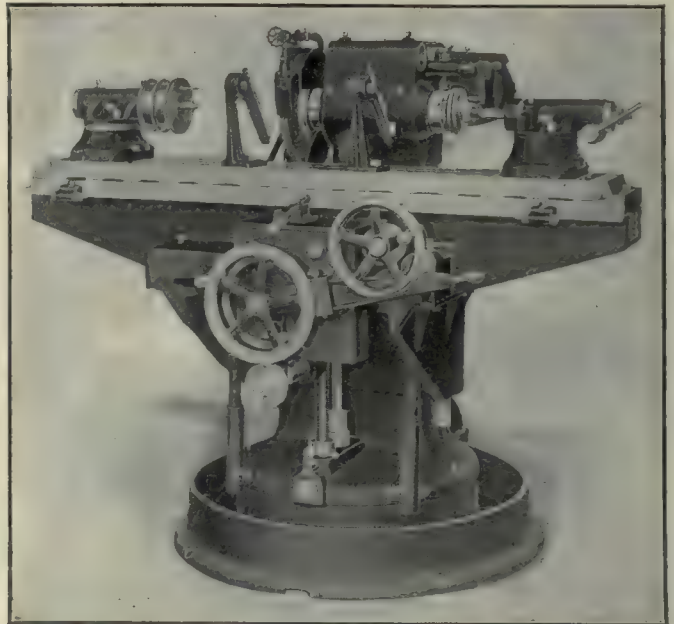


FIG. 1. UNIVERSAL GRINDER

Capacity: Cylindrical grinding, 10 in. in diameter by 36 in. long; surface grinding, 8 in. wide by 48 in. long; internal grinding, up to 12-in. depth, according to attachments used; knife grinding, 48 in. long; milling cutters, up to 20 in. in diameter; grind taper per foot, 3 in.; automatic longitudinal feed to table, 48 in.; automatic crossfeed, 8 in.; hand vertical adjustment to knee, 10 in.; speed changes to table, 5; speed changes to headstock, 4; speed of main spindle, 1,830 r.p.m.; horsepower required, 3; main spindle bearings, 1½x4 in.; headstock spindle bearing, 2x9 in.; main spindle pulley, 3½x3½ in.; headstock swivels 90 deg. each way; countershaft pulley, 10x4 in.; speed of countershaft, 400 r.p.m.; base, 40 in. in diameter; maximum floor space, with full table travel in all positions, 11x11 ft.; net weight, 3,600 lb.; gross weight, 4,300 lb.; dimensions boxed for export, 48x45x78 in.

into a plain grinder for straight or taper work between centers, a surface grinder, an edge grinder, a die grinder, a cutter grinder or an internal grinder. Fig. 1 illustrates the machine set for plain cylindrical grinding, and Fig. 2 shows the table swung at right angles to the spindle for surface grinding. By using a cup wheel this same position serves for edge or knife grinding.

The controlling lever, which starts, stops or reverses the table, is placed on the clutch box immediately in front of the operator. A slight movement of this lever disengages the clutch and stops the table, leaving it free to be operated by the handwheel. The lever controlling the table speeds is placed on the side of the gear box on the rear of the grinding-wheel head and by means of a circular rack and sliding key permits five table speeds ranging from 28 to 128 in. per min. The headstock speeds are governed by the four-step cone pulleys on the countershaft drum and counter. The motion is transmitted through a friction clutch in the drumshaft cone, giving headstock speeds ranging from 30 to 300 r.p.m.

The base is cast integral with the reservoir and has a settling basin open at the top, permitting easy cleaning. The inner column is of box design, rigidly attached to the base on the bottom and to the grinding-wheel

head on top. It also carries the lower bearing for the power-feed shaft. The rear column is also of box design, rigidly attached to base and wheel head, thus making the base and inner column an unyielding unit or frame for the support of the grinding-wheel head. The outer column has an annular bearing on the base and is clamped in any position to suit the work. When this column is to be rotated, a slight movement of a lever brings into action a set of roller bearings that make the movement easy.

The sliding table has a reciprocating movement on the carriage, controlled by dogs operating against the

single easily accessible gear box. Narrow guides are now used on the column, and a new driving clutch, of the expansion ring type, is placed at the back. The top is much stronger than heretofore, and the ways are changed to the 45-deg. type. The table is operated by

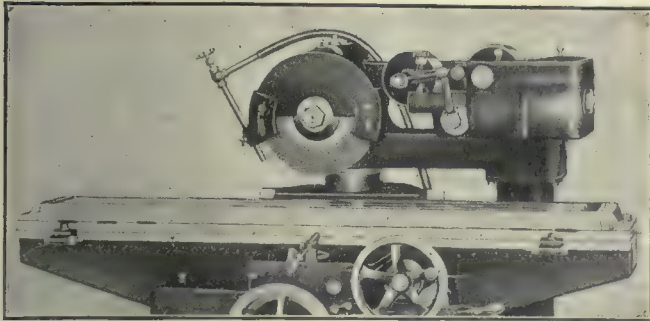


FIG. 2. ARRANGED FOR SURFACE GRINDER

reverse lever. These dogs have a special fine adjustment to permit grinding against shoulders. The swivel table has its bearing on the sliding table and can be set at any angle with the ways, allowing tapers to be ground without disturbing the alignment of the headstock and tailstock centers. It is graduated to read taper in inches per foot. It has three T-slots in it. The headstock swivels and has a graduated base. Its spindle is bored for No. 3 Morse taper shanks. It is also fitted with pulleys for both live- and dead-center work. The tailstock is secured to the table in the same manner as the headstock. It has a device for holding a diamond-tool holder, so the wheel may be trued without removing the work.

The tailstock spindle is bored the same as the headstock spindle and is fitted with a quick-acting lever and a variable-tension spring controlled by a wheel, or it may be clamped solid. The automatic crossfeed is equipped with a lever on which are mounted two pawls engaging with a ratchet on the handwheel, from which a feed variation of one-quarter to four-thousandths is obtained at each reverse. The feed is automatically thrown out when the work is to size, by setting the stop on the ratchet wheel. The pump used is of the centrifugal type, with bearings above the water level, but with the runner immersed at all times, doing away with the necessity of priming. Either plain or universal equipment is furnished on order.

Plain Miller

The machine shown in Fig. 1 is an improved model of the No. 33 miller made by the Kempsmith Manufacturing Co., Milwaukee, Wis. Various modifications have been adopted to meet manufacturing conditions, both in making and use.

Changes in rate of feed and speed are made by means of change gears, mechanism for which is inclosed in a

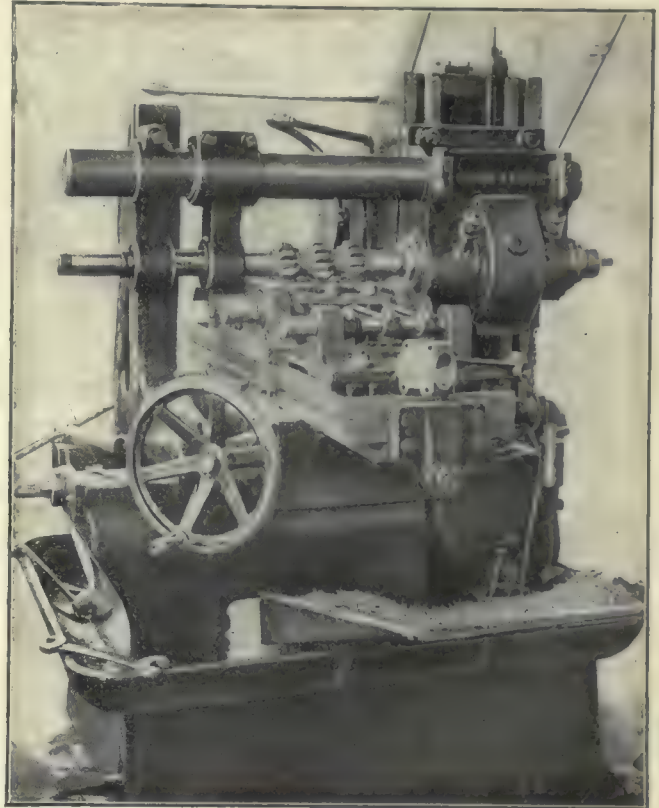


FIG. 1. IMPROVED NO. 33 PLAIN MILLER

Longitudinal power feed, 36 in.; hand crossfeed, 10 in.; vertical adjustment of spindle by hand, 11 in.; maximum distance from top of table to center of spindle, 12 in.; height of table above floor, 37 1/2 in.; power quick traverse, 100 in. per min.; driving pulley, 500 r.p.m.; diameter of driving pulley, 12 in.; width of double belt, 4 in.; six spindle speeds, ranging from 25 to 152 r.p.m.; six changes of power feed in either of two series, ranging from 1 to 8 in., or 2 1/2- to 8-in. table travel per minute; total floor space, 64x106 in.; net weight, about 4,500 lb.

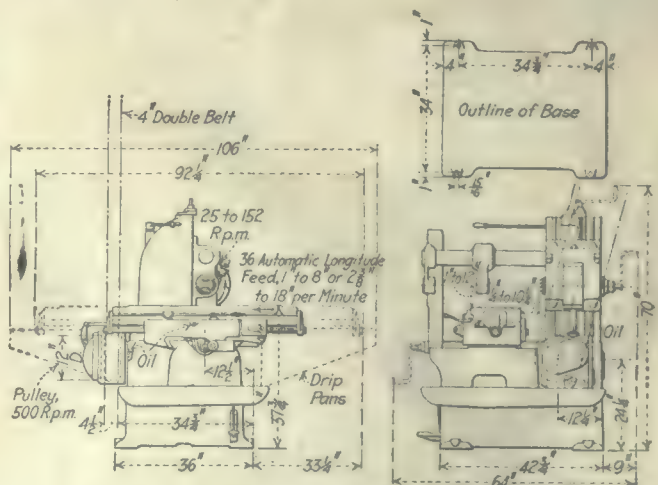
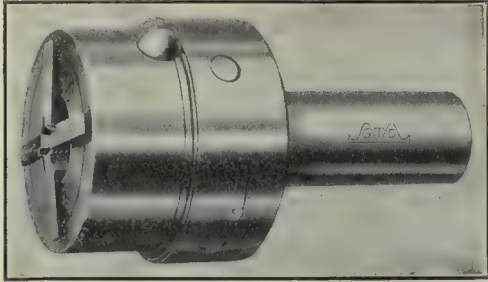


FIG. 2. DETAILS OF PLAIN MILLER

a lead screw instead of a rack, and a quick traverse is provided. The bed and base are cast in one piece, and the pump is placed outside. Fig. 2 shows some of the details.

Self-Opening Die

In the form of self-opening die shown, the latest addition to the line made by the Greenfield Tap and Die Corporation, Greenfield, Mass., the self-opening die principle used in the former products of this company has been retained. Guarding the opening for the chaser setscrews



SELF-OPENING DIE

and substituting a ball-shaped latch for opening the die when the cut is finished constitute the main improvements.

The formerly exposed chaser-setscrew openings are covered by a light steel shell that prevents dirt and chips from entering, with the possibility of marring the work. The shell can be turned to expose the screws in order to release and remove the chasers.

The die is designed to be particularly applicable in cases where the work is stationary.

NEW PUBLICATIONS

GRINDING MACHINERY. By James J. Guest. 440 pages; 5½x8½ in.; cloth. Published by Longmans, Green & Co., New York. Price, \$4.20 net.

The author has used considerable care in the selection of material and shows many of the latest types of grinding machines from various makers, both in this country and abroad. The book includes much detail as to parts, particular attention being devoted to reversing and cross-feed mechanisms, steady rests, details of head construction and also the methods of belting for the various functions.

The author takes exception to the acceptance of standard speeds for work being ground and advocates that they be varied according to the material, the kind of wheel used and other conditions. He gives the work speeds advocated by several of the best-known builders of grinding machines and supplements them with a table of his own in the appendix. All who are particularly interested in grinding machinery will find the book of great assistance.

SAFETY ENGINEERING APPLIED TO SCAFFOLDS.—Three hundred and thirty-nine 6x9-in pages; 127 illustrations; indexed; cloth bound. The Travelers Insurance Co., Hartford, Conn. Price, \$3.

This book should be in the working library of every plant engineer. The literature on the subject of scaffolds is exceedingly meager. In fact, this is the only book that describes American practice with anything like completeness. It is based upon the results of the experience and observation of the engineers of the Travelers Insurance Co. in their regular work of inspection and research.

For the reason that scaffolds are for temporary use only, they are commonly badly designed and badly built. Too often the materials in them are poor in quality and deficient in size and quantity. It appears to be a widespread and almost universal belief that a scaffold is not worth anybody's serious study. Any workman who can drive a nail is looked upon as competent to lay out and build a scaffold, and anything that may happen to lie at hand is good enough for material. As a result many such temporary structures are dangerous to life and limb, as is amply proved by some ten pages of reprinted newspaper clippings gathered during June, July and August, 1911. They aggregate 92 scaffold accidents, or precisely one per day for the period studied.

The work is comprehensive, taking in as it does simple platforms and horse scaffolds, used for interior painting and

decorating, and at the other extreme the well-designed, carefully constructed scaffolding for a skyscraper like the Woolworth Building or for decorating a huge room like the concourse of the Grand Central Terminal in New York City. Scaffolds of some kind between these limits are in daily use in every shop and factory. The engineer in charge should acquaint himself with the best available knowledge on the matter of design, construction and use of these temporary structures.

The field covered by the book is indicated by the headings of the 13 chapters, which are: Reality of the Scaffold Hazard, Scaffolds Considered Generally, Bricklayers' Pole Scaffold—American Practice, Independent Pole Scaffold, Lashed Scaffolds; Other Forms of Pole Scaffold, Special Safety Features, General Features and Operations, Building with Horses, Suspended Scaffolds for Construction Work, Scaffolds of Other Kinds, Structures Similar to Scaffolds, General Counsel.

The mechanical features of the book are far above the average, and the illustrations are excellent.

FORD METHODS AND THE FORD SHOPS.—By Horace Lucien Arnold and Fay Leone Faurote. Four hundred and forty 7x10-in. pages. Published by the Engineering Magazine Co., New York City. Price, \$5.

This book is a reprint of the articles that appeared in the "Engineering Magazine," the main part being by Horace L. Arnold, well known as a contributor to the "American Machinist" in years gone by, and the remainder, completed after Mr. Arnold's death, by Mr. Faurote.

Opening with a chapter on the characteristics of Henry Ford and the beginning of the Ford Motor Co., the book takes up the various departments in detail and gives a wealth of information concerning methods, machines and time required. There are 16 chapters, beginning with the Genius of the Plant and ending with Safeguarding the Workmen. In between come chapters on Stock System and Employment Methods, How the Work Is Done, Inspection and Assembly, Motor Test Blocks and Chassis Assembly, Machining and Assembling the Front Axle, The Crankshaft, Piston and Piston Rings, The Commutator, Production and Assembly, Sheet-Metal Work, Conveyors, Work Slides and Roll Ways, The Bushing Job, Special Machines and Fixtures, The Foundries, Finishing the Bodies, and New Factory Conditions.

Practically every problem of shop management seems to be contained in this plant and is so recorded in this book that no one responsible for production can fail to absorb many valuable ideas from it. True, many of the methods will have to be modified to suit other conditions, but they are none the less valuable on that account.

The whole system of shortening the travel of material, which plays such an important part when over 140,000 lb. of material is moved per day, is brought out in detail.

The questions of hiring and firing, of the health of employees, of the use of unskilled workers, together with the forms employed, are all considered. A commendable plan of having employees fill out a card as to the work in which they believe they can be more valuable than in their present occupation is described.

The work of the shortage chaser is given in detail; and as the steady flow of material to the assembly department is a vital problem in any large shop, this description is of particular interest. Every hour shows just how all departments stand in their supply of parts.

The methods of both machine shop and foundry are illustrated. The sequence of operation, the time required, the shop layout that makes it possible and much else of interest are given. In fact, we know of no other instance where such detailed information has been made public except in connection with the articles in the "American Machinist" on the manufacture of munitions.

The chapter on inspection and assembling is of particular value, for inspection is thorough in order to prevent unnecessary machine work being done on imperfect parts. The reduction of time for assembling is shown in considerable detail and contains many valuable suggestions, among them a comparison of individual assembly of a complete part requiring six operations and the result of dividing this work among three men. Great care is taken to have benches and other assembly devices, such as continuous carriers, at the best height for easy reach—"work high," as it is called. These heights vary from 24½ to 35 in., according to the work being done. This idea is also being applied more and more to machines, so as to bring them to the most convenient height. Minute details of the motor assembly are given, 84 operations being mentioned, with the men required and the number of seconds for each.

Many of the machining operations are also given in detail, both as to sequence and time required; these data should be of service in many shops, even on other lines of work. Crankshafts, pistons, commutators, bushings, gasoline tanks, radiators, etc., are taken up in similar detail.

There is so little specific information available on modern foundry methods and costs that the chapter on this subject should be especially interesting. The size of the foundry alone at once attracts attention—with 1,450 men, melting 192 tons of iron, handling 1,906 tons of sand and pouring 40,450 pieces of an average weight of 8.9 lb. per day. Painting and varnishing of bodies are also treated in detail as to methods, output and the time required.

For both study and reference the book is to be commended to shop executives, planners and those who have to do with production. The only criticism is the failure to mention specifically the work of such men as C. H. Wills, who has been so long associated with Mr. Ford, as well as the chief tool designer, C. Emde, and others. Of course, such a result can only be achieved by the coöperation of many, and the omission may be due to the endeavor to avoid injustice by unintentional omission.

MECHANICAL ENGINEERS' HANDBOOK—By Lionel S. Marks, editor-in-chief. First edition. One thousand eight hundred and thirty-six $4\frac{1}{2} \times 7\frac{1}{8}$ -in. pages; limp leather binding; thumb index. McGraw-Hill Book Co., New York City. Price, \$5.

Reviewed by JOSEPH W. ROE*

Seventy-two years ago Charles Haswell brought out the first edition of his "Engineers' and Mechanics' Pocket-Book." Though general in its nature, its modest size, 264 pages, justified the name "Pocket-Book." It grew from year to year and passed through more than 70 editions, establishing the value of this type of book, and it has led to many similar volumes dealing with special branches. This was inevitable with the vast growth of engineering science and its spread into intricate and widely differing fields. The name "Pocket-Book" still lingers on some, though they have long since grown too bulky for any normal pocket. The present book, the latest of this kind, wisely uses the name "Handbook," which it literally is—a book of reference to be kept at hand on the desk or elsewhere.

Most of these books have been compiled by one man, or by a small group of men. The only reference work for mechanical engineers compiled by a large group of specialists has been the three-volume German book "Hütte," now in its twenty-second edition, which includes civil and electrical engineering as well as mechanical engineering. The present "Handbook" is intended to supply the practicing engineer and the student with a comprehensive and authoritative reference work in mechanical engineering, and it was felt that in a major division of engineering the coöperation of a large number of specialists, as in the "Hütte," is now necessary if a book of this character is to have reliability and adequate authority. It is therefore the work of 50 specialists, with Professor Marks as editor-in-chief, and has been founded in the "Hütte."

The contributors have been well chosen and will carry weight by their authority. The more important sections of the book are the work of several men. That on the Properties of Engineering Materials, for instance, is handled by 13 specialists. Other topics are cared for by separate writers, each familiar with the particular subject. In addition to this many of the sections were submitted to various manufacturers and specialists for corrections and suggestions.

The general arrangement of the "Hütte" has been followed. The presentations of some of the more theoretical subjects follow it closely, others in a general way; but those portions dealing with American engineering practice are almost wholly new.

The "Handbook" contains the usual mathematical tables. These are carried out to only four significant figures, which limits their usefulness for some purposes, but allows space for a more complete treatment of general mathematics than has been usual in books of this character, and for a new and very valuable section on the Graphical Representation of Equations. The theory of mechanics, heat and strength of materials has been brought out in condensed, but clear form, which will make these sections of great value to the engineering student. The one on heat is particularly good and includes much new material and many tables and diagrams. In all these sections a much greater familiarity with mathematics is assumed than in previous handbooks.

The presentation of materials of engineering is full and well arranged, including not only full information and specifications on iron, steel, the alloys and fuels, but also on concrete, brick, wood, lubricants, abrasives, belting, insulation, paints, roofing materials and a wide variety of articles used by engineers.

The other main sections cover Power Generation, Hoisting and Conveying, Transportation, Building Construction and

Equipment, Machine-Shop Practice, Pumps and Compressors, Electrical Engineering, Engineering Measurements, etc. Much new matter will be found under Materials, Power Generation, Conveying Machinery and Buildings. A number of the subsections are wholly new, as those on Aëronautics, Air Conditioning, Accident Prevention, Centrifugal Air Compressors and the A. S. M. E. Testing Codes.

The subdivision of the book into well-defined sections is distinctive and comes as a natural result of the staff authorship. The preliminary index to the major topics, printed inside the covers, taken in conjunction with the thumb tabs and subtables of contents at the head of each section, renders the material more readily accessible than in any other handbook known to the reviewer. An excellent table of references is usually found at the head of each subsection, covering the subject matter of that section. Black-faced type, judiciously used, emphasizes the important subjects in the longer paragraphs. There are about 1,000 illustrations, which include many charts and heat and stress diagrams. The critical reader will find a few mistakes in the text and in some of the illustrations, but this is inevitable in a work of this magnitude. These errors will, no doubt, be eliminated in later editions.

The staff authorship of this book, its skillful editing, the up-to-dateness of its material and the form and accessibility of its information make this the best handbook yet issued for engineers. It will prove of more assistance to students than any before available, without losing any of its value as a reference book for the practicing engineer.

PERSONALS

L. H. Mesker has been appointed sales manager of the Kearney & Trecker Co., Milwaukee, Wis., with direct supervision over the sales in the Ohio territory.

Wallace R. Johns, for the past 11 years associated with the Somers, Fittler & Todd Co., Pittsburgh, Penn., has been appointed manager of its machine-tool department.

F. C. Riddik, formerly general superintendent of the Railway Steel-Spring Co., Chicago Heights, Ill., has become general manager of the Kennedy-Stroh Corp., Oakmont, Penn.

Frank Lundgren, until recently superintendent of the Krajewski-Pesant Co., Brooklyn, N. Y., has become superintendent of the Farrell Foundry and Machine Co., Ansonia, Conn.

W. M. Henderson, formerly assistant superintendent of the frog, switch and signal department of the Steelton plant of the Pennsylvania Steel Co., has accepted a position as assistant works manager of the Taylor Iron and Steel Co., Easton, Penn.

FORTHCOMING MEETINGS

American Foundrymen's Association and American Institute of Metals. Annual meeting, September 11-16, Cleveland, Ohio. A. O. Backert, secretary, American Foundrymen's Association, Cleveland, Ohio.

American Society of Mechanical Engineers. Monthly meeting first Tuesday. Calvin W. Rice, secretary, 29 West 39th St., New York City.

Boston Branch National Metal Trades Association. Monthly meeting on first Wednesday of each month, Young's Hotel. W. W. Poole, secretary, 40 Central St., Boston, Mass.

Providence Association of Mechanical Engineers. Monthly meeting fourth Wednesday each month. J. A. Brooks, secretary, Brown University, Providence, R. I.

New England Foundrymen's Association. Regular meeting second Wednesday of each month. Exchange Club, Boston, Mass. Fred F. Stockwell, 205 Broadway, Cambridgeport, Mass.

Engineers' Society of Western Pennsylvania. Monthly meeting third Tuesday; section meeting, first Tuesday. Elmer K. Hiles, secretary, Oliver Building, Pittsburgh, Penn.

Rochester Society of Technical Draftsmen. Monthly meeting, last Thursday. O. L. Angevine, Jr., secretary, 357 Genesee St., Rochester, N. Y.

Superintendents' and Foremen's Club of Cleveland. Monthly meeting third Saturday. Philip Frankel, secretary, 310 New England Building, Cleveland, Ohio.

Western Society of Engineers, Chicago, Ill. Regular meeting first Wednesday evening of each month, excepting July and August. J. H. Warder, secretary, 1785 Monadnock Block, Chicago, Ill.

Philadelphia Foundrymen's Association. Meetings first Wednesday of each month. Manufacturers' Club, Philadelphia, Penn. Howard Evans, secretary, Pier 45 North, Philadelphia, Penn.

Technical League of America. Regular meeting second Friday of each month. Oscar S. Teale, secretary, 35 Broadway, New York, N. Y.

*Assistant Professor of Machine Design, Sheffield Scientific School, Yale University.

Prices--Materials and Supplies

IRON AND STEEL

Pig Iron—Quotations were current as follows at the points and dates indicated:

	July 7, 1916	One Month Ago	One Year Ago
No. 2 Southern Foundry, Birmingham.....	\$14.00	\$14.75	\$9.75
No. 2X Northern Foundry, New York.....	19.75	20.25	14.25
No. 2 Northern Foundry, Chicago.....	19.00	19.00	13.00
Bessemer, Pittsburgh	21.95	21.95	14.75
Basic, Pittsburgh	18.95	18.95	13.60
No. 2X, Philadelphia.....	19.75	20.25	14.25
No. 2, Valley.....	18.25	18.00	12.75
Basic, Eastern Pennsylvania.....	19.50	20.00	13.75
Gray forge, Pittsburgh.....	18.70	18.70	13.45

Steel Shapes—The following base prices in cents per pound are for angles 3 in. by ½ in. and larger, tees 3 in. and larger and plates ½ in. and heavier, from jobbers' warehouse at the places named:

	New York July 7, 1916	One Month Ago	One Year Ago	Cleveland	Chicago
Steel angles, base.....	3.25	3.50	1.85	3.25	3.10
Steel T's, base.....	3.30	3.55	1.90	3.25	3.10
Machinery steel (bessemer)...	3.25	3.50	1.80	3.25	3.10
Plates	4.00	4.25	...	3.65	3.50

Steel Sheets—The following are the prices in cents per pound from jobbers' warehouse at the places named:

	New York July 7, 1916	One Month Ago	One Year Ago	Cleveland	Chicago
No. 28 black.....	3.65	3.65	2.60	3.20	3.20
No. 26 black.....	3.55	3.55	2.50	3.10	3.10
Nos. 22 and 24 black.....	3.50	3.50	2.45	3.05	3.05
Nos. 18 and 20 black.....	3.45	3.45	2.40	3.00	3.00
No. 16 blue annealed.....	4.45	4.45	2.35	3.70	3.60
No. 14 blue annealed.....	4.35	4.35	2.25	3.60	3.50
No. 12 blue annealed.....	4.30	4.30	2.20	3.55	3.45
No. 10 blue annealed.....	4.25	4.25	...	3.50	3.40
No. 28 galvanized.....	5.40	5.65	6.00	5.20	5.10
No. 26 galvanized.....	5.10	5.35	5.70	4.90	4.80
No. 24 galvanized.....	4.95	5.20	5.55	4.75	4.65

Standard Pipe—The following table shows the comparison in discounts, together with the net prices in cents per foot:

	Black July 7, 1916	One Year Ago	Galvanized July 7, 1916	One Year Ago
¾ to 2 in. steel butt welded....	70%	79%	50½%	57½%
2½ to 6 in. steel lap welded....	68%	78%	48½%	56½%
Diameter, In.				
¾	3.45	2.42	5.69	4.89
1	5.10	3.57	8.42	7.23
1¼	6.90	4.83	11.39	9.78
1½	8.25	5.78	13.61	11.69
2	11.10	7.77	18.32	15.73
2½	18.72	12.87	30.13	25.45
3	24.48	16.83	39.40	33.28
4	34.88	23.98	56.14	47.42
5	47.36	32.56	76.22	64.38
6	61.44	42.24	98.88	83.52

From New York stock the following discounts hold:

	New York Black	Galvanized	Cleveland Black	Galvanized
¾ to 6 in. steel lap welded.....	61%	36%	64%	44%
¾ to 3 in. steel butt welded.....	64%	42%	66%	46%

Malleable fittings, Class B and C, from New York stock sell at 30 and 5% from list price. Cast iron, standard sizes, 55%.

Bar Iron—Prices are as follows in cents per pound at the places named:

	July 7, 1916	Three Months Ago
Pittsburgh, mill	2.50	2.45
Warehouse, New York.....	3.25	3.10
Warehouse, Cleveland	3.25	3.25
Warehouse, Chicago	3.10	3.10

Cold Drawn Steel Shafting—From warehouse to consumers requiring fair-size lots, the following quotations hold:

	July 7, 1916	Three Months Ago
New York	20% above list	15% above list
Cleveland	20% above list	20% above list
Chicago	10% above list	List price

Swedish (Norway) Iron—This material per 100 lb. sells as follows f.o.b. places named:

	New York Today	One Year Ago	Cleveland.....	Chicago.....
\$6.00	\$3.75	@4.00	\$6.30	\$5.25

In coils an advance of 50c. is usually charged.

Drill Rod—Discounts from list price in New York are as follows: Standard, 65%; extra, 60%; special, 55%.

High Speed Tool Steel containing from 10 to 18% tungsten sells as follows per pound in New York:

Billets	\$2.25	Bars	\$3.00
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METALS

Miscellaneous Metals—The present quotations in cents per pound, with a comparison of practically a month and year ago, are as follows:

	New York July 7, 1916	One Month Ago	One Year Ago
Copper, electrolytic (carload lots).....	28.00	29.00	20.25
Tin	39.00	45.00	38.50
Lead	6.50	7.00	5.75
Spelter	10.00	13.75	22.00

ST. LOUIS

Lead	6.37½	7.00	....
Spelter	9.75	13.62½	....

At the places named, the following prices in cents per pound prevail:

	New York July 7, 1916	One Month Ago	One Year Ago	Cleveland	Chicago
Copper sheets, base.....	37.50	37.50	25.00	37.50	37.50
Copper wire (carload lots)...	37.50	37.50	28.00	37.50	38.00
Brass rods, base.....	44.50	44.50	25.37½	38.00	40.00
Brass pipe, base.....	46.50	46.50	29.00	45.00	46.00
Brass sheets	44.50	44.50	25.37½	42.00	38.00
Solder ½ and ½ (case lots)...	25.12½	28.00	27.50	27.00	25.50

Old Metals—The following are the dealers' purchasing prices in cents per pound:

	New York July 7, 1916	One Year Ago	Cleveland July 7, 1916	Three Months Ago
Copper, heavy and crucible.....	21.00	16.50	20.00	22.00
Copper, heavy and wire.....	20.00	16.25	19.50	21.00
Copper, light and bottoms.....	17.00	14.00	17.00	18.00
Lead, heavy	5.00	4.25	5.75	6.50
Lead, tea	4.50	4.00	4.25	5.50
Brass, heavy	11.75	11.50	12.00	18.00
Brass, light	9.25	10.00	10.00	12.00
No. 1 yellow rod brass turnings..	12.75	....	12.00	16.25
Zinc	7.50	13.00	7.00	14.50

Monel Metal—The following are the prices in cents per pound for mill lengths 8 ft. and over:

	10,000 Lb. of a Size and Over	6,000 Lb. of a Size and Over	2,000 Lb. of a Size and Over	500 Lb. of a Size and Over	Less Than 500 Lb. of a Size and Over
Size, In.					
Rounds—Squares					
¾ to 1	35.50	36.00	36.50	37.00	38.00
1 to 1½	35.25	35.75	36.25	36.75	37.75
1½ to 2	35.00	35.50	36.00	36.50	37.50
2 to 2½	35.75	36.25	36.75	37.25	38.25
Rounds					
3 to 3½	36.50	37.00	37.50	38.00	39.00
Squares					
3	36.50	37.00	37.50	38.00	39.00
Rounds					
3½ to 3¾	36.25	36.75	37.25	37.75	38.75
Squares					
3¾ to 3½	36.25	36.75	37.25	37.75	38.75
Rounds—Squares					
4 to 4½	37.00	37.50	38.00	38.50	39.50
5 to 6	38.00	38.50	39.00	39.50	40.50
7	38.50	39.00	39.50	40.00	41.00
Flats	36.50	37.00	37.50	38.00	39.00

Flats not rolled wider than 6 in. or less than ½ in. thick.

Hexagon bars 2c. per lb. over corresponding size of round rods.

For cutting to any specified length not shorter than 1 ft. add 1c. per lb. The scrap allowance is 18c. per lb. delivered at works.

Zinc Sheets—The following prices in cents per pound prevail:

Carload lots f.o.b. mill.....	18.00			
	In Casks		Broken Lots	
	July 7, 1916	Three Months Ago	July 7, 1916	Three Months Ago
New York	20.00	26.00	21.00	26.50
Cleveland	22.50	26.00	23.00	26.50
Chicago	21.00	....	21.50	....

Copper Bars from warehouse sell as follows in cents per pound:

	July 7, 1916	Three Months Ago
New York	43.00	40.00
Cleveland	40.25	33.50
Chicago	40.50	38.00

Babbitt Metal—Quotations are as follows in cents per pound from warehouse at the places named:

	New York	Cleveland	Chicago
Best grade	55.00	47.25	55.00
Commercial	25.00	18.00	21.00

Copper Sheets—In New York, from warehouse, hot rolled 16 oz. (large lots) base per lb. is 37.50c.; cold rolled 14 oz. and heavier, add 1c.; polished takes 1c. per sq.ft. extra for 20-in. widths and under; over 20 in., 2c.

Jigs and Tools Used in Making Pipe and Other Wrenches

BY ETIEN VIAL

SYNOPSIS—While the methods of machining these wrench parts may vary some with different-sized members of the same group, yet the work shown is well standardized. Most of the jigs are simple and easily operated for the removal or insertion of work.

In making the class of small tools described in this article not only must they be well designed and nicely balanced, but tools and jigs must be provided for making commercially accurate and interchangeable parts in an economical manner. These tools and jigs must not be so

understood. While these special wrenches have many different forms and sizes, the general principle on which they are made is the same. Other tools shown differ only in minor details from many with which the reader is already familiar. All the handles or principal parts of these tools are drop forged from a suitable grade of steel. A few of the forgings, with the flask still in place, may be seen in Fig. 3.

In describing the work on some of these tools we will begin with pipe wrenches of the more common sort, shown at the top in the first illustration. The adjustable jaws for these wrenches are made in two ways. The larger sizes are drop forged in a die that also forms the thread



FIG. 1. A FEW OF THE WRENCHES MADE



FIG. 2. METHODS OF GRIPPING WITH CLAW WRENCH



FIG. 3. DROP-FORGED WRENCH PARTS

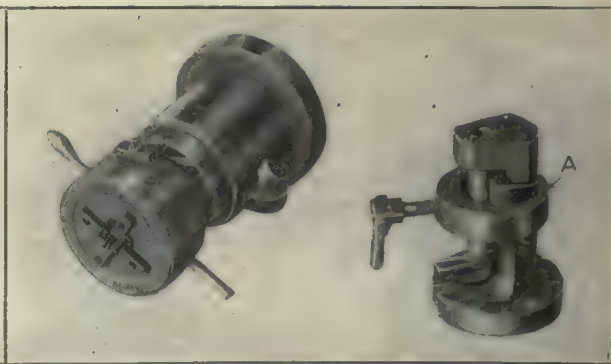


FIG. 4. DIE HEAD USED AS A MILL, AND A DRILLING JIG

difficult to make nor so highly finished as to eat up too large a percentage of the profits. These fundamental conditions seem to have been well met by the Mechanics Tool Co., Rockford, Ill., in its factory equipment and product.

The product consists of a varied line of pipe wrenches, pliers, nippers, nail cutters, end wrenches and the like. Each kind of tool is made in sizes sufficient to meet almost every conceivable requirement. A fair idea of the class of tools made may be had by reference to Fig. 1, where six varieties and several sizes are shown. The ones at the left are known as eagle-claw wrenches and may be used for a large number of purposes. Some of their applications are illustrated in Fig. 2 and will be readily

on the stem for the adjusting nut. On some of the smaller sizes the stem is forged round and afterward hollow-milled and threaded. The hollow milling is done with a self-opening die head like the one seen at the left in Fig. 4. This is a regular thread-cutting head fitted with milling jaws, as shown. The head is held on the spindle of a heavy drilling machine, and the work to be milled is fastened to the table by a two-jawed universal chuck fitted with formed false jaws. After being hollow-milled, the work is placed in a jig like that shown at the right, and a hole is drilled lengthwise of the stem. In this jig the work is placed with the milled stem in a vertical V-groove and is clamped in place by the ring clamp A, which is removed, for the insertion or removal of the work, by slip-

ping it up off the jig. Another form of jig for this same work will be shown later. After these pieces have been milled and drilled, they are threaded for the adjusting nut, using a self-opening die head and holding the work exactly as for hollow-milling.

All the adjustable jaws for pipe wrenches are drilled lengthwise of the stem, whether they come with the

A is placed against the grooved vertical post *B* and locked in by turning the handle *C*. The teeth are then milled at *D* with a formed mill.

The recess for the adjusting nut is finished in a gang jig, seen in the foreground in Fig. 6. The number milled at a time depends on the size, as various holding jigs are provided. In the one shown, twelve are placed at a time,

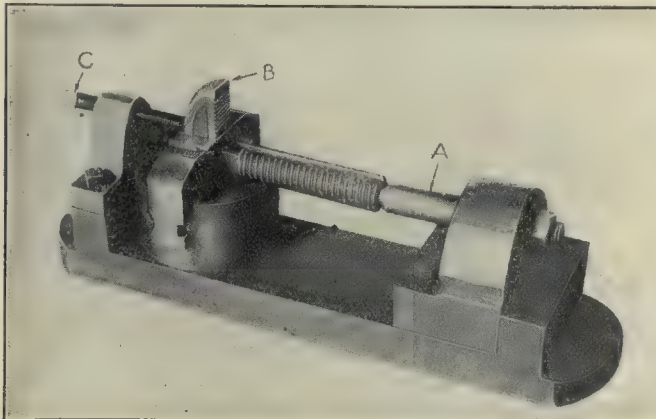


FIG. 5. JAW SLOT-MILLING JIG

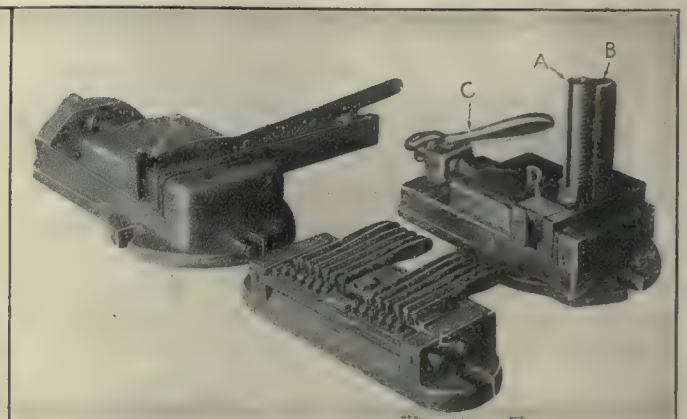


FIG. 6. THREE MILLING JIGS

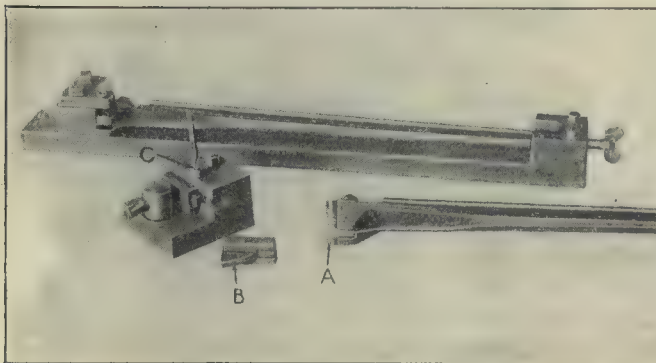


FIG. 7. LARGE WRENCH JIGS

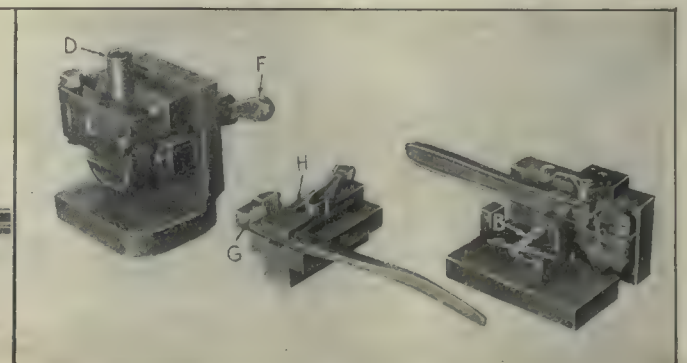


FIG. 8. TWO DRILLING AND A MILLING JIG

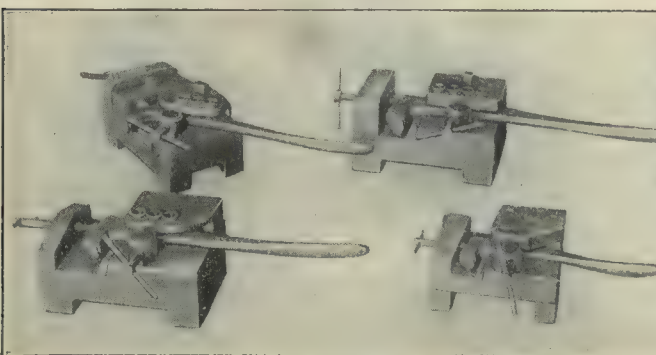


FIG. 9. JIGS FOR PIVOT-SHIFTING HOLES

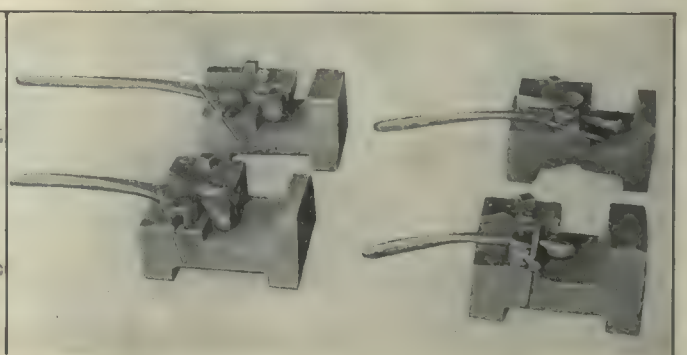


FIG. 10. PIVOT PIN HOLE JIGS

threads ready forged on them or not. After they are drilled, they are placed in a jig, Fig. 5, and a slot is milled lengthwise so as to cut through into the drilled hole. As can be seen, the wrench jaw is placed with the drilled hole over the end of the slotted tail center *A*, and the head end *B* is held between the formed jaws of a chuck. The setscrew *C* forces the work solidly against the tail center and prevents any tendency to work loose during the cut.

The next operation on these adjustable jaws is to mill the "teeth" in them. This is done by placing the work in a vise fitted as shown at the right in Fig. 6. The work

and a milling cutter is run through at *E*. The teeth on the contact end are milled with a formed mill held in a vertical spindle. Some are milled in gangs, while the larger ones are milled one at a time, held as at *F*.

The large sizes of pipe wrenches have steel pieces inserted in the contact ends of the backs, as at *A*, Fig. 7. These inserted pieces are shaped as shown at *B*. The pin hole in the back is drilled in the jig seen at the back, and the pin hole in the inserted piece is drilled as at *C*. The operation of both of these jigs is apparent.

In the type of pipe wrench just shown it is necessary, in order that a good grip may be obtained, for the ad-

justable jaw to be held back until a grip is taken on the pipe. This is done by inserting a small coil spring between the jaw stem and the back of the handle. The hole for this spring is drilled as shown at the right in Fig. 8. The handle is placed in the jig and butted against the pin *A*. The clamp screw *B* is then tightened, and the hole is drilled through the bushing *C*.

At the left in this illustration is shown another jig for holding the adjustable jaw while drilling the hole

same plan, and they differ only in the number of holes to be drilled and the size or angle of the wrench back. The gripping jaws carry the pivot pin and in consequence have but one hole drilled in them. The type of jig used is seen in Fig. 10.

On a few of the smaller sizes the shifting holes are punched instead of being drilled. This is done with the punch and die shown in Fig. 11. Teeth on the jaws of the claw wrenches are milled as in Fig. 12. The jig at the



FIG. 11. PUNCH AND DIE FOR SMALL SHIFTING HOLES

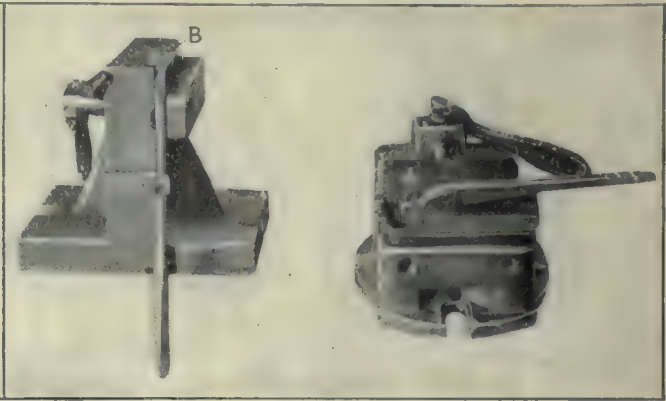


FIG. 12. JAW-TOOTH MILLING JIGS

lengthwise of the stem. This jig differs considerably from the one first shown and is a type used mostly on the larger sizes. A simple cap with a bushed hole in it is used to center with, and then the hole is drilled in the usual way. The piece *D* is placed in the jig in a vertical V-groove, and then the hinged clamp *E* is swung into place and locked by means of the bolt and eccentric lever *F*.

In the middle in Fig. 8 is a simple milling jig for holding eagle-claw backs while milling a cut at *G* to give the proper finish and clearance. The wrench back is located by means of the rivet holes drilled in it, which fit over pins in the jig. The clamp *H* is slotted so as to slide

right is for wrench backs, and the one at the left is for the gripping jaws. While these jigs are for but one size, the jigs for the others are of practically the same design and differ merely in variations of the holding blocks or jaws. The teeth at *A* and *B* are milled with formed cutters, as on the pipe wrenches.

Adjustable end-wrench body forgings are first milled across the ends for the jaws, then a hole *A*, Fig. 13, is drilled through for the adjusting screw. The retaining-pin hole *B* is drilled, and next a slot is sawed out at *C*. The first milling operation is an ordinary one, so need not be shown. The screw hole is drilled in the jig seen at the right. The forging is located in the jig by thrusting the milled surface against a block and tightening the setscrew *D*. Side motion is prevented by a wedge clamp *E* operated by the wedge lever *F*. The hole is then drilled down through the bushing *G*.

The retaining-pin hole is drilled in the middle jig. The forging is located between a stationary pin and an adjustable clamping pin *H*, and the hole is drilled through the bushing *I*.

The movable jaw for the end wrench has a hole *J* drilled in it which is done in the jig at the left. The piece is held in the jig in formed jaws *K*, which are pivoted near the middle; and the work is held by the wedging and spreading action of the pointed screw *L* at the back.

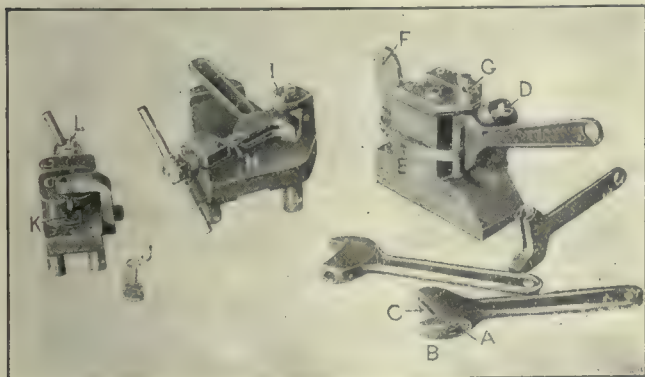


FIG. 13. END WRENCH JIGS

forward or back under its retaining bolt and is locked when in position by a screw operated by the lever.

These plier-like claw wrenches are all made so that the pivoting point may be shifted to two or more positions. This arrangement gives each wrench considerable range in firm gripping within its capacity. The principle of a flattened pivot pin and several pivot holes connected by slots narrower than the holes, on which this shifting is based, is familiar to all readers. The jigs for drilling the shift holes are illustrated in Fig. 9. All are made on the

SAWING OUT THE SLOT

The slot in which the movable jaw slides is cut out in a special machine, Fig. 14, made by the Mechanics Machine Co. The forging is held in practically the same way as in the screw-hole drilling jig. The setscrew is carried in a yoke *A*, and the wedging lever operating the side-clamping jaws is shown at *B*. The slot is cut with the saw *C*, which is worked by means of a crank motion. Feed is obtained through levers and a weight *D*, to which a spring is also attached. Means are provided for automatically stopping the machine at the proper depth of cut. When removing or inserting work, the saw is held up out of the

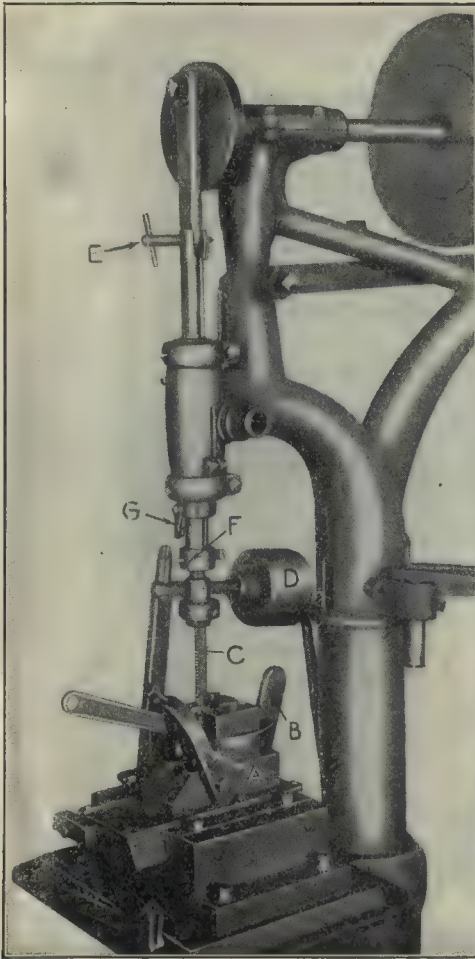


FIG. 14. SLOT-SAWING MACHINE

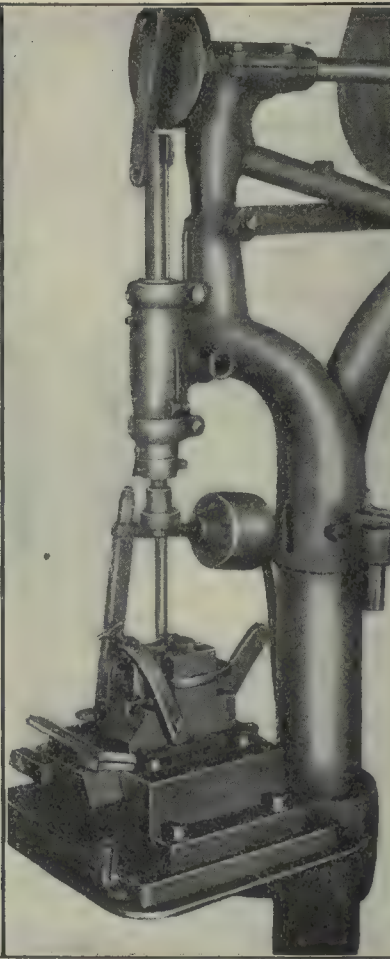


FIG. 15. MACHINE EMPTY

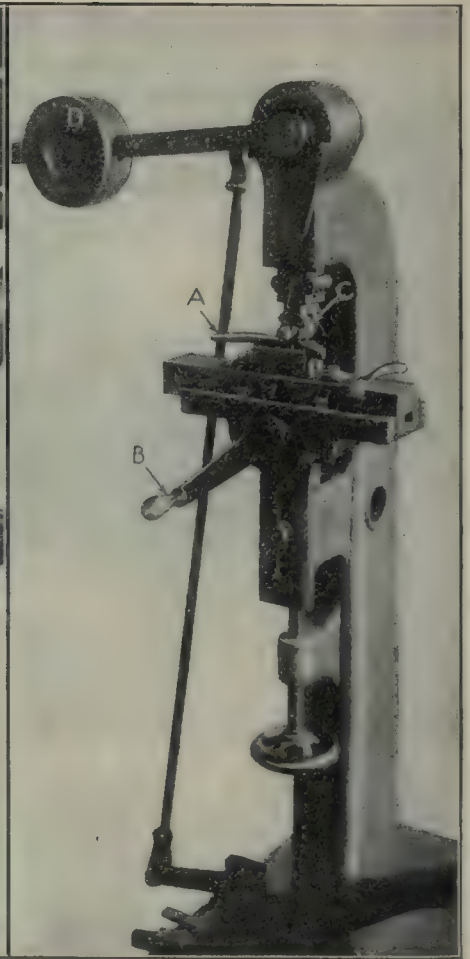


FIG. 16. LETTERING MACHINE

way by first pulling out the pin *E* and then catching the spindle pin *F* in latch *G*. The machine with the work removed and the spindle locked in the upward position, as described, is illustrated in Fig. 15.

Names are rolled into wrench forgings in the machine seen in Fig. 16, which was also made by the Mechanics Machine Co. The forging is placed at *A* and the lettering rolled in by turning the crank *B*, which causes the table to move and traverse the work under the lettering roll *C*. The right pressure to obtain even lettering is obtained by the lever and weight *D*, which may be adjusted to suit the work in hand. The weight and roll are lifted to clear the work by depressing the foot treadle.

■

Teaching the Munition-Making Trades as a War Measure

Interesting reports of the effects of the war on English shops and English workmen include the forming of classes for training workers in munition factories. These, it is understood, are being conducted by the London County Council and other similar bodies in various manufacturing centers and at the request of the Ministry of Munitions. The instruction is given to both machine operators and tool setters, the former predominating, as would be expected. Various branches of the trade are taught, including general machine work, such as is found on shells and fuses; lead burning, which is almost a lost

art in some sections; and tool setting, as distinguished from machine operation.

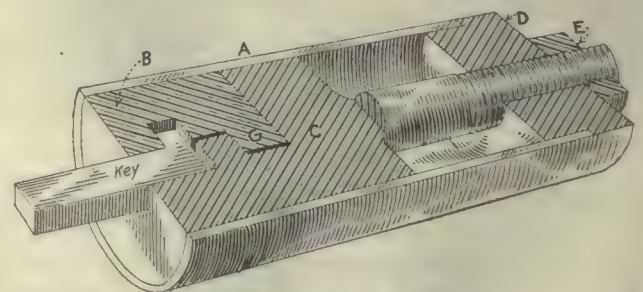
Women are also being trained in some trades. Many seem to be taking up the occupation of tracing in drafting rooms and are said to be making marked progress.

■

A Gib-Key Puller

By J. A. MOFFAT

A gib-key puller is shown in the illustration. It consists of a sleeve *A*, made from iron pipe; a member *B*, which holds the key; and the puller *C*, with a tongue *G* which engages *B*. The washer *D* rests on one end of the



GIB-KEY PULLER

sleeve *A*. The other end of the sleeve rests on the hub of the pulley. When the nut *E* is screwed down, the key puller and the key are drawn through the sleeve. For handling different sizes of keys the member *B* is the only part that need be changed.

Enlarging the Small Shop Through Special Policies

BY JOHN H. VAN DEVENTER

SYNOPSIS—The "special-machinery" shop is heavily handicapped as compared with shops that work upon a definite product. This article tells of the special policies that have enlarged a New England special-machinery shop from 7-man size to 100-man size within the space of four years. These policies may well be adopted by other special-machinery shops anxious to build upon a solid foundation.

A special-machinery company has nothing tangible to sell except labor, the use of its tools, and the ability to construct machinery in accordance with the specifications

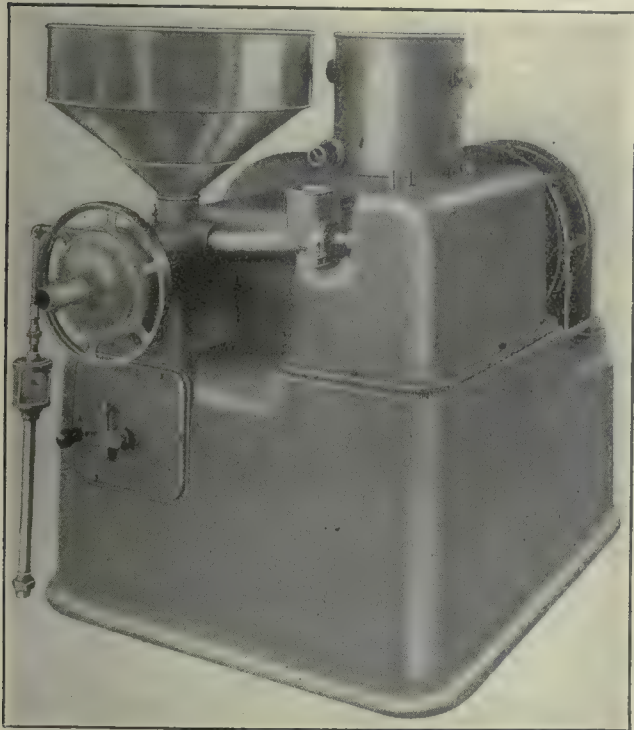


FIG. 1. MACHINE FOR MAKING PEANUT BUTTER

of its customers. It can seldom show a man what he is going to get for his money, nor can it often predict the cost of the thing to be made. Consequently the small special-machinery shop has a hard row to hoe and needs a fertilizer in the shape of some good definite policies that will enable the shop to grow and the profits to blossom forth.

The shop that I am going to describe has had some very definite policies ever since its establishment; not as theories only, but embodied in hard iron and steel. That they have been profit-producing policies is evidenced by the 100 men now employed as compared with the seven men employed four years ago. Not the spasmodic growth accompanying unusual conditions is this, for the plant and equipment have grown as fast as the number of men; in fact today one would find in this plant a higher percentage of machine tools per man than in the original seven-man shop.

The materials used in building shops are considerable in number, among them being structural steel, concrete, stone and glass. But even more varied are the materials upon which shops are sometimes built. This one—the Hartford Special Machinery Co., of Hartford, Conn.—may be said to have been partly built upon peanut butter and bacon. Previous to starting this shop, Joseph Merritt was a special machine designer and among his principal products had been machines for the Beechnut Packing Co., one of which is shown in Fig. 1. This is a special machine that turns out peanut butter from hulled nuts as raw material, at the rate of some 11 tons per day, and is an example of well-executed safety engineering, its working parts being guarded in such a manner as to make it impossible for the girl operator to be hurt.

That a shop partly founded upon peanut butter and bacon should in its younger days be nourished by the fragrant odors of good cooking is rather a coincidence. On investigation of Hartford manufacturing history however, a very good precedent is found for this. The Dwight-Slate Co., the Woodward & Rogers Co., the Pratt & Whitney Co., and the Penn Machine Co. (afterward Taylor-Fenn Co.) all made their initial start in this same loft over Harry Bond's restaurant. Perhaps good cooking may have something to do with the growth of a shop as well as with the growth of a man! At any rate, Mr. Merritt selected this same loft building with its encouraging precedents as a place in which to make his start. The first purpose in starting it at all was to build machinery of his own design under his own direction. However, this idea of exclusiveness was abandoned shortly afterward and the shop began to turn out special machines of other design also.

One of the first policies established in this special-machinery-building plant had to do with the employment of high-grade operators. A \$6,000 tool and a \$6-a-week boy do not get along well together. The boy is likely to be spoiled, and the machine is sure to be. A special-machinery-building shop with its great variety of work does not have an opportunity to train specialists such as are found in a manufacturing shop. Its need is for all-around men, and good all-around men are high-priced. Every machine-shop manager knows that the difference in established rates of pay between a "cheap" man and a "good" man is nowhere in proportion to their difference in skill. It is therefore to the customer's advantage to go where skilled and high-rated men are employed, for although he pays a higher rate per hour he secures a big increase of skill at a small increase of rate as compared with the ordinary shop. The contents of hours may vary as much as the contents of paper boxes of the same size!

The cost of an experimental machine is the least important thing about it, in spite of the contrary opinion of many who buy them. As a rule machines of this kind are outside of standard machine competition, and hence their earning ability is sometimes phenomenal. This is particularly true of the cases in which special machines

are built to combine a number of operations. A half-day's shutdown on a machine of this kind is sometimes more expensive than the original cost of the machine itself. Many special-machinery-building shops are obliged to resort to daily makeshifts, which tax the ingenuity of the men employed, in order to rig machines up for operations that are not suited to them. Ingenuity of this kind is depicted every week in the pages of the *American Machinist*; but these admirable and interesting stunts do not benefit the customer who is paying for work by the hour. In this shop the attempt is made to have a suitable tool for each operation, so that the use of makeshifts may be practically eliminated. In line with this, when a machine is purchased, all of the special attachments and fixtures listed for it are also usually bought, even though there may be no immediate prospect of their use. This policy runs up the investment in machinery and equipment to a figure that would alarm owners of a good many plants of similar size, but it has been proved to be a profitable policy in this case. On the larger tools the policy established has been to buy machines that are oversize in one or more particulars. This gives a degree of flexibility that would not be obtained in a similar shop equipped with standard tools. A horizontal boring machine, for example, has a column one foot higher and a bed two feet longer than standard for this size of machine. This saves the use of makeshifts on work that would otherwise be just a little too big for the standard machine. An apt comparison of this policy might be that between two motor truck



FIG. 2. THE LARGE NUMBER OF LATHES EMPHASIZES THE IMPORTANCE OF THIS TOOL FOR GENERAL WORK



FIG. 3. THE TOOLROOM PRESENTS AN EXAMPLE OF CAREFULLY PLANNED STORAGE FACILITIES

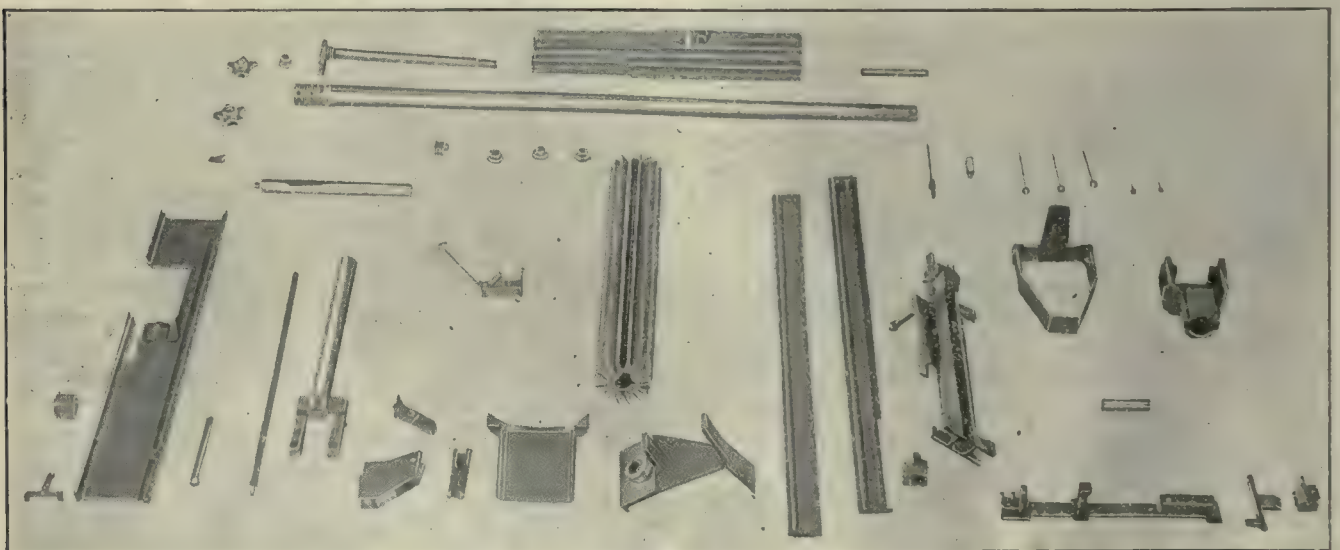


FIG. 4. AUTOMATIC RIFLE PARTS, MOST OF THEM MILLED FROM SOLID STOCK

owners, each having the same size truck, but one of which has a truck body twice as large as the other. Each truck can carry the same load of some heavy material, such as pig iron, but when it comes to transporting light,

those who don't. Strange to say, the latter class is often the more satisfactory to work for! One who has been through the mill in building experimental machines makes a good customer for the special-machinery-building shop,

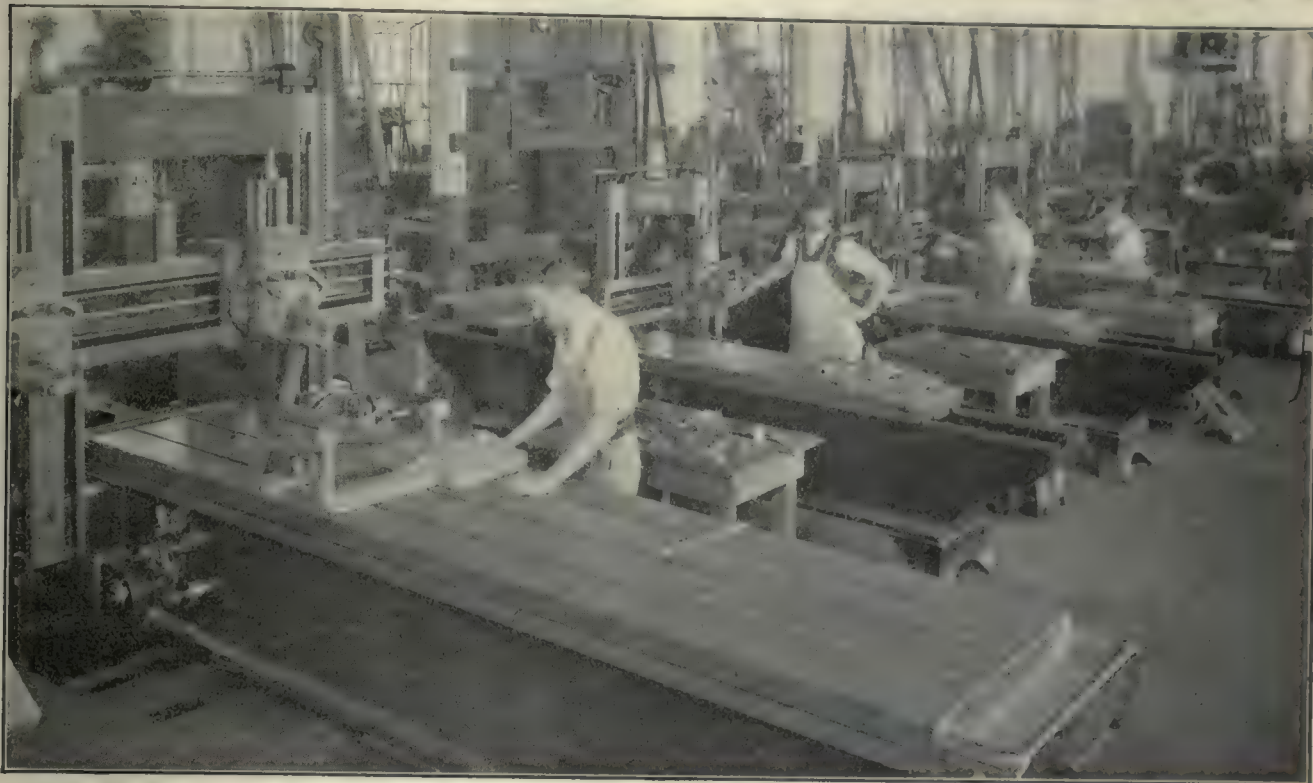


FIG. 5. NOTE THE UNBLEMISHED PLATENS AND THE TOOL TABLES

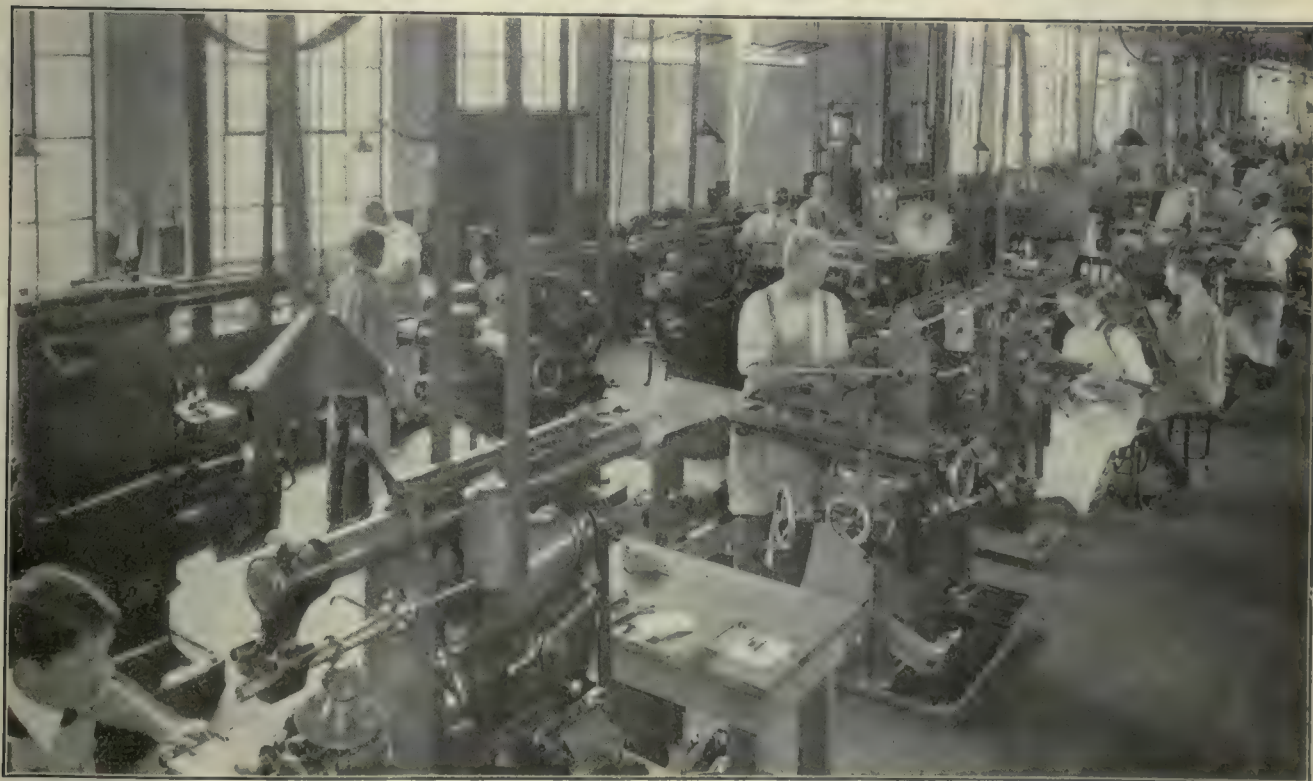


FIG. 6. THE CONDITION OF THE MACHINES REFLECTS THE CARE OF HIGH-GRADE OPERATORS

bulky material, the fellow with the oversized body has the bulge on his competitor.

Buyers of special machinery may be broadly divided into two classes—those who know what they want, and

for he knows the difficulties encountered in making the first workable machine of a new kind. He does not expect to get the first machine as cheaply as the second or third, and is prepared to make allowances for a high

first cost. Those who are not so prepared do an injustice to special-machinery-building shops. Some of them after having the first machine built take the second one to

a workable first machine than it is to build an improved model of a machine that already works.

The policies outlined and applied in this Hartford shop are worthy of study and imitation by other special-machinery-building plants. They all crystallize into one machine-building axiom: Experienced men with tools suitable for the job will give the customer more work and better service than inefficient men with unsuitable tools.

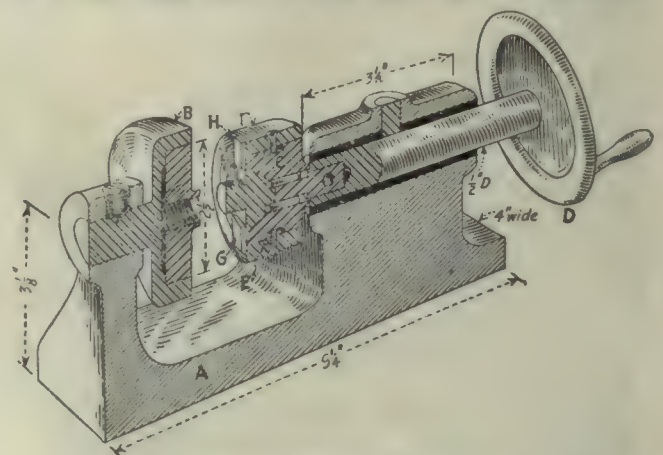
Hand-Driven Thread-Chasing Fixture for Detonator

By J. J. EYRE

A simple device for sizing threads on small parts for quantity production is shown in the illustration. The fixture was fitted for sizing the thread on caps for a detonator body, but can be adapted to other lines with good results.

The body *A* of the fixture is bored in line to receive the die holder *B* and the driving shaft for the work holder *C*, to which is attached the handwheel *D*. The die holder is bored a little large to hold the standard die to be used, drilled and tapped for three headless screws that retain the die, and the screws should be adjusted to allow for float of die.

The work holder, or chuck for the work, required a special construction, owing to the crowning surface of the work. The chuck was turned down for a shank to



THREAD-CHASING FIXTURE

fit in the shaft that rotates it and is bored out so that the work will seat flush with the face of the chuck. Two holes are bored in the seat of the chuck in line with the wrench holes in the work, and pieces of drill rod are inserted, projecting above the surface of the chuck to act as drivers for the work.

The outside diameter of the chuck is turned $\frac{1}{8}$ in. off center and a groove turned to receive the spring band *E* that secures the shell *F* in place. Two $\frac{1}{16}$ -in. holes are drilled in the face of the chuck for riveting on a $\frac{1}{16}$ -in. plate, or sector, *G* that forms a ledge on the chuck to act as a seat when inserting work. This plate should be located directly opposite the eccentric center of the outside diameter.

The shell *F* is bored out to a slip fit over the body, knurled on the outside for hand control, and is drilled to rivet to the band *E* after it is sprung over the body and into the groove. Two holes are drilled in the front face of

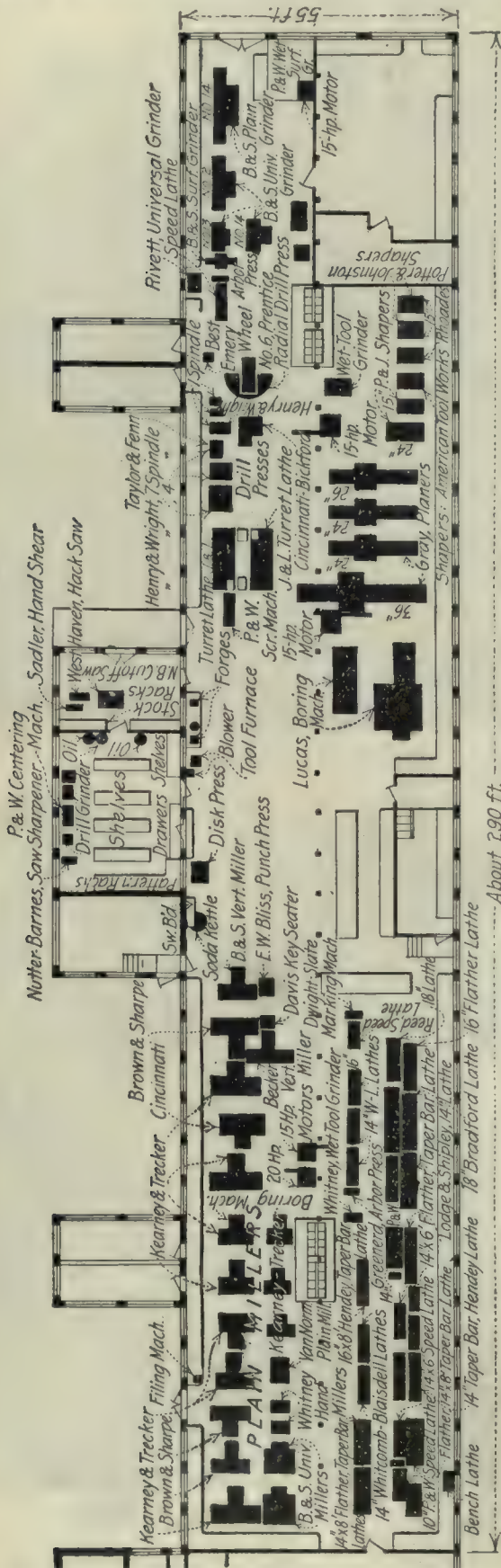


FIG. 7. PLANT LAYOUT DESIGNED TO BE ESPECIALLY ADAPTED FOR CONTRACT SHOP

another shop and then make unkind remarks about the amount that the first shop charged them. They forget that it is far more difficult to transform paper plans into

the shell for riveting on the work-retaining plate, which is a short sector H , $\frac{1}{16}$ in. thick, that projects on the inside diameter over the surface of the work. The shell can be quickly turned by hand so that the projecting edge of the sector will instantly release or lock the work in place, owing to the outside ring or shell being eccentric with the work center.

The hole for the shaft can be bushed, an oiler added and a compression spring placed over the shaft between the handwheel and the bearing for the shaft for the return of the chuck, if desired.

Locomotive Valve Chambers Bored on Engine Lathe

BY ROLAND V. HUTCHINSON

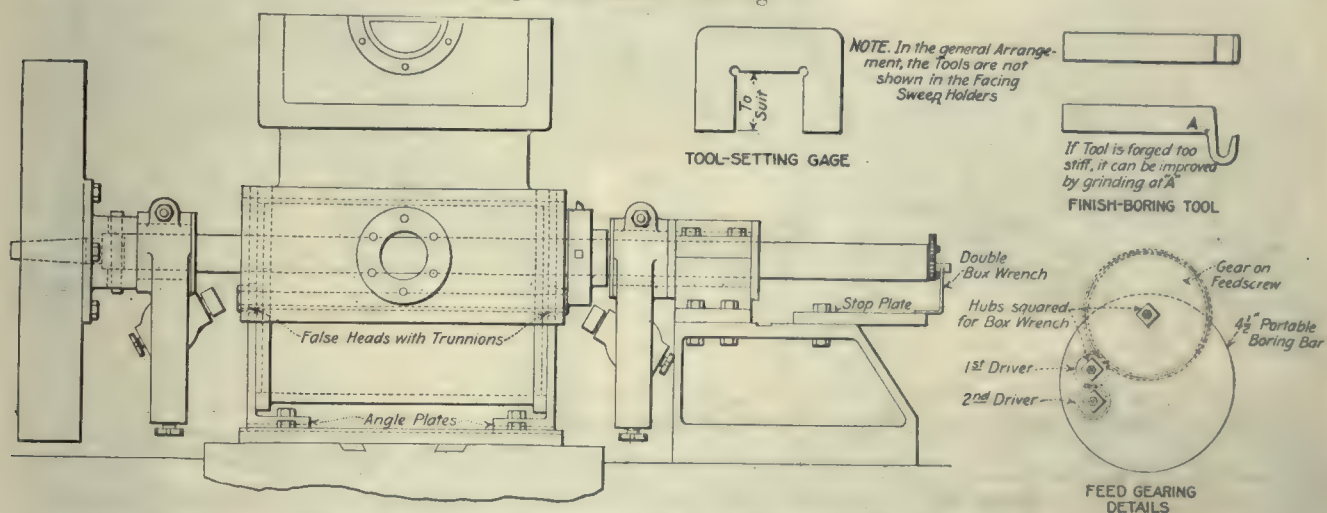
The use of the lathe as a boring machine is by many looked upon as a makeshift; but the instance herewith described will be of interest, as the output of a special cylinder-boring machine on similar work was equaled.

The job was a number of large locomotive cylinders for freight engines and was handled by the Ironton Engine Co., Ironton, Ohio, which made the castings, bored and faced the cylinder and valve chests, tested the castings to 250-lb. cold-water pressure and shipped the cast-

ings to the customer, who completed the machining himself.

Each false head was lightly fastened to its respective angle plate by two $\frac{3}{4}$ -in. cap-screws, and a long bolt was passed through the middle of each false head, holding it securely in place on the cylinder.

The feeding arrangement was originally a star feed, but was changed to give two speeds to the feed screw and a reverse. Each gear shown has a square hub and a socket wrench with a bent handle, slipped upon the hub of the gear that is required to give a feed in each direction of $\frac{1}{16}$ in. per revolution, or $\frac{1}{4}$ in. per revolution in only one direction. The feed screw is $\frac{1}{4}$ in. pitch. The wrench was made with a long socket, so that it could be turned around and used for easily adjusting the head by hand.



BORING AND FACING LOCOMOTIVE VALVE CHAMBER IN A LATHE

ings to the customer, who completed the machining himself.

Early delivery had been promised, and the Barrett cylinder-boring machine was tied up with the work on the barrels, so recourse was had to a 48-in. Schumacher & Boye lathe for boring out the valve chambers. It was rigged up as shown in the drawing.

A driving plate centered by a plug in the lathe spindle was bolted to the large faceplate. This plate was bored out to fit the $4\frac{1}{2}$ -in. portable boring bar and turned on the outside to fit the facing arms, or sweeps, which were made duplicates of those on the Barrett machine. The upper part of the tailstock was removed, and in its place a bearing was bolted and doweled. This bearing carried a sleeve, holding the other facing arm, and the sleeve was driven by a feather key.

To hold the cylinders, a large cast-iron plate was planed up on each side and a groove cut in one side. This plate was bolted to the carriage. Two angle plates, fitted with keys, had holes bored in them for the hubs of

When the job is clamped, roughing tools are set in the boring head to a gage, as shown, and rough-boring and facing each end take place. The head was turned exactly 12 in. in diameter, so that the making of tool-setting gages presented no difficulty. The type of finishing tool shown has been successfully used on both horizontal and vertical boring machines for finishing cylinders, valve bushings, etc. It does away with the unlovely "washboard finish" that has a tendency to intrude where it is not wanted, when an ordinary broad-nose tool is used. Grinding in the corner indicated will "limber up" this type of tool so that it will soon work well.

Although apparently working under handicaps, this arrangement enabled the valve chambers to be machined at the same rate as that at which similar work had been done on the cylinder-boring machine; in addition, there were duplicate parts for the special machine, should accident make it necessary ever to have a new facing arm and part in a hurry.

Tools Used in Machining Textile Machine Parts

BY ROBERT MAWSON

SYNOPSIS—In this article are illustrated some of the jigs and fixtures used in machining parts of hosiery machines. The fixture employed in milling the dropper post is arranged to hold eight parts at one operation. A fixture having an adjustable stop mills the angular surfaces on the dropper. For milling the bed plate the correct location is obtained by a pin fitted into a hole previously drilled in the part. The jigs are provided with latch covers and each part is quickly and accurately placed in the tool.

Some of the tools used by Scott & Williams, Inc., Laconia, N.H., were shown on pages 1020 (Vol. 44) and 10. In this article are illustrated other tools which consist of jigs and fixtures used in machining other elements.

For milling the slot in the bed plate the fixture consists of a plug on which the casting is placed. A knurled-head pin is fitted into a machined hole in the bed plate and into a hole in the fixture. By this method the surface machine is in the correct location with the holes. The jig employed in drilling the bed plates has a turned plug which fits into the large bored hole in the casting. The location is obtained by a surface against which the part is revolved. The milling fixture used for the dropper posts machines a number at one time, the rough casting being located by pins. The parts being machined are held in position by straps.

A graduated fixture is used for machining the angular surfaces on the droppers. The part is held by a strap, the round shank fitting into a concave surface.

The two positions at which the fixture is placed are determined by adjustable screws provided with check nuts.

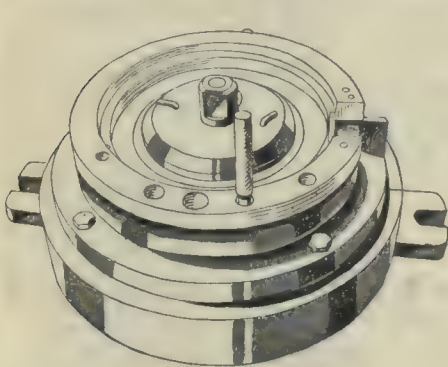


FIG. 2

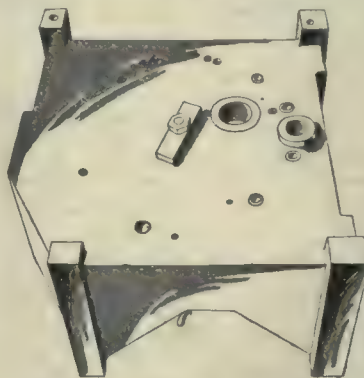


FIG. 3

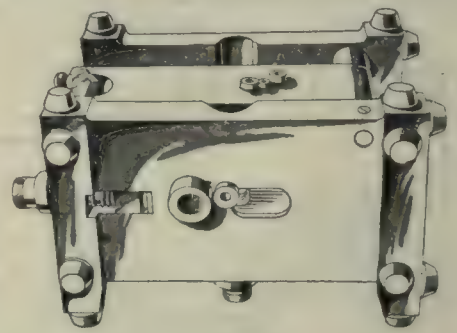


FIG. 6

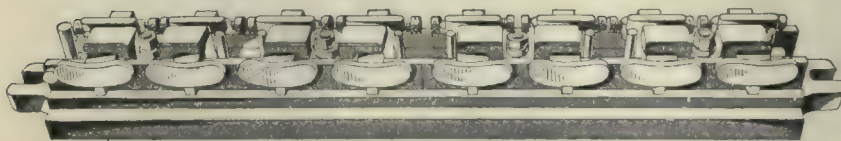


FIG. 5



FIG. 8

TOOLS USED IN MACHINING TEXTILE-MACHINE PARTS, WITH WORK SHOWN IN POSITION

FIGS. 2 AND 2-A

Operation—Milling the slot in the bed plate, Fig. 1. The casting is placed on a plug which fits into the large center hole previously bored. The casting is slid around until the edge of the slot comes in contact with a stop surface. The cover is then dropped down and latched. Afterward knob-headed screws, being tightened on the casting, hold it securely in the jig.

Surface Machined—The slot using a $1\frac{1}{2} \times 5$ -in. diameter cutter operating at 140 r.p.m.

FIGS. 3 AND 3-A

Operation—Drilling and reaming the bed plate, Fig. 1. The casting is located on a plug which fits into the large center hole previously bored. The casting is slid around until the edge of the slot comes in contact with a stop surface. The cover is then dropped down and latched. Afterward knob-headed screws, being tightened on the casting, hold it securely in the jig.

Holes Machined—One $\frac{11}{16}$ -in. drilled, three $\frac{3}{8}$ -in. spot-drilled and reamed, one $\frac{11}{16}$ -in. drilled, two No. 6 drilled, two No. 13 drilled, four No. 19 drilled, one $\frac{1}{2}$ -in. spot-drilled and reamed.

FIGS. 5 AND 5-A

Operation—Milling surfaces on dropper post, Fig. 4. The rough casting is located against pins resting on a height block. The various clamps are then tightened down, thus holding the eight castings in position on the fixture.

Surfaces Machined—Ends of casting and pad. The gang cutters used consist of two 6-in. diameter by $\frac{3}{4}$ -in. wide and one $2\frac{1}{2}$ -in. diameter by $\frac{3}{8}$ -in. wide, operating at 100 r.p.m.

FIGS. 6 AND 6-A

Operation—Drilling and reaming dropper post, Fig. 4. The milled casting is located against stop-pins being forced back by setscrews. The casting is held down by hook bolts operated at the end and under the jig. The cover is then dropped down and held with a thumbscrew.

Holes Machined—Two $\frac{17}{64}$ -in. drilled, one $\frac{\pi}{64}$ -in. drilled, one $\frac{7}{8}$ -in. spot-drilled and reamed, one No. 32 drilled, three No. 20 drilled, one No. 47 drilled, one No. 28 drilled and one $\frac{3}{8}$ -in. spot-drilled and reamed.

FIGS. 8 AND 8-A

Operation—Milling dropper, Fig. 7. The steel-forged element is placed in a machined groove in the fixture and held with the strap and nut as shown. The revolving member of the fixture is swung around against one stop-screw and the angular surface machined. The member is then swung against the other stop and the other surface machined.

Surface Machined—The two angular surfaces at the outer end of the dropper. For this purpose a $\frac{3}{8}$ -in. end mill operating at 250 r.p.m. is used.

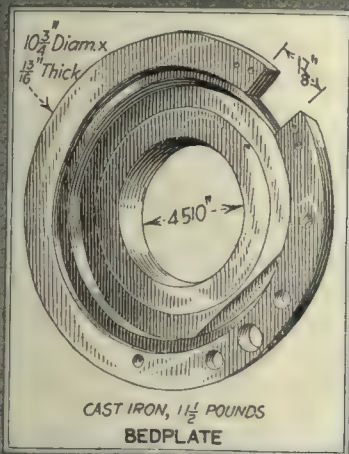


FIG 1

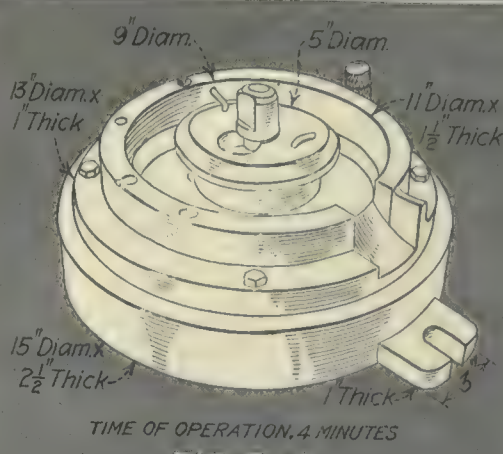


FIG 2-A



FIG 4

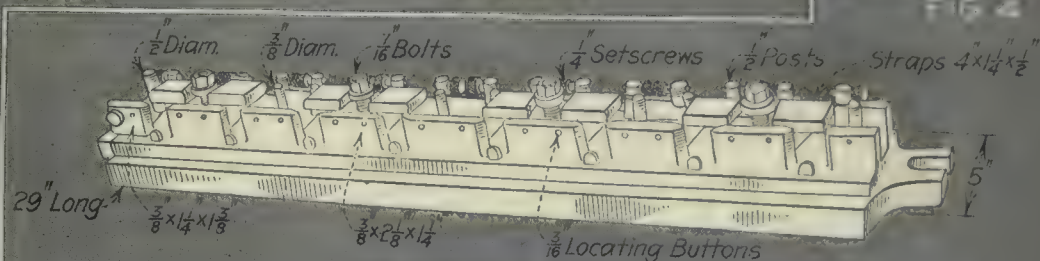


FIG 5-A

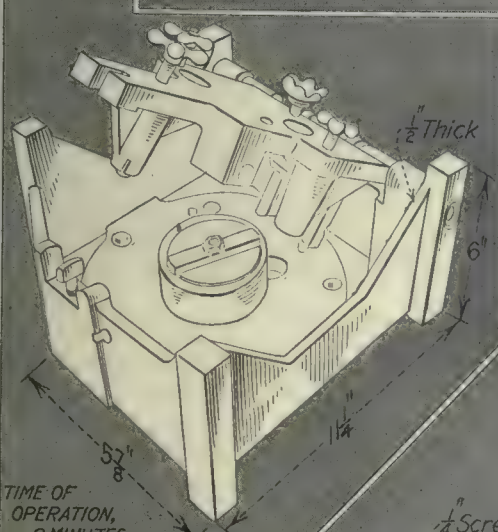


FIG 3-A

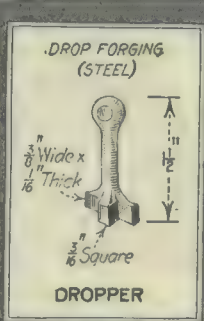


FIG 7

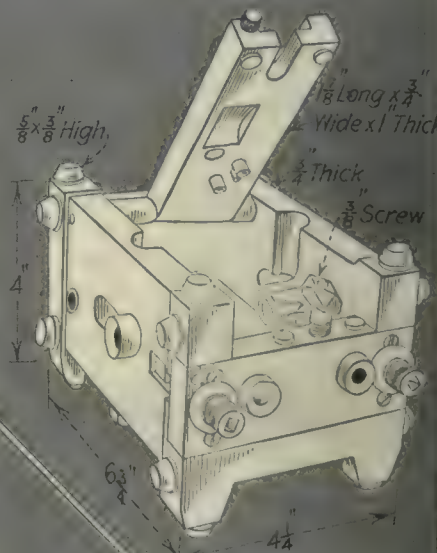


FIG 6-A

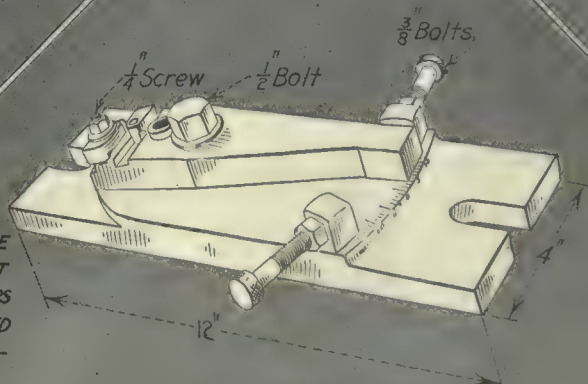


FIG 8-A

THE JIGS AND FIXTURES SHOWN ARE MADE WITH THEIR BASES OF CAST IRON. THE PINS, SCREWS AND STRAPS ARE OF MACHINE STEEL, CARBONIZED AND HARDENED. THE LOCATING SURFACES AND GUIDE BUSHINGS ARE TOOL STEEL, HARDENED AND GROUND. ON THE MILLING FIXTURES TOOL-STEEL SURFACES ARE PROVIDED AND SET BLOCKS TO ASSIST

THE OPERATOR IN SETTING THE MILLING CUTTERS. MACHINE-STEEL TONGUES ARE FITTED IN THE BASES OF THE MILLING FIXTURES SO THAT THE TOOLS WILL BE PLACED ON THE TABLE IN THE CORRECT ALIGNMENT. ALL BUSHINGS USED FOR GUIDING TOOLS ARE BLACKENED

High-Speed Steel Collapsing Taps for Iron Fittings

BY A. J. CHAMBERLAIN

High-speed steel collapsing taps are rapidly replacing solid taps in the manufacture of pipe fittings, although much difficulty has been experienced with some of the taps that have been on the market. The continuous tapping of rough-cored holes in gray and malleable iron fittings calls for greater rigidity and better wearing

high-speed steel, and the end bearing *B* is tongued into the body, as shown, and held to it with fillister-head screws.

The opening plug *C* should be made of hardened high-speed steel, as there is considerable pressure upon it when it slides back during the closing action—enough to cause a carbon-steel plug to wear. The closing collar *D* should be hardened on its face, which comes against the face of the fitting being tapped. The plug *C* is thereby caused to slide back into the body until its surfaces that contact with the bottom of the tap cutters are in line with the cutter grooves, when the springs *E* force the cutters down into the grooves of the plug, thereby closing the tap. The tap is then run back against a fixed stop on the machine, which comes in contact with the back face of the closing collar and forces the plug back to the opening position shown. Adjustment is obtained on taper taps by placing the screw *F* in the different holes provided in the closing collar.

This tap, if made in sizes from 2½ in. pipe up, will bear hard usage; but as is readily apparent, its parts would have to be too frail to stand up if it were made smaller.

In this article the tapping of common iron-pipe fittings in rough-cored holes has been referred to. It is an altogether different proposition from the ordinary bar-stock work on a screw machine or the better grade of turret-lathe work. A tap on a screw machine or turret lathe generally has a rest at regular intervals while the remainder of the operation is performed, but on a pipe-fitting tapping machine the operation consists of tapping rough-cored holes in enormous quantities, with

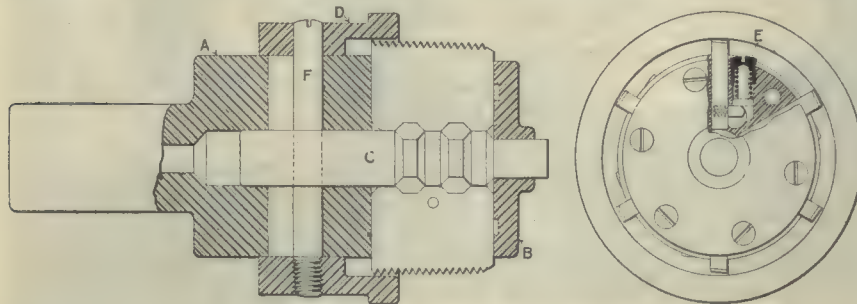


FIG. 1. TAP FOR LARGE-SIZED PIPES

qualities than most collapsing taps possess, particularly when made in small sizes. It is a comparatively easy matter to construct a rigid small-opening die, for the designer can make the die head of a size large enough to allow generous proportions to the different parts of the opening mechanism; but the mechanism of a small collapsing tap is generally jammed into the small body of the tap, necessitating the use of small parts that are too frail to stand the strains in a pipe-fitting tapping machine.

When one considers the enormous strain that the mechanism must operate under and the amount of metal that a collapsing tap must remove in a day's run on an automatic tapping machine, the necessity of rigid fool-proof construction and generous wearing surfaces in the mechanism of these tools is readily realized. In the pipe-fitting business it is generally known that most small-sized collapsing taps, although sometimes recommended for this purpose, are not always successful, for the cost of maintenance and renewals and the lost time in breakdowns are often greater than the increase in production will warrant.

Perhaps the most rigid small-sized taps are those designed with roller-type cutters, in which the cutters are made of round steel and the closing action is obtained by revolving them until the cutting teeth will clear the threads. This form of tap is adjusted for size by varying the cutting position of these roller cutters. Although mechanically incorrect, because adjustment changes the rake and clearance of the cutting teeth, these taps are widely used and the adjustment seems to answer the purpose for most work.

The tap shown in Fig. 1 was designed to be made in the larger sizes only—from 2½-in. pipe size up—and was quite satisfactory, as it seemed to stand up much better than others that had been used. It is very rigid, its cutters contain less high-speed steel than the roller-type taps, and it is easily made. The body *A* is of hardened

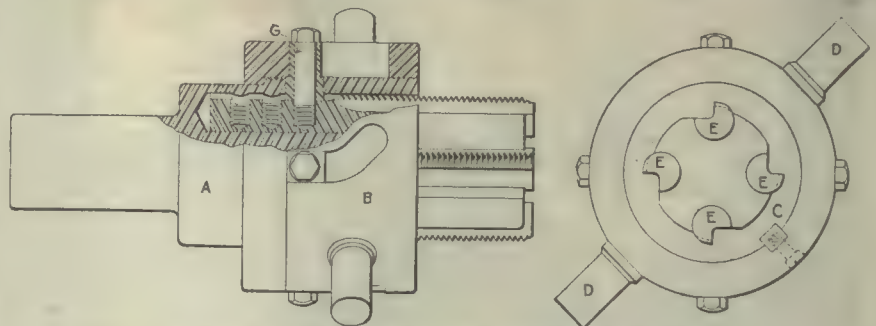


FIG. 2. TAP FOR SMALLER SIZES OF PIPES

perhaps only a slight shift in one lot of cored holes, but more shift in the next. On brass goods I have used collapsing taps as small as ¾-in. pipe size.

The roller-type tap, Fig. 2, is designed to be made in pipe sizes above 1¼ in. The body *A* is of low-grade tool steel hardened on its working end. *B* is the sliding cam collar, which has a cam slot milled on it for each cutter in the tap and a keyway with small holes in it to admit the dove-tailed key *C*. It also has two tapped holes for the stop pins *D*. The cutters *E* are made of round stock, and three tapped holes are provided to allow advancing them when ground off on their cutting ends by sharpening. They also have a keyway milled across these holes, to admit the solid keys that are machined on the hardened cam pins *G*. These cam pins are held to the cutters by hardened hexagon-head screws.

Some Foundry Practice in a Connecticut Plant

By FRANK A. STANLEY

SYNOPSIS—Castings and foundry methods in making lathe and cistern-pump parts. Machine molding is shown on a pump cylinder. Transporting methods are also illustrated.

The machine-shop practice of W. & B. Douglas Co., Middletown, Conn., will be shown in a later article in these columns. The purpose of the present article is to show some lines of apparatus manufactured by the same

Although labor in this line of work is not highly paid, as compared with the skilled trades in the foundry and shop, it is nevertheless an important factor in determining total items of expense, and such hand processes as chipping, filing and grinding should be eliminated as far as possible by improved facilities in the foundry or by careful and complete utilization of such facilities and equipment as are now present.

In the Douglas pump factory an endless number of castings of all kinds—handles, barrels, cylinders,

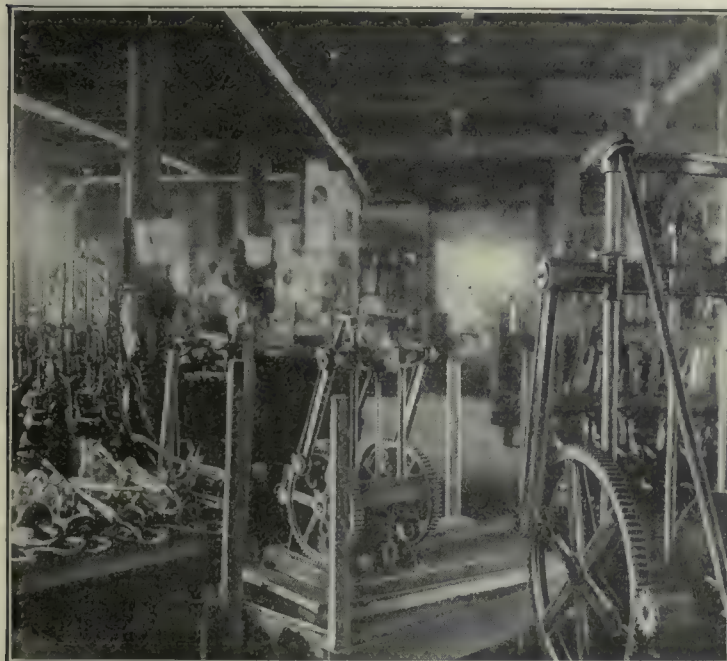


FIG. 1. PUMPS IN STOREHOUSE

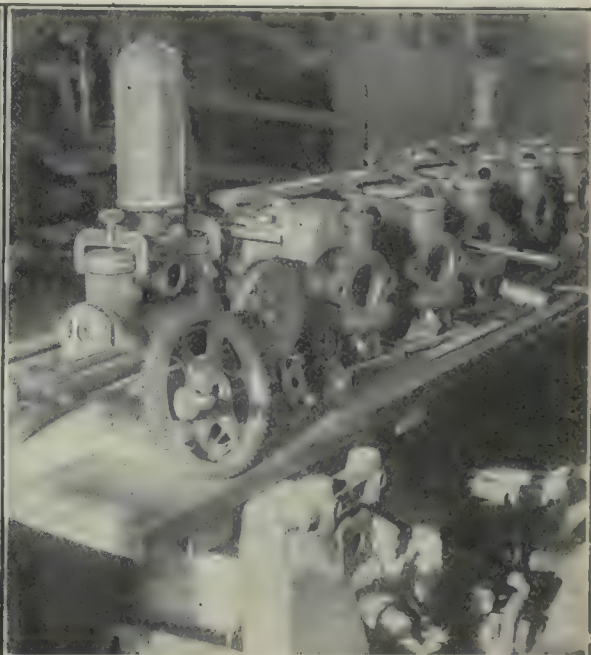


FIG. 2. PUMPS UNDER ASSEMBLY

concern and to illustrate in connection therewith some of the foundry methods and equipment for preparing the cast parts for machining.

As is well known, there is no great amount of machine work on ordinary pumps, particularly on the hand or household type, commonly called the cistern pump. The principal job on this is to bore out the cylinder, an operation that is usually performed by some special machine that bores several cylinders simultaneously.

In such a plant, therefore, the importance of foundry operations relative to machine-shop work is proportionately increased as the amount of machine work required decreases. The tendency is to expect more and more from the foundry in the way of producing castings that, if they require few shop operations, such as boring, turning, facing, etc., at the same time need little in the way of cleaning up with emery wheel, chisel or file to make them presentable after they have been painted. It is not an uncommon experience to find that the cost of putting small and medium-sized castings into shape, clearing off fins, ugly burrs, smoothing up the irregular bosses and the like, forms a big percentage of the total cost of the castings when ready for assembling in the finished machine.



FIG. 3. LATHE UNDER ERECTION; PUMP IN BACKGROUND

stuffing-boxes, bases, joints and connections—are produced in the foundry. Without attempting to indicate directly even a small percentage of the output, it may

be well to call attention to the different finished pumps shown in the stockroom, Fig. 1, and to the bench loaded with pump parts, Fig. 2. These are shown merely to give some hint of the variety of material handled in the foundry and factory of the Douglas company.

ating the pumping apparatus for all kinds of wells, and these may be driven by gasoline, oil or steam engines, electric motors or lineshafts.

Fig. 2 shows a somewhat different line of pump work, the castings on the bench in this view being for a set



FIG. 4. MOLD FOR HEAVY LATHE BED WITH CORES SHOWN TO THE LEFT



FIG. 5. TROLLEY SYSTEM FOR HANDLING LADLES ABOUT THE FOUNDRY



FIG. 6. MACHINE MOLDING OF PUMP PARTS

The hand pumps, at the left in Fig. 1, are made in many styles and in tremendous numbers. The larger machine, in the middle and right foreground, are what are commonly called deep-well working heads for oper-

of 3x5-in. pumps, for either hand or power operation; that is, while these pumps may be normally used under power, there are occasionally times when it is desirable to be able to operate them by hand, as when current

may be cut off, gasoline exhausted or steam power shut down. In such cases the hand lever may be applied and the pump worked satisfactorily during such period as may be necessary until the resumption of the supply of power.

The boxes for the shafts of these pumps are babbitted before the castings come to this bench, and here the shafts are put in, the bearings scraped, caps fitted up, the crossheads, connecting-rods, and other parts tested thoroughly.

Fig. 3 represents still a different class of work carried on at this plant. At the left, in the rear, is shown the largest type of pump made by the company. This is

lifting by the crane and placing in position as the top member of the flask.

Fig. 5 illustrates three of the big ladles on the trolley rails, one ladle empty and ready for filling in front of the cupola, the one at the left filled for running down the foundry to a lot of floor work that is awaiting the arrival of the hot metal for pouring. In the immediate foreground are seen a large number of molds for small pumps, all rammed up for closing and pouring.

There is a great deal of bench work and machine work in this foundry, and some idea of its character will be gathered from Fig. 5 and from the other illustrations that follow. Fig. 6, for example, shows the machine



FIG. 7. SMALL MOLD READY FOR POURING



FIG. 8. MOLDS FOR SMALL PUMP PARTS

a triplex-gear and belt-driven machine for operating under high pressure. Immediately in front will be seen several lathe-bed castings, and at the right a heavy lathe in process of assembling. This company has during the past year entered the machine-tool building field, with a heavy projectile lathe.

The illustrations that follow are all reproductions of photographs taken in the Douglas foundry, giving typical operations. The first of these foundry views, Fig. 4, shows the mold for the lathe bed illustrated in Fig. 3. The flask is here seen open, the mold having been all rammed up and ready for closing for pouring. The drag is shown at the left of the picture, with the five cores in place for forming the openings between the cross-girds and the lathe bed. The mold for the headstock is seen rammed up in the cheek of the flask at the center of the illustration. This portion of the flask is provided at each end with substantial guides that fit over corresponding guide members projecting above the face of the drag to allow the heavy cheek to be dropped into position, so that the dowels will enter properly when the faces of the two portions of the flask come together. The cope, or nowel, is shown at the right ready for

method of preparing the molds for the hot metal, this particular view showing molding machines used especially for right- and left-hand halves of the pump molds, each machine making its own half of the mold. The two machines are seen in the middle of the background of the view, the one in front with the flask removed, the one in the back with the flask ready for ramming up. Upon the completion of the ramming up of the molds the pattern is withdrawn by turning a crank at the end of the machine, drawing the pattern down flush with the surface, where the flask is lifted off. The machine in the center is shown with the patterns pulled out at the lowest point by the action of the crank.

The flasks are fitted with conveniently arranged handles so that they may be picked up and moved easily. A number of molds are shown open and closed on the foundry floor, and at the left will be seen two or three hinged flasks that are easily manipulated for the placing of patterns, ramming up of mold, setting of cores and preparing for pouring. The machine at the right is shown gated up with four patterns for similar pump parts that are small enough so that several of them may be rammed up simultaneously on the plate.

A large number of these flasks are of iron, as would naturally be the case with the smaller class of work, and a lot of these are shown on the foundry floor, Fig. 7, where they are placed for pouring. At the extreme left in the view will be seen the end of the cope portion of the three-part flask used for molding the big lathe bed referred to in connection with Fig. 4.

A good idea of the work of this foundry is gathered from Fig. 8, which shows several hundred molds closed and ready for the pouring operation. These pretty well cover one section of the foundry floor, and incidentally the view represents the method of handling hot metal up and down the line by the trolley system.

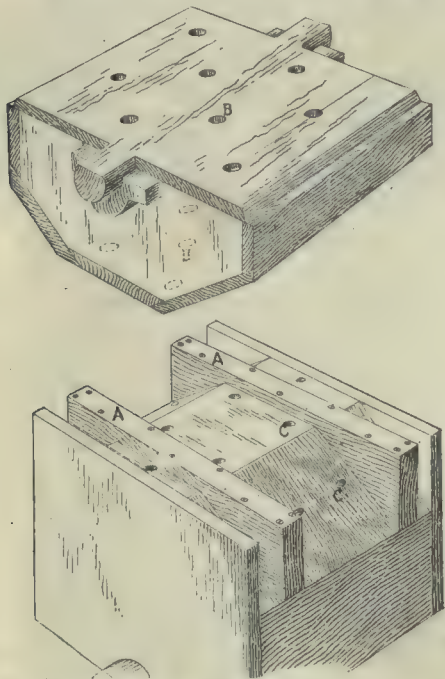
The work assigned to this type of flask is indicated by the gated pattern shown on top of the flask in the immediate foreground, where eight small cylindrical castings are molded at once, the work for this department being all bench or machine molding.

As already pointed out, the greater part of the process of manufacturing pumps is attended to in the foundry, the members thus produced without requiring further finishing than perhaps the drilling and tapping of certain holes and the fitting of some connecting member includes such parts as handles, air chambers, bases and the like.

Vent Holes in Patterns and Core Boxes

BY JOHN PARKER

In the experience of all foundrymen one of the most unsatisfactory phases of the work is the hugging down of the sand in the mold or core box. This difficulty is



VENT HOLES IN PATTERNS AND CORE BOXES

caused by too little draft and by the pattern being too deep for the air to enter between the walls of the box and the sand or between the outside of the pattern and the sand. The result is what is commonly known as hugging or sucking of sand and pattern. The molder hammers the pattern to loosen the grip of the sand, or in case of a core box pounds the outside of the box till the battens *A* and the box are in a sorry state, requiring trips back and

forth between the foundry and the pattern shop for repairs. This trouble could be eliminated, or helped in a great degree, by simply boring holes in the pattern at *B* or in the box at *C*, to allow air to reach the bottom of the mold or core, releasing the sand from the grip caused by air pressure.

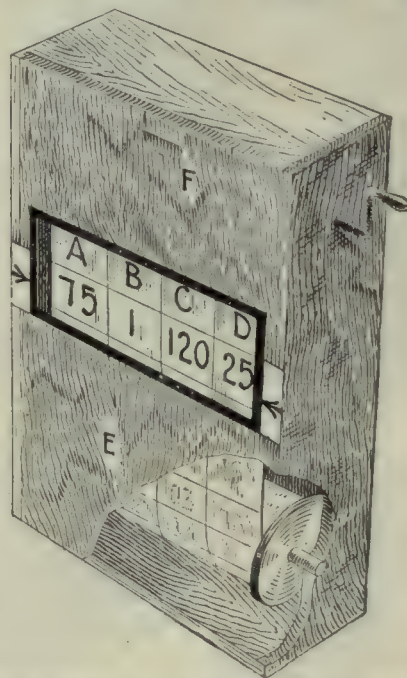
This is an old recipe, but the writer has been surprised to see how many foundrymen and pattern makers will stand by and patiently bother with core and mold or repair the pattern and core box repeatedly, when a little foresight and a bit of brace would avoid spoiling both the molds and the molder's temper, besides saving the expense of repairs to patterns and core boxes.

The writer has seen many patterns and boxes costing large sums ruined in a month's time by the pounding they received to draw them from the sand, when three or four holes through the pattern or the bottom of the core box would probably have saved them.

Dividing-Head Tables

BY J. H. MOORE

The miller dividing-head table shown in the accompanying illustration will, I am sure, be approved by operators of such machines. What is more confusing than the attempt to pick out a line of numbers from the mass,



CONVENIENT TABLE FOR DIVIDING HEADS

usually in small type, in the dividing-head tables? It takes considerable concentration of mind, and even then one is apt to make an error, especially after the list is well thumbed and soiled.

The table shown can be made from any box of convenient size (such as comes to the plant with large sizes of taps). The spools are easy to get. Hardly any further information is needed except that the box has a glass or mica front. The spaces *E* and *F* are painted black, while the remaining space is left transparent, to show the numbers as they appear. Spaces *A*, *B*, *C* and *D* are printed as follows: *A* has number of teeth, *B* the number of turns to handle, *C* has gear on handle, and *D* has the gear on worm stud.

Arrangement and Maintenance of Machine Tools*

BY W. ROCKWOOD CONOVER†

SYNOPSIS—An outline of the principles that should govern the selection, arrangement, care and maintenance of machine tools. Emphasis is placed on the value of a monthly inspection and report on every machine in the shop.

To attempt to discuss in detail or in a fully adequate manner all the features of advantage embodied in the various machine tools or other special tools which have been brought out in recent years by the tool builders and which enable the manufacturer to effect savings of greater or lesser proportions in his yearly output would open up a broad field of discussion, and would be of little interest, except in so far as the tools under consideration are adapted directly to the particular class of production in which the individual manufacturer is engaged.

When contemplating the purchase of new machine tools the manufacturer should aim to select the type or make of machine that has been proved by actual service, under both favorable and unfavorable conditions, to be best adapted to the specific purpose for which it has been designed and the specific work to be performed. He should not allow the personal opinion of the individual foreman or of the machine operator to bias or influence him in determining what tool to buy.

A complete record of all machine tools purchased and installed within the plant should be kept revised to date for constant reference. All tools should be assigned a catalog number; and the record should not only show the location of the tool, but should also give a description of the machine, its size, working dimensions, limits of speed and kind of work it is designed to do. If a machine is transferred from one department to another, the record should show the transfer in each case. This record should be so classified as to show all the tools of a similar type and all tools designed for similar classes of work grouped together in such convenient form that information concerning them can be obtained with facility. The value of such data will readily be recognized when the manufacturer is considering the purchase of tools like those already on hand in some portion of his factory.

INFLUENCE OF SPEEDS ON PRODUCTION

The subject of speeds is one that requires careful study and observation and the exercise of wise judgment. Few manufacturers are getting the maximum production possible from their machine-tool equipment, owing to various causes. Some machines are operated at full capacity, while others fall below with varying percentages of loss. As in each department every foot of floor space occupied either by man or machine bears its relative proportion of investment cost and expense, the necessity for running machine tools to their full capacity consistent with economy and safety hardly needs touching upon. When

the foreman's duties will not permit his devoting the necessary time to careful trial and investigation of speeds, it should be the duty of his assistants to conduct such investigations in each individual case as far as possible. If this practice is systematically and thoroughly followed in all departments of the factory, the tool investment can be kept within the lowest limit consistent with production requirements.

The tool operator needs to possess some knowledge of the kind of material he is about to cut and whether the depth of cut he proposes to take is practical and economical or not. A speed that may be demonstrated to be economical for one casting or class of material may not be advantageous or practical for another. If he is cutting steel, he needs to know something about the degree of its hardness—that is, the percentage of carbon in its composition. He should know that he can operate his tool at a much higher rate of speed on steel containing 0.20 to 0.30 of 1 per cent. of carbon than on steel containing 0.50 or 0.60 of 1 per cent. of carbon.

High-speed steel tools, because of greater endurance, make it possible greatly to increase the number of revolutions, but the workman must be able to determine the proper coarseness of feed in order to maintain a profitable rate of speed. With too coarse feed the tool becomes quickly heated, requiring too frequent changing, which causes a reduction in output; and proper accuracy and cleanness of cut are not assured. On the other hand, if the feed is too fine, the amount of material removed is not uniform with each revolution. The tool is not held to its work with equal and steady pressure at all times. It will do little or no cutting at one revolution and cut too deeply or roughly at the next, not producing a clean job. In cases of this kind the work presents a bad appearance.

With openhearth steels a speed as high as 250 ft. per min. may be obtained according to conditions, such as quality of finish required, rate of feed, etc. If the material to be machined is iron, the operator will naturally give consideration to the relatively slight difference between cast and malleable iron. A comparatively coarse feed in most instances can be taken, limited only by the quality of finish required, durability of tools and rate of peripheral speed that is demonstrated to be proper in relation to feed to produce the finished piece accurately and in the shortest space of time. In most classes of turret-lathe work the peripheral speed and coarseness of feed determine the rate of speed, the depth being a factor of minor importance that on many jobs need receive little consideration.

In general, the operator should have sufficient knowledge to judge carefully average conditions and arrive at satisfactory decisions in his work. Without such knowledge he is not properly qualified to operate his tool either efficiently or intelligently. The facility and precision with which he chucks or clamps his work, the time he takes to turn the turret head, throw in the feed, change or grind tools, etc., all indicate his efficiency

*Prepared for the author's forthcoming book on "Industrial Economics." Copyright, 1916, Hill Publishing Co.

†Factory economist, General Electric Co.

or lack of efficiency as a good mechanic. The factor of personal interest and ambition also has much to do with the output of machine tools, both as to quality and quantity.

There is a wide variation in economical speeds on almost any type of machine, governed by the character of the operation and materials used. Speeding a machine up too high naturally results in rapid wear of tools and consequently too frequent stoppage for grinding or exchange, which means decreased productive output to a degree that often more than offsets the gain made by the higher rate of speed. It may also affect the finished dimensions adversely. The actual amount of accurate work done will often be greater when a machine is operated at a medium rate of speed than when operated at a high rate, and this fact should always receive careful consideration.

Another element affecting the speed of machine tools is that of cutting lubricant. This should always be of a kind and quality to keep the point of the cutting tool thoroughly cool and well lubricated and should be supplied to the tool in ample volume, according to conditions.

With the advent of high-speed steels and the building of machine tools adapted to their use there has naturally come a change in the number of power tools operated by the individual employee. Previous to the period of their introduction the time of setting up a job was relatively short in comparison with the time occupied in the machine process itself; and under these conditions the operator tended two or more machines. In recent years high developments in speed of power-cutting tools, which have been secured in conjunction with the new steels, have resulted in reducing operating time to such an extent as entirely to change the ratio of the labor of setting-up to the production process and make it desirable in many cases for the operator to tend one or two machines only. The tendency in this direction has been fully justified by the increased product per machine and reduced labor cost of the individual piece.

It will be found a valuable help to the various foremen of the machine departments if accurate data on the efficiency and speed of machine tools in each individual department are prepared and kept available for use.

ARRANGEMENT OF MACHINE TOOLS

The arrangement of machine tools is a subject that requires careful consideration. It should in all cases be governed by local conditions and the kind of product manufactured. It is the usual practice to centralize in one department machines that turn out product for the whole or a large portion of the plant, such as screw machines, polishing machines, grinders, etc. This plan is undoubtedly the most economical when we consider the expense of supervision and also the investment in machine-tool equipment. Under this system the number of machine tools can be limited to actual requirements, and as a rule, all the machines built to produce similar kinds or classes of work can be kept in constant operation. A falling off of production in one department of the plant will usually be compensated for by orders from another, so that under normal conditions all the machines will be kept busy. The labor of trucking the machined or finished parts to the various departments must necessarily be considered, but this item will generally be

small in comparison with the other factors of expense and investment saved and the advantages gained.

It is often desirable, however, as in the case of decentralized departments or shops, to manufacture and finish all the parts for a given type of apparatus within the department itself. Under this plan, wherever practicable and the nature of the product will permit, the tools should be so arranged that the materials will pass in consecutive order of operation from one machine or set of machines to another and thence to the assembly floor or benches, with the minimum amount of labor handling by hand, truck or crane. Any arrangement that necessitates the movement of materials back and forth from one part of the floor to another or from one shop to another is not only expensive in operation, but also not infrequently the cause of delay in turning out the finished product.

In general, the best arrangement provides for the grouping of machines performing similar operations, such as lathes, planers, millers, gang drilling machines, etc., in such location as will aid the systematic movement of materials from operation to operation. Ample space should be provided between the different rows or tiers of machines to permit the free access of castings or other materials and to facilitate the handling of the same by the tool operator. There should be sufficient room so that platforms or boxes containing material may be placed in close proximity to the workman and in a position accessible to the floor laborer or truckman, in order that they can be quickly moved with an elevating transfer truck. The workman should not be compelled to place material on the shop floor because of lack of proper space and facilities about his tool.

The line-up of machine tools nearest the main or central aisle of the shop should provide ample space for platforms, material crates or boxes near the tools, leaving a broad, open, central way always clear for the free transportation of partly finished or finished product. This is true, also, where machine tools are placed in galleries or in long narrow areas of the shop. Too close setting of tools prevents the operator from handling his machine with the greatest safety and convenience and delays him in his work because of his cramped position and surroundings. Under such circumstances the floor becomes cluttered, is rarely properly cleaned, and the general tendency is to make the workman careless of the condition of his machine, if not generally slovenly.

The importance of furnishing ample space about machine tools cannot be too strongly emphasized. Congested aisles and gangways sometimes present the aspect of rush of business, but they as often indicate lack of proper executive knowledge and supervising ability. Such conditions give the shop a most untidy appearance in general; they not infrequently are the cause of serious accident and, beyond doubt, tend to raise the cost of production.

Decentralization of departments or classes of manufacture in large plants involves increased overhead expenses. The economic arrangement of machine tools in such cases must therefore obviously depend largely on local conditions and the advantages to be gained; and the individual manufacturer must necessarily be left to adopt the practice best suited to his own individual needs, the product he manufactures and the results he seeks to obtain.

The care of machine tools is of great importance. The work of preservation and proper maintenance is but half-accomplished if this feature receives but indifferent attention. A dirty or clogged oil cup is but little better than none at all, and the machine that is left to accumulate metal dust and gum up with oil residue will depreciate rapidly in proportion to the neglect. It is not sufficient to clean tools occasionally or to leave this work to the discretion of the operator. All slides and exposed surfaces should be cleaned at periods not exceeding one week, and shorter periods are preferable whenever practicable. This is especially true in the case of machines loaded with any of the various cutting compounds. Periodically all journals, spindle heads and turret heads, as well as unexposed bearing surfaces, should receive attention; and the frequency of this examination will obviously depend in no small degree on the quality of lubricant used.

The importance of frequent and thorough cleaning cannot be too often urged upon the workman or too strongly emphasized. The machine that is neglected rapidly degenerates, and the factor of depreciation necessarily becomes greater as time goes on. The slovenly workman soon finds the bearings and slides of his machine worn or clogged; and if his neglect is not the immediate cause of actual breakdown, in the end it results in increase in the tool maintenance and renewal account.

POINTS IN CARE AND MAINTENANCE

Particular attention should be paid to the care of roadways and the areas between machine shops, in order to prevent dust from entering through open doors and windows and coming in contact with the bearing surfaces or slides of valuable machine tools. The grit that in temperate or warm climates for the greater portion of the year fills the atmosphere of the shop during periods of wind is unquestionably detrimental to these bearing surfaces. Even where roadways are coated with preparations, it will be found desirable and necessary to keep them frequently and constantly sprinkled.

Detachable pans for the reception of oil drippings and chips, which are hung close up under the body of lathes, add much to the neatness and appearance of the department in which any number of these machines are concentrated. Not only are the floors more readily and easily cleaned, but the health and comfort of the employee are better preserved, particularly during the heated months of summer when the odors from saturated floors become increasingly obnoxious.

Maintenance of machine tools is a serious problem in the big shop. Every tool should be kept in a state of perfect repair and perfect adjustment if it is to produce perfect product. It is not possible for the operator to do good work if his machine is allowed to become loosened in any of its parts and remain out of alignment. During high peaks of production, when the factory is working overtime and the machine departments are rushed with orders, there is a tendency to ignore small repairs and delay the making of them until a more opportune time arrives when business is slack. This practice frequently necessitates operating the tool under strain, resulting in larger and more expensive repairs later on.

It is usually a fact in such factories that, when dull times arrive, the machine-tool equipment is found to require a general overhauling. A large percentage of

this expense could have been saved, had the smaller repairs been made at once as the necessity occurred and the tools thus kept in working condition. The manager is often surprised at the close of the year to learn that the total cost of tool maintenance in his factory has mounted to many thousands of dollars. If this maintenance account exceeds 5 to 8 per cent. of his tool investment, after charging off depreciation, it is evidently high, and he has definite reason to consider investigation and action imperative.

A valuable economy in the tool-repair account can be effected by making regular monthly inspections of all machine tools. This should be done by the efficiency man, or by a regular experienced machinist. A card record should be kept showing the catalog number and name of each machine and stating its condition. If a machine is found in perfect order, the card should show the date of inspection, notation of its condition and be filed in the drawer where are kept the records of machines in good repair. If a machine is found on inspection to require repairing, a notation should be made on the card of the date of inspection and the cause and nature of the repairs required. This card is placed in the drawer containing record of repairs to be made. A shop order should be issued to cover cost of labor and material and the cost entered on the cards, together with the date the repairs were finished. The card is then placed in the drawer showing machines repaired.

The value of such a record is obvious. It shows several important facts relating to machine-tool equipment and investment, which may be briefly stated as follows: The frequency with which a given machine is repaired; the cost of maintenance of each individual machine in the factory; the durability and life of a tool made by one builder as compared with a similar tool doing similar work, but made by another builder; the maintenance cost of similar tools sold by different builders; the advisability of replacing with new tools those showing high maintenance cost; the degree of care and experience exercised by different operators in the handling of their tools where the working conditions are similar.

It is hardly necessary to enlarge upon the importance of the knowledge thus gained. Few manufacturers know either the cost of maintenance of any given type of machine or its durability and economy of operation, as compared with the machines of other builders designed to do similar work. More often a machine tool is bought on recommendation or guarantee of the maker or on the fact of its having been observed in duty in another shop. Quite frequently, low initial cost is the governing factor. Repairs, also, are sometimes looked upon as one of the necessary routine evils contingent upon the factory's operation.

It is good business in almost any shop to invest a certain amount yearly in replacing old machine tools with new up-to-date types, which increase production and reduce costs.

All requests for shop orders for making repairs should receive the approval of the superintendent, in order that investigation can be made by him, where deemed advisable, before the shop foreman proceeds with the work. There are few emergency cases of such importance that they cannot be promptly brought to the attention of the proper official for approval before the company's money is expended for the necessary labor and material.

Railway Car-Wheel Flanges and Frog Clearances

The late A. M. Wellington once remarked that it would be difficult to find anywhere in engineering a small amount of metal performing such an important service with such marvelous reliability as that rendered by the flange of a railway car wheel. This little projecting lip on the rim of a car wheel, only about an inch in thickness and in height when the wheel is new, is the sole means of protecting from derailment every wheel of every railway train in the world. As is well known, the great bulk of the car wheels in service in the United States are made of cast iron, and the engineer as a rule hesitates to trust cast iron where it is to be subjected to transverse stress and to shocks; but the casting of car wheels has been so perfected that their record of safety and reliability in service leaves little to be desired.

When Mr. Wellington made the remark quoted, the average railway freight car had a capacity of 30,000 to 40,000 lb. Freight cars of the present day are built to carry a load of 100,000 lb., and many of higher capacities are in service. In addition to this there has been a notable increase in freight-train speeds with a corresponding increase in shocks to the wheels and axles.

There has been a general feeling that because of the increase in stresses to which car wheels are subjected some additional thickness should be given to the wheel flange so that it might better withstand the severe and incomputable stresses which it receives.

As every engineer connected with railway work knows, however, the present standard practice as to width of openings through frogs, switches and guard rails is based upon the use of car wheels with flanges of the present standard thickness, and any material increase in the flange thickness would necessitate an alteration in these track standards. The difficulty of altering these standards is apparent. A railway freight car in its wanderings may run over the tracks of any railway in the United States and Canada. It is impossible, therefore, for any single railway company to change the thickness of its car-wheel flanges without endangering the operation of these cars on every railway that did not alter its track standards to correspond. Moreover, if a thicker wheel flange were adopted by the railways of the United States for new cars, there would be fully a dozen years while the car wheels already in service were wearing out during which there would be a variation in flange thicknesses. It would be unwise, of course, to begin the changing of track standards until at least a large majority of the cars in service had the thicker flanges, and during all this transition period there would be increased danger of derailments at switches and frogs.

Nevertheless, the Association of Manufacturers of Chilled Railway Car Wheels recommended some time ago that car-wheel flanges should be increased in thickness about $\frac{1}{4}$ in. As a result of this recommendation, the matter has been under investigation by committees of the Master Car Builders Association and the American Railway Engineering Association. At the recent meeting of the former association held at Atlantic City, its committee submitted a report in which it said that "nothing will be gained in the interest of safety or

economy by adding metal to any portion of the flange of cast-iron car wheels in such locations as will in any way affect track clearances."

The investigation which led to this conclusion included a detailed study of car-wheel fractures and showed that the wheel fractures which caused derailments were almost invariably of a character that would not have been prevented by any increased thickness of the flange. Further than this, the committee reports that a certain railway had special wheels cast for use under its tenders having a flange $\frac{1}{8}$ in. thicker than the standard. The average age of 203 of these wheels when condemned was 11 months, whereas of the same number of wheels with M. C. B. standard flanges in the same service the average age when condemned was 11.1 months. Of these thick-flanged wheels condemned, 28 per cent. were thrown out of service on account of worn flanges, while of the wheels condemned having M. C. B. standard flanges but 15.2 per cent. were condemned on account of worn flanges. From this it would appear that the thickening of the wheel flange tends to increase the rate of flange wear. Two other railways reported to the committee that they had experimented with car wheels having thicker flanges and had found that the back of the flange in almost every case was grooved by contact with guard rails and frogs.

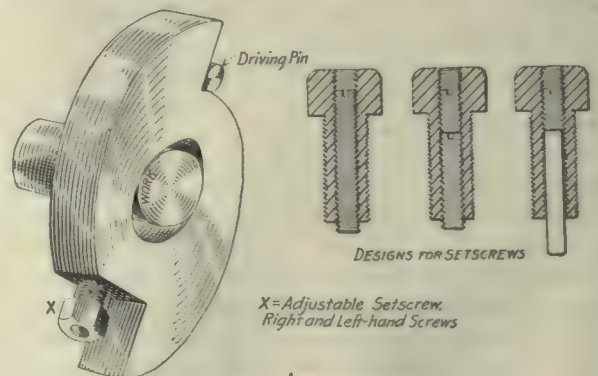
No better proof could be asked for that the present standard car-wheel flange is as thick as it can safely be made without a readjustment of track standards. The very great difficulty of maintaining safe operating conditions during the long transition period which would be necessary if a change in flange thickness were decided on has just been pointed out. It is exceedingly fortunate, therefore, that this small projection on the car-wheel rim, which seemed barely large enough for its work 25 years ago, is now proved to be still entirely reliable, notwithstanding the great increase in weights and speeds of rolling stock.—*Engineering News*.



Safety Lathe Dog

BY GEORGE C. LAWRENCE

In the dog illustrated the setscrew is made adjustable for length to accommodate work of different diameters and at the same time keep the head well down behind



SAFETY LATHE DOG

the safety projection. I have also found this telescopic arrangement convenient in adjusting the length of driving pins.

Making the 4.5-In. Howitzer Cartridge Case--III*

BY ROBERT MAWSON

***SYNOPSIS**—This third section completes the article on manufacturing 4.5-in. cartridge cases. The operations are continued from the machining of the head of the case to the inspection, acceptance and packing. The gages, special small tools and attachments are shown in detail in a manner similar to that followed in the previous sections describing the machining of the case. The article as a whole thus makes a complete treatise on this size and type of cartridge case.*

The thread is finish-tapped as the next operation. This is done in the drill press, Fig. 64. It will be noticed that the tap is fitted with a pilot, so that the thread will be tapped square. Details of the tap and pilot are given in Fig. 65 and of the pneumatic holding chuck in Fig. 66. The novel and valuable feature of this chuck is the method of locating the cartridge case. It will be observed that when the air pressure is admitted to the chuck the case is raised. It is then located against a finished flange on the chuck. As the outside face of the case flange has been accurately machined, the hole tapped and counterbored will thus be square with it, as the tap operates at right angles to the locating face of the chuck.

For this operation the same pneumatic holding chuck, Fig. 66, holds the case. The counterbore is shown in detail in Fig. 61 and is the same as used in the fifth suboperation of operation 25. The finish-counterboring operation is given in diagrammatical form in Fig. 69.



FIG. 64. TAPPING THE PRIMER HOLE

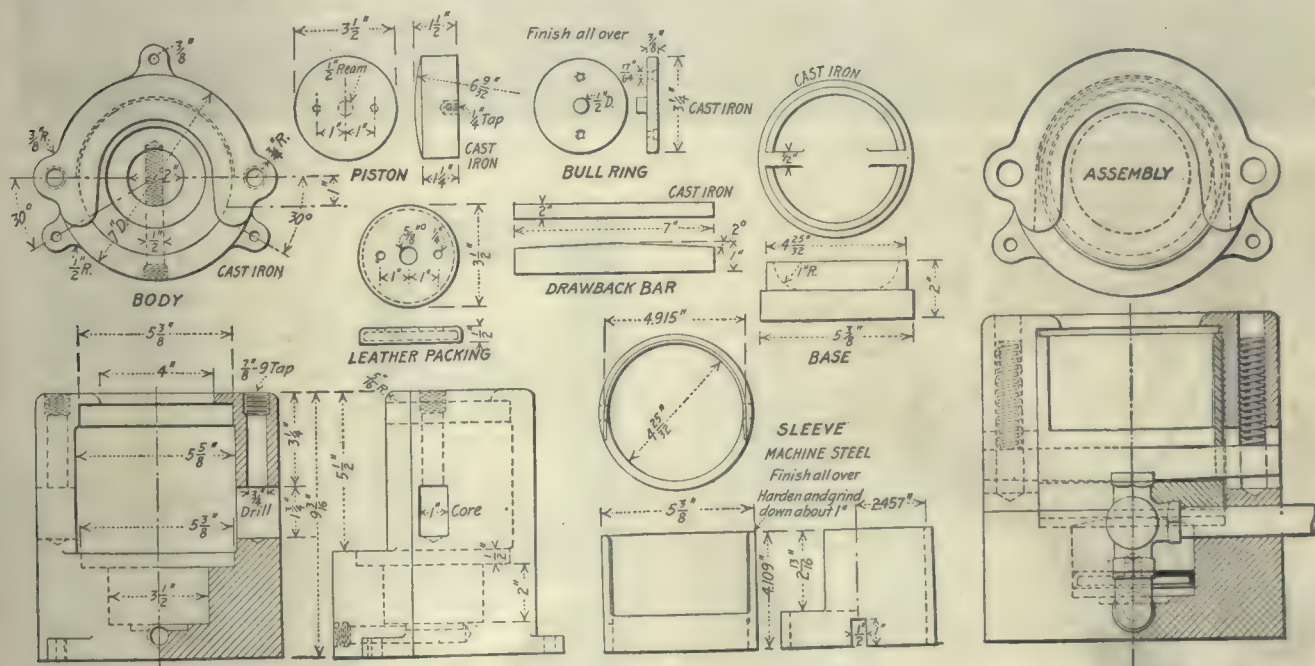


FIG. 66. PNEUMATIC HOLDING CHUCK

Lard oil is used during this tapping operation, also when rough-tapping in the twenty-fifth operation. The finish-threading operation is shown in diagrammatical form in Fig. 67.

The next operation is finish-counterboring. The drill press set up for this operation is illustrated in Fig. 68.

*Previous installments appeared on pages 21 and 67.
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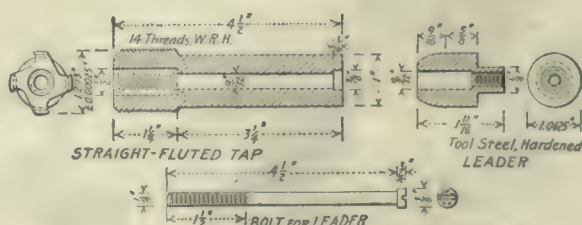


FIG. 65. DETAILS OF TAP AND PILOT

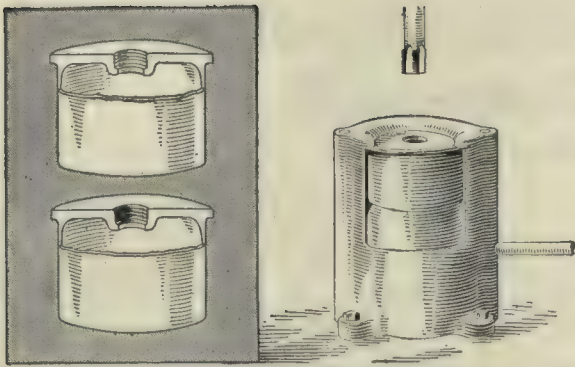


FIG. 67. OPERATION 26: FINISH-THREAD

Machine Used—Snyder drilling machine.

Production—380 per hr.

Lubricant—Lard oil.

References—Figs. 64, 65 and 66.

Note—Pilot used but not shown in the above illustration.

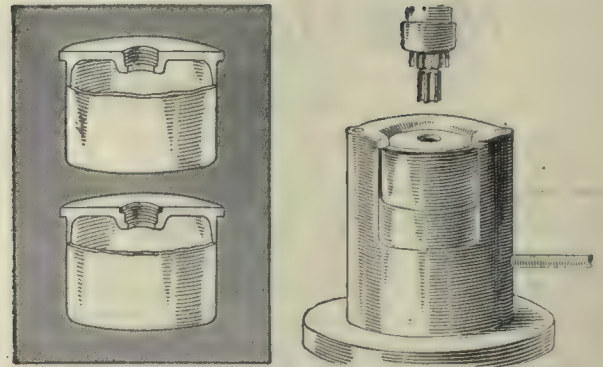


FIG. 69. OPERATION 27: FINISH-COUNTERBORE

Machines Used—Leland-Gifford and Barnes drilling machines.

Production—380 per hr.

References—Figs. 61, 66 and 68.

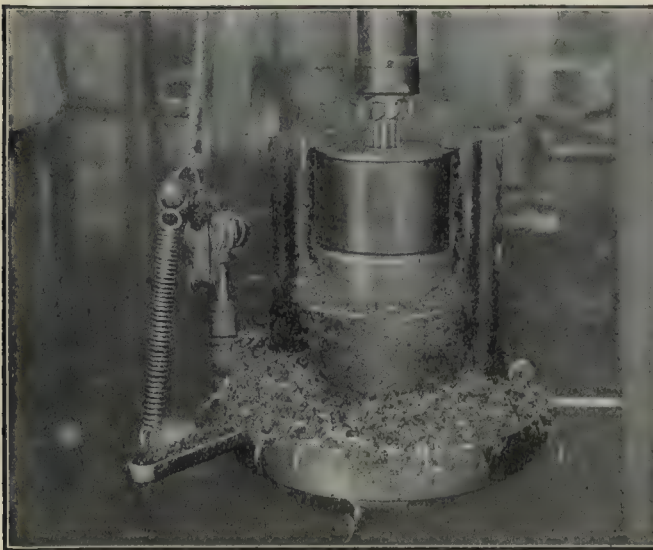


FIG. 68. COUNTERBORING THE PRIMER HOLE

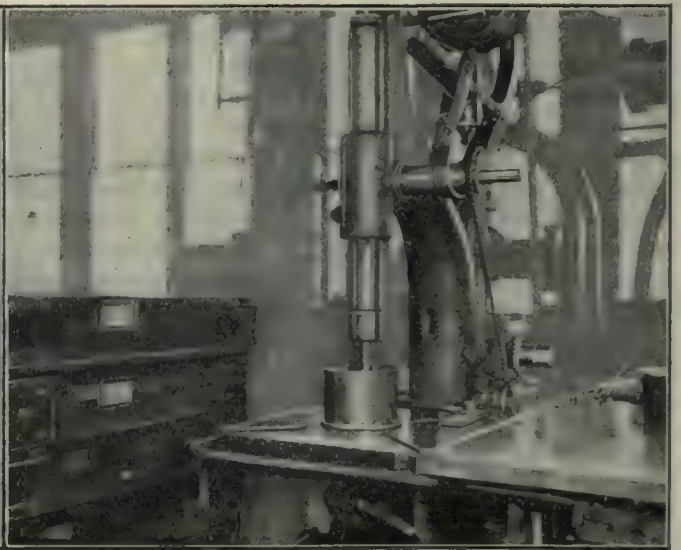


FIG. 70. FACING INSIDE BOSS

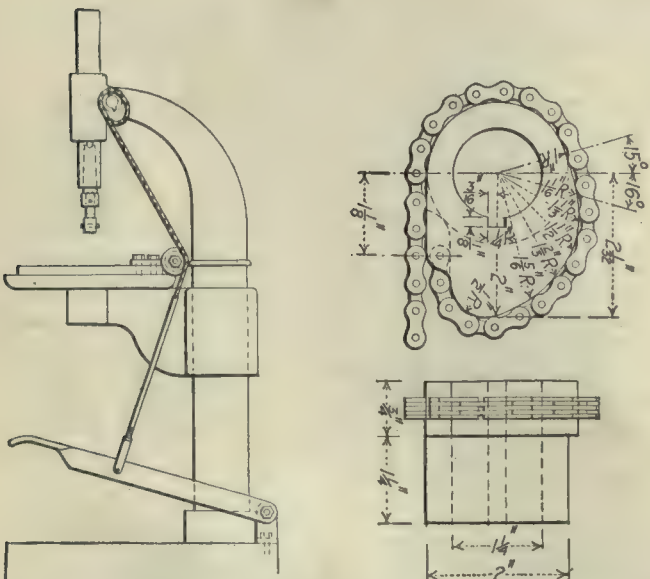


FIG. 71. ASSEMBLY AND DETAIL OF CAM ATTACHMENT

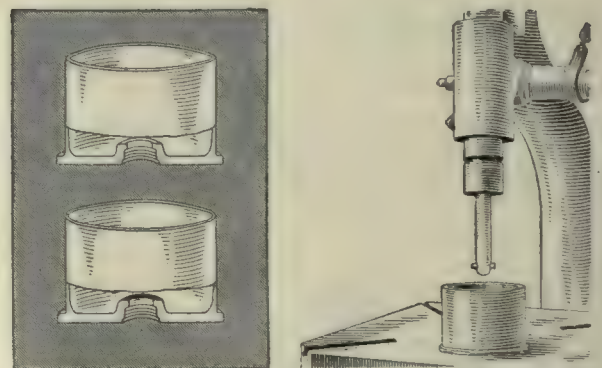


FIG. 72. OPERATION 28: FINISH INSIDE BOSS

Machines Used—Barnes and Dwight-Slate drilling machines.

Production—380 per hr.

References—Figs. 70 and 71.

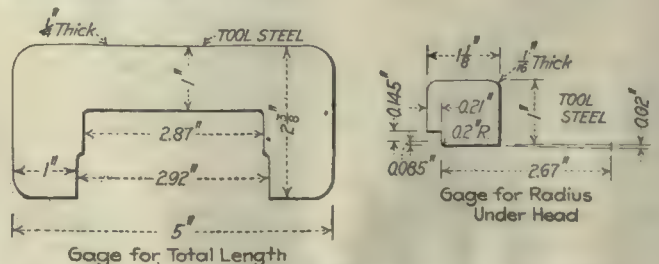


FIG. 73-A. GAGES FOR 4.5-IN. HOWITZER CASE

The surface of the inside boss is faced as the next operation. This is not done to any gage, being only to remove the burr left in the threading and counterboring operations. The machine for this work is shown in Fig. 70.

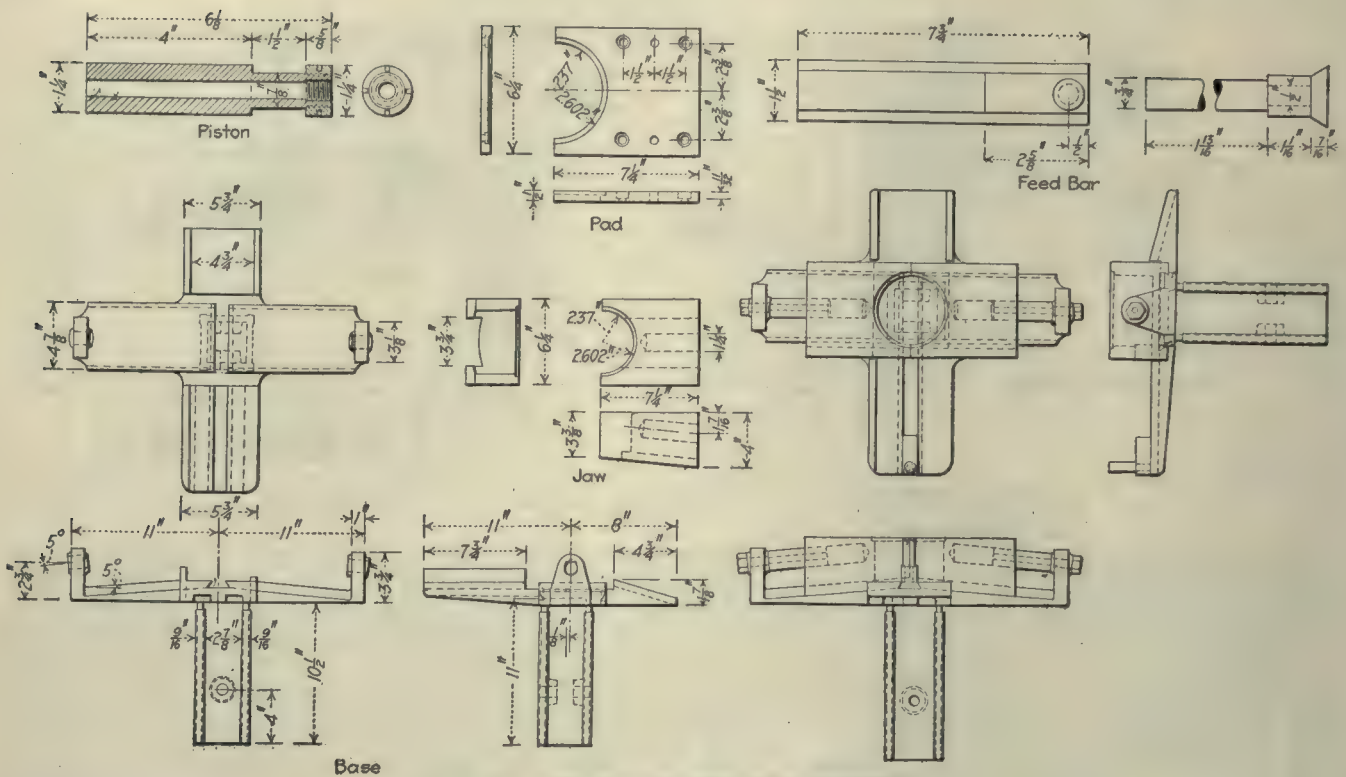


FIG. 76. DETAILS OF HOLDING FIXTURE

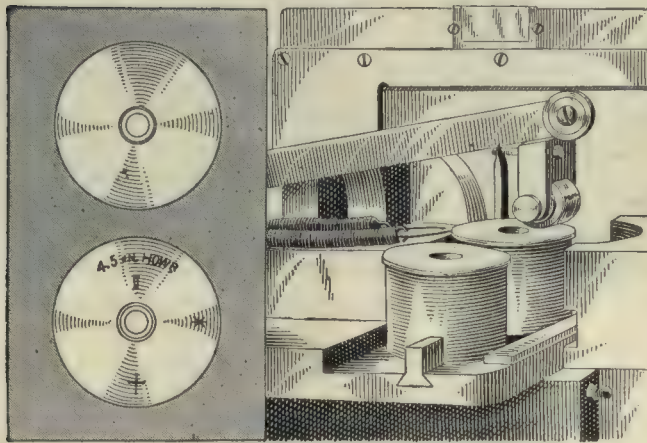


FIG. 78. OPERATION 31: STAMPING

Machine Used—Dwight-Slate marking machine.
 Production—1,200 per hr.
 References—Figs. 75, 76 and 77.

operated by air for holding the case are given in Fig. 76. It will be noticed that the jaws slide on a slight incline. By this means, when the case is in position under the stamp ready for marking, the pressure during the operation comes on the flange, thus avoiding injury to the thin wall of the open end of the cartridge case. A detail of the cartridge stamp is shown in Fig. 77. The stamping operation is given in diagrammatical form in Fig. 78.

The final operation is packing for shipment. The wooden case is made to hold 100 cartridge cases, which are placed in 5 layers of 20 each. Between each layer and around the insides of the packing case is placed corrugated paper. A view of one of the packing cases, partly filled, appears in Fig. 79, and the operation is also shown in diagrammatical form in Fig. 80.

In Fig. 81 is shown the method of conveying the filled packing cases. At the rear may be observed the



FIG. 79. CASE PARTLY PACKED



FIG. 81. VIEW OF CONVEYING SYSTEM

accepted and stamped cartridge cases being conveyed by an endless belt to men packing the wooden cases. After these have been filled, the cover is fastened down. The wooden cases are then pushed along the roller track and finally down the inclined chute shown. Such a method

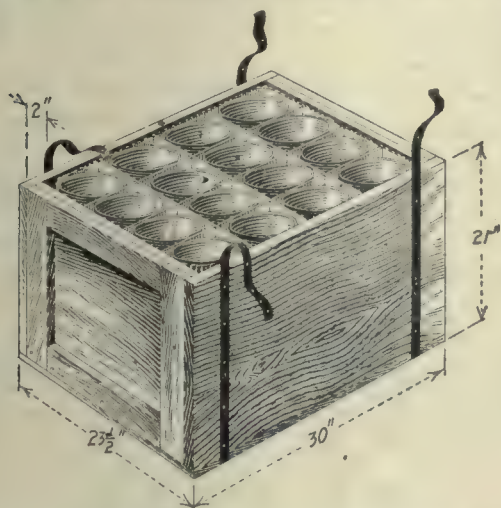


FIG. 80. OPERATION 32: PACKING

Production—One man packs 1,200 per hr.; one man fastens up boxes.
Reference—Fig. 79.

eliminates any lifting or carrying of the cartridge cases during the packing.

With the operations and tools here described the Worcester Pressed Steel Co. is producing the largest quantity of accepted 4.5-in. cartridge cases of any single concern in the United States, and the tools and methods were in successful operation very shortly after the first experimental case was made.

Design of Rolls for Making Steel Shrapnel Bars

BY W. S. STANDIFORD

The increasing orders of some of the belligerent nations for shrapnel shells and bars have resulted in manufacturers in this country making strenuous efforts to do the work. Many firms making widely diversified products are entering the munition field and manufacturing shrapnel, as it is a most lucrative business, the demand greatly exceeding the supply.

The metal from which the projectiles are made comes in round steel bars produced by rolling, which makes a dense and fine-grained metal well suited to the exacting processes of manufacture before the shells are ready for the guns. As steel bars form the basis from which the shrapnel is manufactured, the designs of the rolls, their proper adjustment and handling will be found interesting to the readers of this magazine. It may be thought that the shells could be made faster and better from castings containing the chamber for the powder and bullets, thus leaving very little metal to take off in the machining processes, instead of having to punch a hole in a solid steel blank and then finish the interior and exterior, as is done with each projectile made at the present time.

The reason that castings are not used for this purpose is that cast steel is a metal that usually contains blowholes, thus making it a dangerous material for shells, as they would be liable to burst in the guns. Another

reason is that the weight and balance of a shell made from a solid bar give a steadier flight through the air than is characteristic of one made from a casting; in the latter case the heavier ingredients of the steel settle to the bottom during cooling, thus making certain parts of the walls of the projectile heavier than others, which disturbs its balance during flight.

The bar rolled is $3\frac{1}{2}$ in. in diameter. This is the size used for the 18-lb. projectile for British guns, sufficient metal being in a bar of this size to allow for the machining operations to make the finished product.

The roughing rolls are three-high; they reduce the steel very quickly as compared with the two-high design. Quick reduction of the hot steel at the start is most important, as it is necessary to reduce the steel as rapidly as possible while it has a high heat, in order to make it fibrous, which is a quality desired. Referring to the roughing rolls, Fig. 1, it will be seen that each roll contains a box and edging pass, while the others are put in on an angle. Box and edging passes, by their shape, allow heavy drafts. The first and second passes work the metal on the top and bottom, there being little done on the sides. The illustration shows how the sides are made slanting toward the top of the groove, so that the bloom will leave the pass easily. If the sides were straight, the bloom would stick in the pass, some of the metal being forced between the collars, which would be broken. In actual practice the sides of the box and edging passes are opened out 6 deg., the width at the bottom being just enough so that it will fit the bloom. The box, edging and angle passes all contain fillets at the bottom,

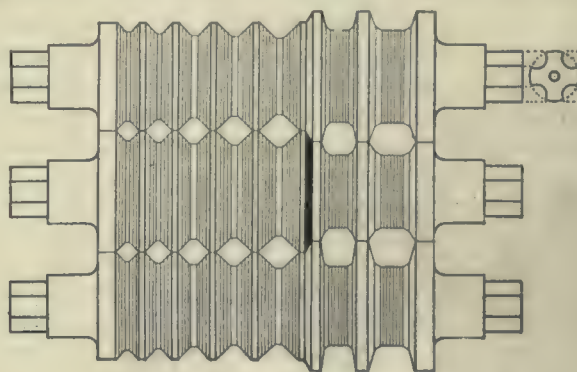


FIG. 1. ROUGHING ROLLS

so that the corners of the bloom will be worked as much as possible, in order to make all parts of the bar uniform in strength.

Roughing rolls are made of either chilled cast iron or steel, the latter being preferred, as it withstands rough usage better. It occasionally happens that a pair of tongs will slip out of the rougher's hands and go into the rolls. If the rolls are made of cast iron, a collar will be broken off; thus the set will be idle until a new roll can be turned. Should a pair of tongs go into steel rolls, the tongs will be cut in two—the collar edge where it cut the tongs will be dented, but this does not prevent the rolls from working.

As it takes a blacksmith about one hour to make a pair of tongs, while it will consume about one week's time to turn a new roll, it will readily be seen that steel roughing rolls are more economical than cast-iron ones. In purchasing steel rolls it is best to get a metal having a high-carbon content, as they will wear better in the mill

and do not bend, which latter characteristic is usually seen in the small-sized guide roughers used in a 10-in. mill. Following is a chemical analysis of roll steel, which is considered "next to the ideal metal" by chemists. Rolls of this analysis have withstood the roughest kind of usage in the mill and last long in the housings before requiring dressing in the lathe.

Carbon combined	0.49
Silicon	0.211
Sulphur	0.036
Phosphorus	0.041
Manganese	0.68

To make the $3\frac{1}{2}$ -in. round bars, bessemer or open-hearth steel blooms 8 in. square and $2\frac{1}{2}$ ft. long are used. They are pushed through the box and edging passes, emerging in the shape of a long, square bar.

The work done on the bloom by the passes has so compacted the metal that when the angle grooves are reached there is very little flashing of the molten steel coming from the bar, as is the case when the bloom first enters the rolls. The full number of grooves in both sets are not shown in Figs. 1 and 2, this being done for clearness and to keep the size down within reasonable limits.

The angle grooves have an angle of 95 deg., and by their position in the rolls work the bar mostly on the top and bottom corners. The corners of the bar at the sides have no work done on them while the bar is going through one pass. Before it goes through the next smaller groove, the bar is turned over at a right angle to its previous position; thus the two corners which were at the sides of the pass have work done on them. The bar goes through the angle passes alternately until it is reduced to 4 in. in diameter; then it is ready for rolling in the finishing rolls, Fig. 2. These are usually made of hard cast iron. Some mills use chilled rolls for making their hand rounds. The chilled rolls last longer before requiring dressing; but being very brittle, the collars between the passes are liable to break out if a sliver on a bar wedges itself between them.

The grooves in the hand rounds are put in by means of round steel plugs, as hard as fire and water can make them. They are ground after hardening, as the latter throws them out of true circular form. Tools for use on the roll lathe work best when left as hard as it is possible to get them. The pass is cut down in each roll to nearly half the diameter of the plug, sufficient clearance being allowed so that, when in the mill, the rolls will not have to touch each other; $\frac{1}{8}$ in. clearance is the usual allowance. This is to prevent the collars between the passes from breaking out on their peripheries, which is likely to happen when rolls are pressed against each other while working. After the groove is turned in the roll to the proper depth, the steel plug is withdrawn and a tool put in that widens the sides of the pass and rounds the corners at the same time, but does not touch the center.

This tool is then removed, and the pass with its cut-away sides has the appearance illustrated in Fig. 2. The other grooves in both rolls are turned the same way, care being taken to have them exactly opposite one another. The reason that the sides of each groove have to be cut away for a short distance is to prevent a long ridge, or fin, on each side of the bar at the joints of the rolls. The 4-in. square bar from the roughing rolls goes once through the $3\frac{3}{4}$ -in. pass. It is then turned over at a right angle to its previous position and pushed into the $3\frac{1}{2}$ -in. finishing pass.

As the bar from the $3\frac{3}{4}$ -in. groove passes through the $3\frac{1}{2}$ -in. one, the metal spreads out in the beveled sides and is about $\frac{1}{8}$ in. wider at the sides than at the top and bottom. It is then turned over at a right angle, so that the wide part is touching the top and bottom of the groove, and is rolled again, after which it is again turned over at a right angle to its previous position and receives the final rolling.

The last rolling which the bar receives rounds out slight inequalities that may exist on the surface. The shaded outline of the finished bar shows that the total width of the cut-away clearance part of the pass is very small. In the manufacture of round iron or steel bars by the use of rolls it is impossible, by rolling, to produce a bar that measures the same on all sides, the variation

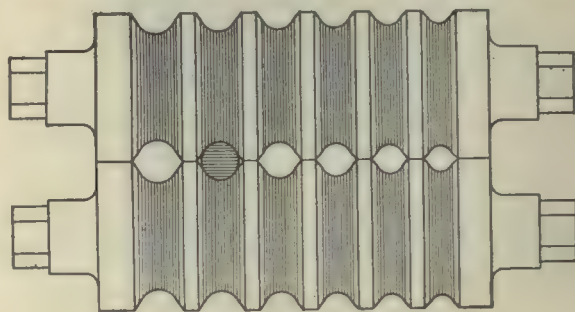


FIG. 2. HAND ROUND ROLLS

from a true circular shape being about 0.007 in., although some manufacturers, by placing an extra set of rolls in front of, and at an angle to, the regular ones make a bar having a variation of only 0.003 in. oversize, which is about the best that can be done.

It is a fact that the consumers' demands for exactly sized rounds is increasing every year. To get such results in keeping the variation in size down to a few thousandths of an inch requires the utmost care and skillful setting and handling of the rolls by the roller—and it also takes a roller who knows his business, as no amateur roller can set and maintain the rolls in position to make accurate rounds. The best that the ordinary roller can do is to make round iron or steel bars $\frac{1}{64}$ in. out of true circular form. This is due to incorrect setting and handling of the rolls, such as inserting the metal at too high a heat in the finishers, not having the grooves in line and not turning the metal over at an exact right angle at each rolling in the finishing pass. Too low a temperature in the finishing pass also influences the shape of the bar and makes it uneven in size. Thus when the bar has places on it that are relatively cold to other parts, in going through the rolls the cold spots cause the rolls to spring more than on the hot parts, thus making the bar larger in diameter at those places. If there are a number of cold spots on a bloom, due to careless heating in the furnace, the finished bar will be wavy in appearance. It is necessary to have the metal at a uniform temperature and evenly heated all through, if fine bars are desired.

In buying steel for shrapnel shells the requirements of the purchaser are even more exacting. This makes the manufacture of shrapnel bars an expensive operation. As an example: Bars for high-explosive shells call for a discard of 40 per cent. of the ingot; bars for shrapnel, 30 per cent.; and ordinary steel bars, about 15 per cent. The bars for high-explosive and shrapnel shells are subjected to rigid inspection.

A Method of Cutting Cams

By F. P. AMPUDIA

With the method here described, when one has to design a cam it is not necessary to make a detail drawing; but a small sketch is made showing the dimension and direction of rotation of time, as shown in Fig. 1, which also gives a table diagram that represents numerically the movements of cams by degrees, and the cuts in the milling machine by thousandths of an inch.

With this table the operator places in the milling machine the cams to be cut, in accordance with the numbers indicated. The operations are executed by following the data on the diagrams given.

On the upper part of the sheet, as in Fig. 1, a description indicating by degrees the times, direction and dimensions is made. On the opposite side a sketch is drawn that will show the times and directions and the table is compiled as shown, each division representing a degree.

The first column gives degrees, the second column the numbers of thousandths of inches that are to be cut, and the third column the total, representing the cuts.

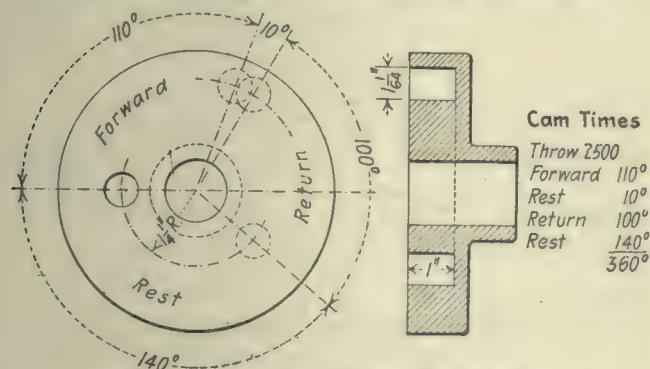


TABLE METHOD OF LAYING OUT FACE CAM

De- grees	Thou- sandths of an Inch To Be Cut	Thou- sandths of an Inch, Sum	De- grees	Thou- sandths of an Inch To Be Cut	Thou- sandths of an Inch, Sum	De- grees	Thou- sandths of an Inch To Be Cut	Thou- sandths of an Inch, Sum
1	2	2	47	14	611	93	14	1,255
2	3	5	48	14	625	94	14	1,269
3	5	10	49	14	639	95	14	1,283
4	7	17	50	14	653	96	14	1,297
5	9	26	51	14	667	97	14	1,311
6	11	37	52	14	681	98	14	1,325
7	14	51	53	14	695	99	14	1,339
8	14	65	54	14	709	100	14	1,353
9	14	79	55	14	723	101	14	1,367
10	14	93	56	14	737	102	14	1,381
11	14	107	57	14	751	103	14	1,395
12	14	121	58	14	765	104	13	1,409
13	14	135	59	14	779	105	13	1,423
14	14	149	60	14	793	106	13	1,437
15	14	163	61	14	807	107	13	1,451
16	14	177	62	14	821	108	13	1,465
17	14	191	63	14	835	109	13	1,479
18	14	205	64	14	849	110	13	1,493
19	14	219	65	14	863	111	13	1,507
20	14	233	66	14	877	112	13	1,521
21	14	247	67	14	891	113	13	1,535
22	14	261	68	14	905	114	13	1,549
23	14	275	69	14	919	115	13	1,563
24	14	289	70	14	933	116	13	1,577
25	14	303	71	14	947	117	13	1,591
26	14	317	72	14	961	118	13	1,605
27	14	331	73	14	975	119	13	1,619
28	14	345	74	14	989	120	11	1,630
29	14	359	75	14	1,003	121	9	1,639
30	14	373	76	14	1,017	122	7	1,646
31	14	387	77	14	1,031	123	5	1,651
32	14	401	78	14	1,045	124	3	1,654
33	14	415	79	14	1,059	125	2	1,656
34	14	429	80	14	1,073			
35	14	443	81	14	1,087			
36	14	457	82	14	1,104			
37	14	471	83	14	1,115			
38	14	485	84	14	1,129			
39	14	499	85	14	1,143			
40	14	513	86	14	1,157			
41	14	527	87	14	1,171			
42	14	541	88	14	1,185			
43	14	555	89	14	1,199			
44	14	569	90	14	1,213			
45	14	583	91	14	1,227			
46	14	594	92	14	1,241			

FIG. 1. DIMENSION AND DIRECTION OF ROTATION OF TIME

TABLE 1. MILLING-MACHINE CUTS

De- grees	Thou- sandths of an Inch To Be Cut	Thou- sandths of an Inch, Sum	De- grees	Thou- sandths of an Inch To Be Cut	Thou- sandths of an Inch, Sum	De- grees	Thou- sandths of an Inch To Be Cut	Thou- sandths of an Inch, Sum
1	3	3	70	24	1,829	150	27	1,790
2	5	8	80	24	1,853	151	27	1,763
3	8	16	81	24	1,877	152	27	1,736
4	13	19	82	24	1,901	153	27	1,709
5	18	47	83	24	1,925	154	27	1,682
6	24	71	84	24	1,949	155	27	1,655
7	24	95	85	24	1,973	156	27	1,628
8	24	119	86	24	1,997	157	27	1,601
9	24	143	87	24	2,021	158	27	1,574
10	24	167	88	24	2,045	159	27	1,547
11	24	191	89	24	2,069	160	27	1,520
12	24	215	90	24	2,093	161	27	1,493
13	24	239	91	24	2,117	162	27	1,466
14	24	263	92	24	2,141	163	27	1,439
15	24	287	93	24	2,165	164	27	1,412
16	24	311	94	24	2,189	165	27	1,385
17	24	335	95	24	2,213	166	27	1,358
18	24	359	96	24	2,237	167	27	1,331
19	24	383	97	24	2,261	168	27	1,304
20	24	407	98	24	2,285	169	27	1,277
21	24	431	99	24	2,309	170	27	1,250
22	24	455	100	24	2,333	171	27	1,223
23	24	479	101	24	2,357	172	27	1,196
24	24	503	102	24	2,381	173	27	1,169
25	24	527	103	24	2,405	174	27	1,142
26	24	551	104	24	2,429	175	27	1,115
27	24	575	105	24	2,453	176	27	1,088
28	24	599	106	18	2,471	177	27	1,061
29	24	623	107	13	2,484	178	27	1,034
30	24	647	108	8	2,492	179	27	1,007
31	24	671	109	5	2,497	180	27	980
32	24	695	110	3	2,500	181	27	953
33	24	719	111		2,500	182	27	926
34	24	743	112		2,500	183	27	899
35	24	767	113		2,500	184	27	872
36	24	791	114		2,500	185	27	845
37	24	815	115		2,500	186	27	818
38	24	839	116		2,500	187	27	791
39	24	863	117		2,500	188	27	764
40	24	887	118		2,500	189	27	737
41	24	911	119		2,500	190	27	710
42	24	935	120		2,500	191	27	683
43	24	959				192	27	656
44	24	983				193	27	629
45	24	1,007				194	27	602
46	24	1,031				195	27	575
47	24	1,055				196	27	548
48	24	1,079				197	27	521
49	24	1,103				198	27	494
50	24	1,127				199	27	467
51	24	1,151				200	27	440
52	24	1,175				201	27	413
53	25	1,200				202	27	386
54	25	1,225				203	27	359
55	25	1,250				204	26	333
56	25	1,275				205	26	307
57	25	1,300				206	26	281
58	25	1,325				207	26	255
59	24	1,349				208	26	229
60	24	1,373				209	26	203
61	24	1,397				210	26	177
62	24	1,421				211	26	151
63	24	1,445				212	26	125
64	24	1,469				213	26	99
65	24	1,493				214	26	73
66	24	1,517				215	26	47
67	24	1,541				216	18	20
68	24	1,565				217	13	16
69	24	1,589				218	8	8
70	24	1,613				219	5	3
71	24	1,637				220	3	00
72	24	1,661						
73	24	1,685						
74	24	1,709						
75	24	1,733						
76	24	1,757						
77	24	1,781						
78	24	1,805						

In order to prevent roughed surfaces when cutting a cam, owing to the irregularity of the cam curves and the difficulty in smoothly converting angles into curves, the angles should be cut before the curves.

Referring to Table 1, it will be seen that the first five degrees and the last five degrees to 110 deg. of the cam begin with 0.003 in., and they are increased by degrees up to the fifth, that is, 0.018 in. The same cuts when reversed should be given from 110 to 106 deg. Now the five first and five last degrees, representing 0.094, must be deducted from the 2,500 thousandths of an inch of the throw and also the 10 thousandths of an inch subtracted from the 110 deg. corresponding to the cuts. After this the remainder, or in other words 100 cuts, or one throw of 2,406, or $\frac{2,500 - 94}{110 - 10} = \frac{2,406}{100} = 24 + 0.06$. These figures show that we shall have to make 94 cuts to 24 thousandths of an inch and six cuts to 25 thousandths

of an inch. In order to give more uniformity to the cam, the six cuts of the 25 thousandths of an inch are to be given in the center that will correspond to the degrees between 53 and 59 deg. Following the diagram in its corresponding column, the operator will readily see that the number of thousandths of an inch cut are to correspond with the diagram, serving to check constantly the operation of the cut reaching to 110 deg. The diagram then shows 10 deg. rest up to 120 deg.; the return of 100 up to 220 deg. is done by subtracting on the cut 2,500 thousandths of an inch from the throw. By following the above explanation it will be found that the five first and the five last are to be indicated exactly the same, or 94 thousandths of an inch in 10 deg. For the remaining cuts $\frac{2,500 - 94}{100 - 10} = \frac{2,406}{90} = 26 + 0.66$, or in other words 44 cuts to 26 thousandths of an inch, and 66 cuts to 27 thousandths of an inch.

After the face has been finished and the holes drilled from the center of the radius, indicated on the illustration, the cam is placed on the spiral dividing head and placed on the work table. Then the cutter is attached to the clutch-driving cutter collar. By the dividing head we

have the degrees, and by moving the elevating shaft we obtain the thousandths of an inch.

In Table 2 is shown a similar table used in machining a three-lobe cam. The graphic method, as used when

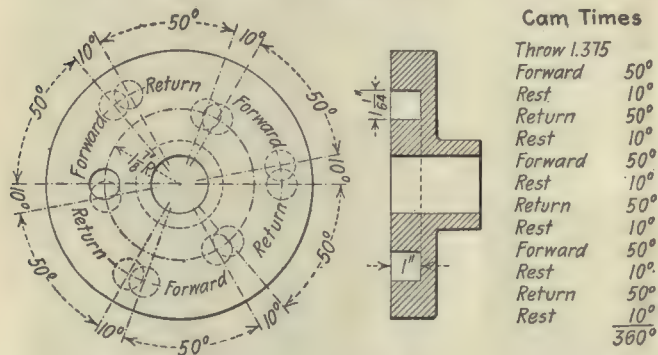


FIG. 2. DIMENSION AND DIRECTION OF ROTATION THREE-LOBE CAM

TABLE 2. CAM WITH THREE CUTS

De- grees	Thou- sandths of an Inch To Be Cut	Thou- sandths of an Inch, Sum	De- grees	Thou- sandths of an Inch To Be Cut	Thou- sandths of an Inch, Sum	De- grees	Thou- sandths of an Inch To Be Cut	Thou- sandths of an Inch, Sum	De- grees	Thou- sandths of an Inch To Be Cut	Thou- sandths of an Inch, Sum
1	3	3	32	32	1,263	79	32	879	100	32	207
2	5	8	44	32	1,295	80	32	847	101	32	239
3	9	17	45	32	1,327	81	32	815	102	32	271
4	13	30	46	17	1,344	82	32	783	103	32	303
5	17	47	47	13	1,357	83	32	751	104	32	335
6	32	79	48	9	1,366	84	32	719	105	32	367
7	32	111	49	6	1,372	85	32	687	106	32	399
8	32	143	50	3	1,375	86	32	655	107	32	431
9	32	175	51		1,375	87	32	623	108	32	463
10	32	207	52		1,375	88	32	591	109	32	495
11	32	239	53		1,375	89	32	559	110	32	527
12	32	271	54	10°	1,375	90	32	527	111	32	495
13	32	303	55		1,375	91	32	495	112	32	463
14	32	335	56		1,375	92	32	463	113	32	431
15	32	367	57		1,375	93	32	431	114	32	399
16	32	399	58		1,375	94	32	399	115	32	367
17	32	431	59		1,375	95	32	367	116	32	335
18	32	463	60		1,375	96	32	335	117	32	303
19	32	495				97	32	303	118	32	271
20	32	527				98	32	271	119	32	239
21	32	559				99	32	239	120	32	207
22	32	591				100	32	207			
23	32	623				101	32	175			
24	32	655				102	32	143			
25	32	687				103	32	111			
26	32	719				104	32	79			
27	32	751				105	32	47			
28	32	783				106	17	30			
29	32	815				107	13	17			
30	32	847				108	9	8			
31	32	879				109	5	3			
32	32	911				110	3	00			
33	32	943				111					
34	32	975				112					
35	32	1,007				113					
36	32	1,039				114					
37	32	1,071				115					
38	32	1,103				116					
39	32	1,135				117					
40	32	1,167				118					
41	32	1,199				119					
42	32	1,231				120					

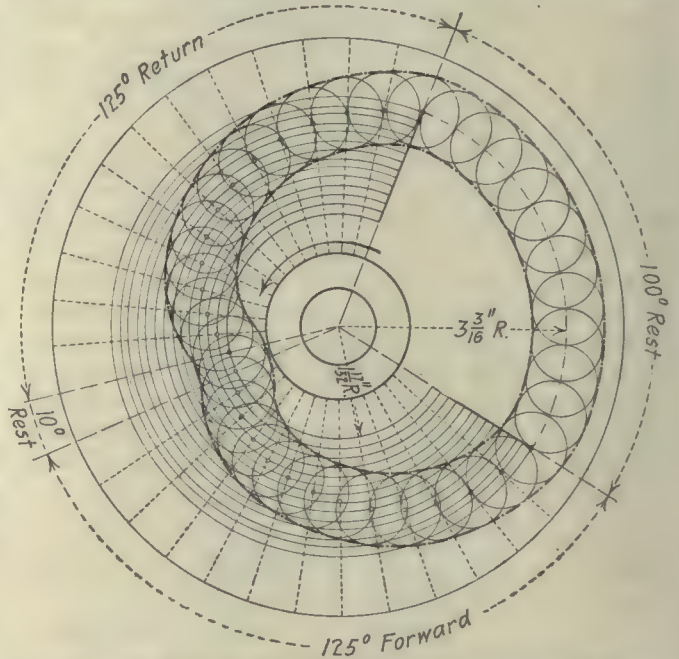


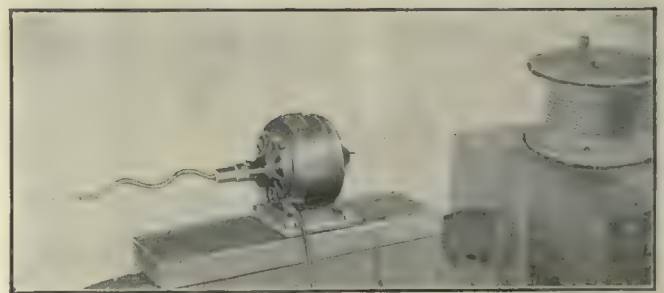
FIG. 3. GRAPHIC METHOD OF LAYING OUT FACE CAM

laying out a face cam, is shown in Fig. 3, and the table method here described is shown separately.

Wire Straightener

By E. V. ALLEN

A rather novel wire straightener, here shown, is used in the shop of the Campbell Industrial Co., Chicago. This company makes car seals and the like and uses a large number of small wire springs. The wire is about 22-gage coppered spring wire. The straightener itself consists of a rod with a hole drilled through it lengthwise. This rod is bent as shown and fastened to the



A SIMPLE WIRE-STRAIGHTENING DEVICE OPERATED BY ELECTRIC MOTOR

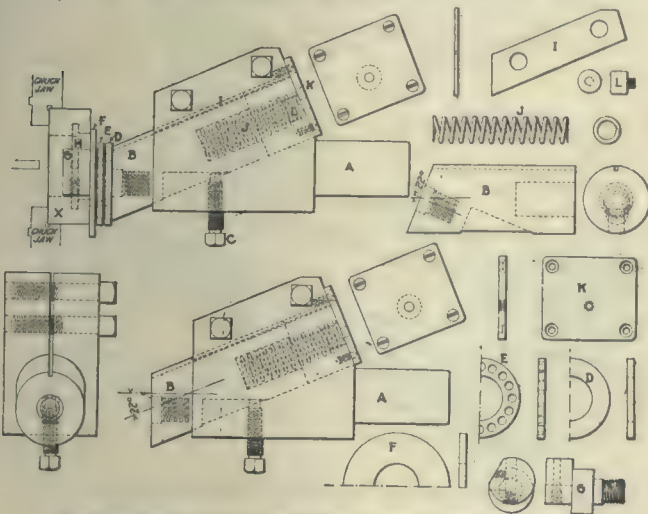
spindle of a small electric motor that runs about 1,800 r.p.m. The wire feeds from the spool in through the hollow motor spindle and out of the end of the wavy rod. The wire is flexible enough to be easily threaded through the hole when starting, and the result is as satisfactory as if a more expensive and complicated machine was used.

The wire feeds from the roll at the right and is pulled through to the left.

Letters from Practical Men

Recessing Tool Holder for Heavy Work

We had a lot of trouble in recessing the gear *X*, shown in the illustration. This gear, which is made of chrome-nickel steel and finished on a 5A Potter & Johnston auto-



RECESSING TOOL HOLDER FOR HEAVY WORK

matic, has a $2\frac{1}{4}$ -in. hole. It is counterbored $2\frac{7}{8}$ in. in diameter, $\frac{11}{16}$ in. deep and has a recess $\frac{1}{4}$ in. wide, $3\frac{1}{8}$ in. in diameter and $\frac{11}{16}$ in. from the face.

The recessing tool holder is very easily made. It consists of a main body *A*, the shank of which is turned to fit the turret of the machine. A hole is bored at an angle of 22 deg. with the center line of the shank. I find that this angle gives the best results. The body is split, and the key *I* is fitted and held in place by two setscrews. The plate *K* is fastened on the back to take the thrust of the spring *J*. A plug *L* is fixed on the plate to keep the spring central. The slide bar *B* is made a sliding fit in the body. It is bored and threaded to fit the tool holder *G*, and a keyway is cut the full length to fit the key *I*. It is bored on the opposite end to take the spring *J*. There are two hardened and ground washers *D* and *E*. A brass washer *E* has balls fitted into it. The tool holder *G* carries the washers *D*, *E* and *F* and the tool *H*.

When the turret comes forward, the washer *F* comes in contact with the face of the work. As the turret advances, the bar *B* moves up on the angle, the tool *H* is forced into the work, and the recess is formed. When the recess is completed, the backward motion of the turret allows the spring to return the bar to the starting point.

The setscrew *C* acts as the stop. The bar *B* is milled to take the point of this screw.

Any size of hole can be recessed with this holder by making a special holder on the same lines as the holder *G*. Adjustment to bring the tool holder *G* central with the bore is made with the setscrew *C*. A holder made the same as this one is working at the present time and gives an increase in production over one used before.

Philadelphia, Penn.

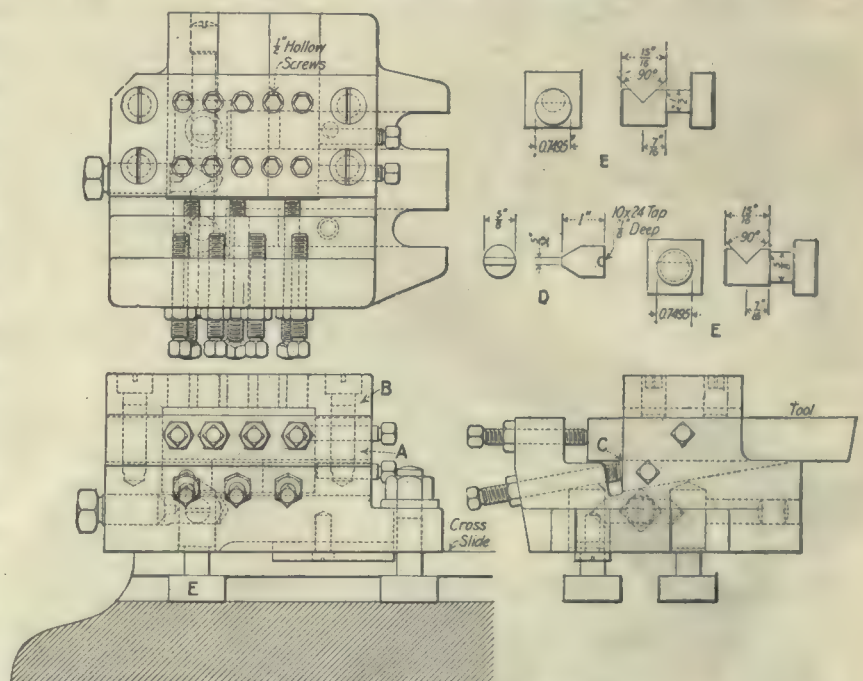
GEORGE GOLDING.

Tool Post for Flat Forming

We frequently have jobs on the Cleveland automatic screw machines where we could drill and form at the same time if we had no interference, but very often the reamer or counterbore or other turret tool will hit the top of the forming tool post on the front slide. To overcome this, it was necessary to have the forming tool post as low as possible.

After trying several tool posts which we purchased, we decided to design one of our own—with the result shown. It gives clearance enough so that a 2-in. reamer can pass over it. It also gives a wide range of flat forming tools and will hold a number of cutoff tools. The peculiar way in which it is made allows the form or cutoff tool to get close up to the collet.

The cast-iron body *B* is shown in detail. *B* is a machine-steel cap that carries $\frac{1}{2}$ -in. hollow hexagon setscrews which hold the tools down. As we are not using all of these tools at once, the four $\frac{1}{2}$ -in. fillister-



TOOL POST FOR FLAT FORMING

head screws that hold the cap down will more than offset the strain put on these hollow hexagon setscrews. The wedge *C* is used to raise and lower the tools. Two

sets of wedges are shown in detail. These are to accommodate two different sizes of tool— $\frac{5}{8}$ in. and $\frac{7}{8}$ in. thick. The way in which the block is fastened to the cross-slide on the left side may also be of interest. Owing to the fact that the block extends beyond the cross-slide, it was impossible to fasten the left side in the same way as the right, so we finally hit upon the wedge system shown.

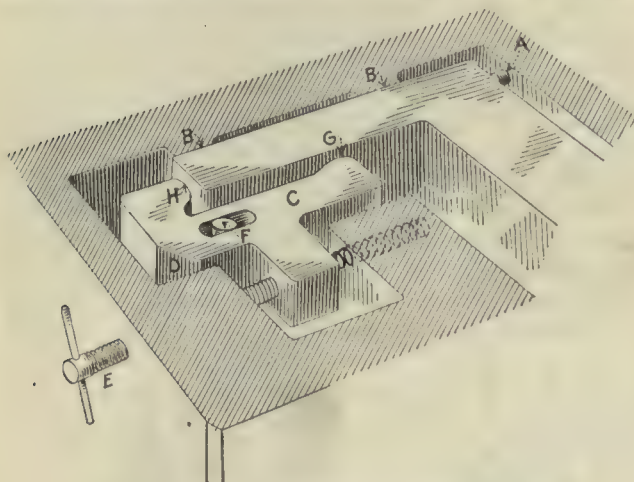
The tapped hole in the wedge *D* was put in so that it could be removed in case it stuck or roughed up; and it would not come loose of its own accord. The wedge is $\frac{5}{8}$ in. in diameter and fits into a hole $\frac{21}{32}$ in. in diameter, which allows the wedge to float back and forth, equalizing the pressure on each stud *E*.

After using this tool block for several months I heartily recommend it to anyone who has work that it is possible to form and drill simultaneously.

Dayton, Ohio. RAYMOND W. BECKMAN.

Single-Screw Two-Direction Jig Clamp

The accompanying sketch shows a method of clamping a piece in a drill jig, the idea being to clamp with a single screw against the stop pin *A* and against the surfaces *BB*, which are used to square up by. The clamp *C* is held



SINGLE-SCREW TWO-DIRECTION CLAMP

sidewise in a slot *D* in the jig body. As the screw *E* is tightened the clamp *C* swings around the pin *F* until it touches the work at *G*, when it slides on the pin *F* until it touches the work at *H*. A continued tightening gives a combination of both these actions at once. When the screw is loosened, the spring causes the clamp to return to its first position, leaving the piece clear to be withdrawn. It is necessary to exercise care in locating the pin *F*.

Hartford, Conn.

OTIS R. WILLIAMS.

Wrenches for Crankpin Bolts

Fig. 1 shows a pair of wrenches for tightening nuts on the inside of crankpin collar bolts. In nearly all front driving wheels of locomotives the side rods are held on by a collar bolt, as at *A*, Fig. 2, which goes through the hollow crankpin *B* and is tightened from the inner side of the wheel. The only time it can be tightened is when the wheel is on the bottom quarter,

as the frame and pedestal caps prevent getting at the nuts in any other position.

We formerly had to use a hammer and long chisel for this purpose; and it was not a pleasant job, inasmuch as the ends of crankpins are counterbored more or less. The two wrenches shown make the work much simpler

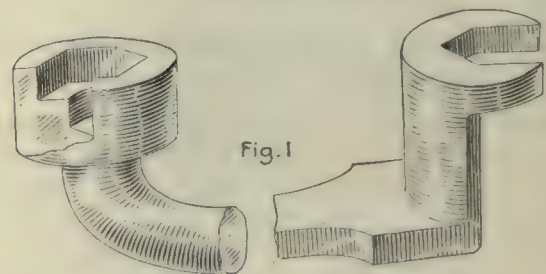


Fig. 1

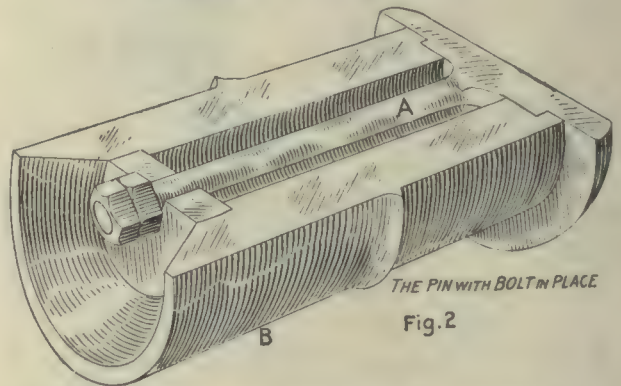


Fig. 2

WRENCHES FOR CRANKPIN FLANGES

and save time. They are more satisfactory in every way, as they reach into the counterbore and handle the nuts easily.

Renovo, Penn.

JOSEPH K. LONG.

Do You Use Dynamite?

An article recently appeared in the *American Machinist* regarding a method of removing die keys in drop hammers by means of dynamite. No doubt there are many concerns who would be glad to avail themselves of further information on this point, and I would like to hear from other readers of the *American Machinist* who have used dynamite for this purpose.

CHARLES C. FOSTER.

Buffalo, N. Y.

Two Examples of Welding Work

The Laconia Car and Foundry Co., Laconia, N. H., uses the oxyacetylene torch for many cases of welding. In Fig. 1 is shown a frame field for an automobile starter that has been made on the bulldozer. The joint is then welded with the oxyacetylene torch, as shown in Fig. 2. One of the fields after welding is illustrated in Fig. 3. The apparatus used at this factory was made by the Waterhouse Co., Boston, Mass. The average time required to weld one of these frame fields is 5 min. With a No. 13 tip, the consumption of acetylene and oxygen gas is 2 ft. of each.

Some electric welding is also performed on various parts of car bodies. One example of this sort is seen in Fig. 4. The work is spot-welding the insulation clips on a motor

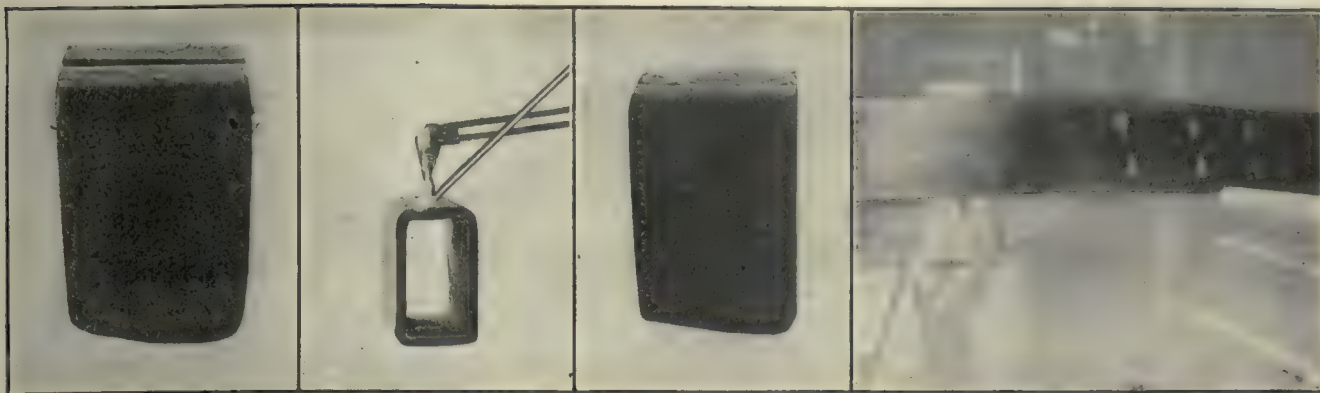


FIG. 1. THE FRAME FIELD BEFORE WELDING

FIG. 2. WELDING THE FIELD

FIG. 3. THE WELDED FIELD

FIG. 4. SPOT-WELDING THE CLIPS

sheet. The machine used is a Toledo electric welder. In the illustration are shown six of these clips that have been welded on the sheet.

A. TOWLER.

New York City.

flat-head screws. I have experienced some trouble in getting the heads of screws well fitted in the pieces machined, according to the tables given in the different handbooks. I was successful in getting a good fit and also facilitated the work in the machine shop by having all the drawings made up according to this table, which was also furnished to the men in the shop.

PAUL HETCUYI.

New York City.

Tap and Body Size Drills for Counterbores

The table gives A.S.M.E. standards and special machine screws with the proper dimensions of body drills and sizes of counterbores for fillister-head screws and

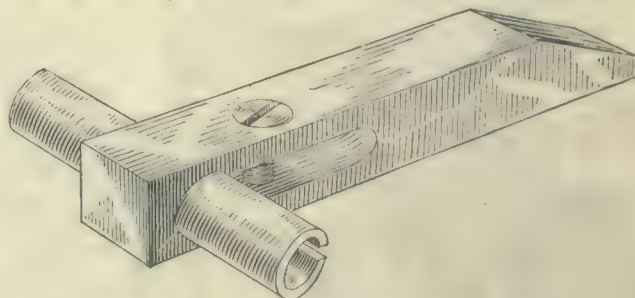
TAP DRILL, TAP AND BODY HOLE SIZES FOR A.S.M.E. STANDARD AND SPECIAL MACHINE SCREWS

Screw and Tap No.	Threads per Inch	Maximum Out- side Diameter of Screw	Nearest Fraction of an Inch	Tap Drill	Body Drill "A"					
					Loose Fit	Snug Fit	Fillister Head	Flat Head		
0	80	0.060	$\frac{1}{16}$	56	51	52	0.0376	$\frac{3}{32}$	0.029	0.112
*1	72	0.073	$\frac{5}{64}$	53	48	49	0.0461	$\frac{1}{8}$	0.037	0.138
*1	64			54						
*2	64	0.086	$\frac{3}{32}$	50	43	44	0.0548	$\frac{5}{32}$	0.045	0.164
*2	56	51								
*3	56	0.099	$\frac{7}{64}$	46	39	40	0.0633	$\frac{3}{16}$	0.052	0.190
*3	48			47						
*4	48	0.112	$\frac{7}{64}$	43	34	35	0.0719	$\frac{7}{32}$	0.060	0.216
*4	40			44						
*4	36			45						
*5	44	0.125	$\frac{1}{8}$	38	29	30	0.0805	$\frac{7}{32}$	0.067	0.242
*5	40			39						
*5	36			40						
*6	40	0.138	$\frac{9}{64}$	33	27	28	0.0890	$\frac{1}{4}$	0.075	0.262
*6	36			34						
*6	32			36						
*7	36	0.151	$\frac{5}{32}$	31	23	24	0.0976	$\frac{9}{32}$	0.082	0.294
*7	32			31						
*7	30			32						
*8	36	0.164	$\frac{11}{64}$	29	18	19	0.1062	$\frac{9}{32}$	0.090	0.320
*8	32			30						
*8	30			30						
*9	32	0.177	$\frac{11}{64}$	26	15	16	0.1148	$\frac{5}{16}$	0.097	0.346
*9	30			27						
*9	24			29						
*10	30	0.190	$\frac{3}{16}$	22	10	11	0.1234	$\frac{11}{32}$	0.105	0.372
*10	32			21						
*10	24			26						
*12	28	0.216	$\frac{7}{32}$	15	1	2	0.1405	$\frac{3}{8}$	0.120	0.424
*12	24			17						
*14	24	0.242	$\frac{1}{4}$	7	D	C	0.1577	$\frac{13}{32}$	0.135	0.472
*14	20			11						
*16	22	0.268	$\frac{17}{64}$	2	J	I	0.1748	$\frac{15}{32}$	0.150	0.528
*16	20			3						
*18	20	0.294	$\frac{19}{64}$	C	N	M	0.1920	$\frac{1}{2}$	0.164	0.580
*18	18			B						
*20	20	0.320	$\frac{5}{16}$	H	Q	P	0.2092	$\frac{9}{16}$	0.179	0.632
*20	18			H						
*22	18	0.346	$\frac{11}{32}$	L	T	S	0.2263	$\frac{10}{32}$	0.194	0.682
*22	16			K						
*24	16	0.372	$\frac{3}{8}$	N	W	V	0.2435	$\frac{21}{32}$	0.209	0.732
*24	18			O						
*26	14	0.398	$\frac{25}{64}$	Q	Z	Y	0.2606	$\frac{11}{16}$	0.224	0.788
*26	16			P						
*28	14	0.424	$\frac{27}{64}$	S	$\frac{7}{16}$		0.2778	$\frac{23}{32}$	0.239	0.840
*28	16			T						
*30	14	0.450	$\frac{29}{64}$	V	$\frac{15}{32}$		0.2950	$\frac{3}{4}$	0.254	0.892
*30	16			W						

*Special machine screws.

Boring-Tool Holder for a Bench Lathe

For boring small holes I constructed a tool holder, as shown, for use in a bench lathe. Its chief advantage is that the tool is always on center for its whole length,



BORING-TOOL HOLDER FOR BENCH LATHE

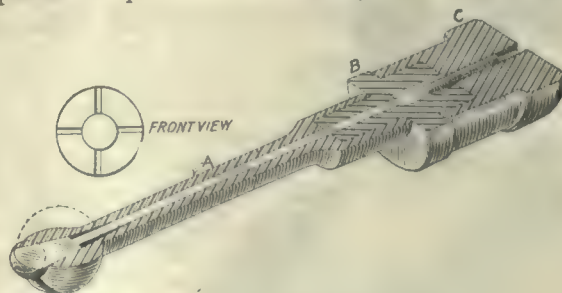
unlike most boring-tool holders in a tool post with rocker, with the tail end below the center, so that continual adjustment is required to bore a hole of any depth.

Bridgeport, Conn.

JAMES MCINTYRE.

Adjustable Internal Gage

The drawing shows a gage with fine adjustment for holes. A is of tool steel. The gage end is made as hard as possible to prevent wear. The parts A and C are an



ADJUSTABLE INTERNAL GAGE

easy fit on *B*. This device would hardly be practical in quantity manufacturing, on account of the small bearing surface, but for a few holes, or where the gage is set frequently to the micrometer, it will be found handy.

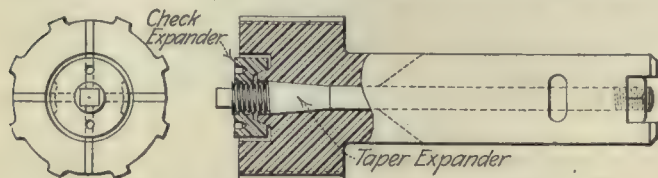
Brooklyn, N. Y.

GEORGE C. LAWRENCE.



Parallel Expanding Tap

Allow me to call your attention to a grave error in the sketch showing a parallel expanding tap, page 689, Vol. 44. The expander is threaded in the end below the taper



A PARALLEL EXPANDING TAP

engaging the check expander. These threads are not shown. The illustration herewith shows the tap correctly.

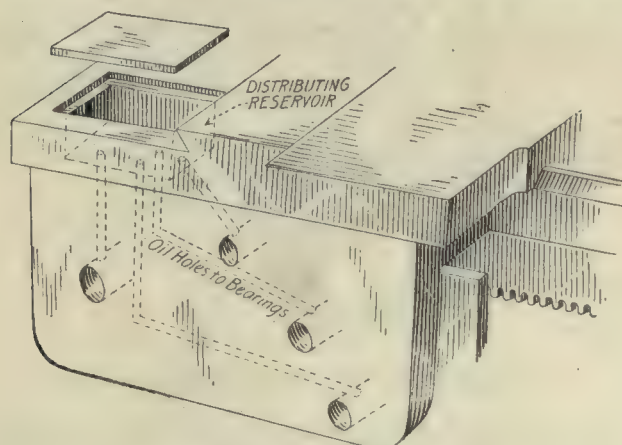
Kenosha, Wis.

E. HAWKINSON.



Oiling the Lathe Apron

I make a point of oiling my lathe all over every Monday morning. The following five days I oil only the headstock spindle bearings. It has occurred to me that



OILING THE LATHE APRON

it would be a good plan to put an oil-distributing reservoir in the carriage, as shown in the sketch. It would cut out about ten individual oil holes on the carriage and prevent a man's forgetting any of the holes.

Wembley, England.

J. H. DAVIS.

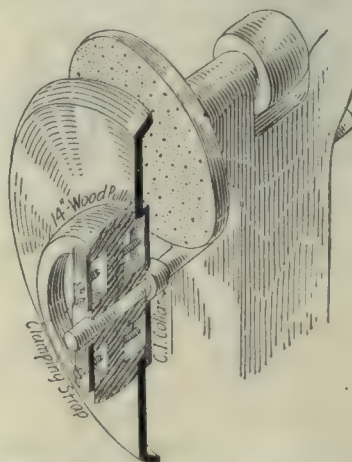


Grinding the Edges of Sheet-Steel Pans

That the disk grinder can often take jobs that would be done on the lathe is illustrated by the sketch of a simple rig for cleaning up the edge of a shallow cast-iron pan. The pan was 28 in. in diameter, had a 13-in. hole in the center, was 2 in. deep, and the metal was not over $\frac{3}{8}$ in. thick. It was almost impossible to do the job in the lathe, as the metal was very hard. The edge of the pan fitted against a plate-glass disk and it

was necessary that the surface be flat. The work was done on the disk grinder in the following manner:

A 14-in. wood pulley was placed on a mandrel and a fitting turned on one side. This fitting served to locate the casting. Four straps and bolts were used to hold the casting up against the pulley, and a cast-iron collar



GRINDING EDGES OF SHEET-METAL PANS

was placed on the disk-grinder shaft for the pulley hub to butt against. Grinding was kept up till the hub of the wooden pulley came in contact with the collar that had been fastened on the shaft. The entire lot of pans came out flat and all alike.

WESLEY McARDELL.

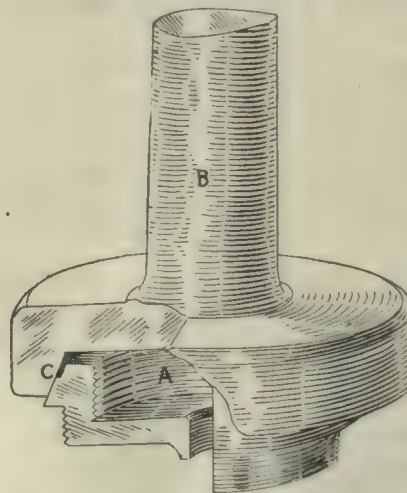
New York City.



Tool for Closing Fuse Sockets Tapped Oversize

The illustration shows a tool for contracting fuse sockets for 18-lb. shrapnel. If in machining the inside thread *A* of the fuse socket the tap cuts the thread diameter too large, the tool here shown can be used to correct this trouble, so the socket may be used. The tool *B* is made out of tool steel, hardened and tempered.

The angle *C* is made to conform with the angle of the fuse socket. After the latter is screwed into the shrapnel,



TOOL FOR CLOSING LARGE FUSE SOCKETS

the tool is placed over the socket, as shown. By hitting one or more blows on the top with a hand hammer, the inside diameter will close in evenly all around, thus saving the fuse socket.

H. WATTS.

Turtle Creek, Penn.

Discussion of Previous Question

Cutting Downward in the Lathe

The editorial on page 255, Vol. 44, on the value of reversing the direction of rotation of a lathe when cutting off stock, calls to my mind a job we had to do about 12 months ago, which was successfully accomplished only after reversing the tool.

We had to prepare a set of 12-ft. boiler-plate rolls for rolling traction-engine wheels. It was necessary to put in the bottom rolls six grooves each and four in the top one. The job presented something of a problem. To take the rolls out was impossible, owing to lack of

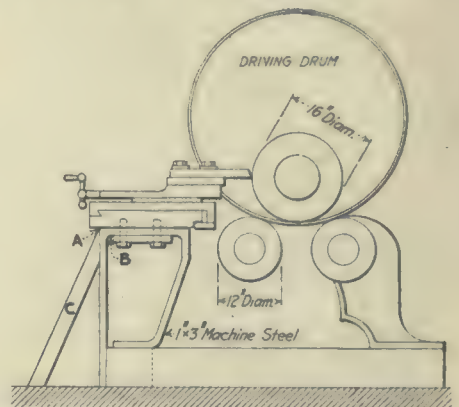
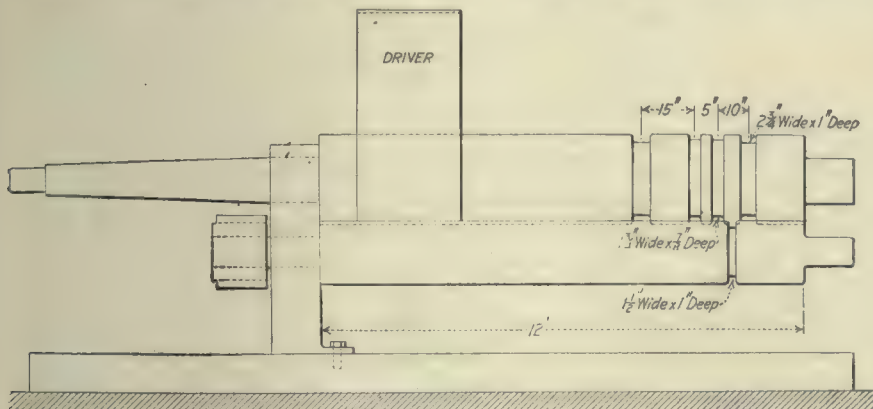
were completed, the brackets were cut to the height necessary for the lower roll and the process repeated.

Mansfield, Ohio.

R. A. WILLIAMSON.

Precision Gage-Making Work

Mr. Remacle's article, p. 635, Vol. 44, on precision gage making, together with a previous contribution regarding over-complicated gages, makes the following suggestions and drawings timely. Three points are brought out: Our system of calling for dimensions that permit



CUTTING DOWNWARD IN THE LATHE

time. We decided to do the work in place, using the power of the machine as a driving medium.

We took the cross-slide off a planer and set it up on two brackets that were bolted to the base of the machine, setting up for the top roll first. The brackets were finished on the faces A and B, and the strips were laid against the face B.

As only the bottom rolls were geared, the top one being merely a follower, the method of driving the top roll presented another difficulty. This problem was solved by placing a drum about 36 in. in diameter between the rolls and adjusting the top roll until the friction between the roll and the drum was sufficient to drive for the cut.

We first tried to drive in the usual way, with the work traveling toward the tool. Progress was extremely slow and the job poorly done. Whether the cut was light or heavy, the tool would dig in and chatter to an extent that made it appear impossible to get good results that way. We applied the brace C without improving things much.

When matters had reached this point, I thought of the European practice of reversing the tool and direction—a method I have seen used in English shops. After making that change, our troubles were over, for everything went right along. The tendency now was to pull the tool into the work, which only served to feed a little heavier, instead of driving it away from the work as in the first case. After the four grooves in the top roll

the use of standard sizes of stock with minimum waste and the incorporation of conveniences for the user of the gage; a shining example of over-design, entailing useless work on the part of the tool maker; and a brief description of our methods of grinding and lapping limit gages of extreme accuracy.

While it may seem right to consider first the more conspicuous points, as shown in the drawing, still I think the order of discussion really should be as enumerated; so I will first take up the matter of system and design as we have successfully practiced it for some years. We design and build nearly all our own tools and gages, and we require a higher degree of accuracy than is usual even in this close work.

Considering Fig. 1, it will be seen that the general dimensions, as given, allow stock sizes of material to be used and finished to a certain size with very little waste. For illustration, the thickness of this particular gage is $\frac{1}{8}$ in. minus 0.010 in., the 0.010 in. being allowed for surfacing and finishing. A similar idea is carried out as regards the width of these gages, while the length is merely specified as $2\frac{3}{4}$ in., since the length is not a stock size, but may be cut off the bar at any desired point.

This method of calling for stock assures that the gage, when finished, will be of a certain length, breadth and thickness, all of which is not only in keeping with high-grade workmanship, but produces a number of gages that, if of the same size, will be equally affected by temperature changes; and this plan also enables us to use

thick is used and side clearance dressed with a diamond, or even with a carborundum brick. In all cases one side of the gage slot is ground at a time, removing approximately one-half the stock, while the remainder of the stock is ground from the other side. The gage should not be removed from the clamp and turned around under any circumstances, but the dished wheel should be turned so the concave side will be to the cut, or toward the side of the slot being ground.

This method enables the gage to be readily ground to within a "short tenth," then lapped, either in the same machine and at the same setting, using a charged metal lap, or at the vise. In Fig. 2 the direction of the wheel movement is indicated by the arrows *A* and *B*. The chucking parallel block is shown at *C*. The gage being ground is shown at *D*, and *E* is a "setting" line.

Plainfield, N. J.

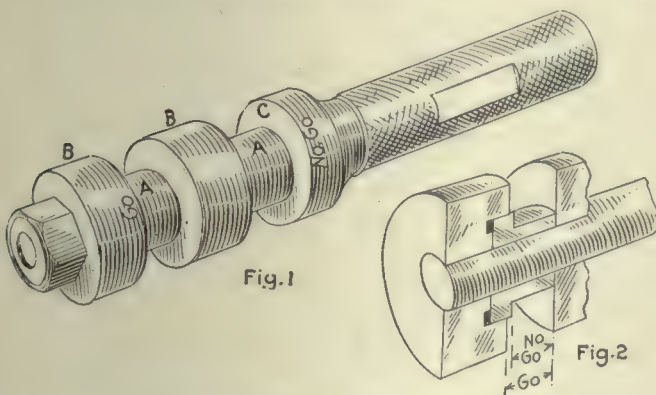
J. B. MURPHY.

[We never heard of "milling or planing off $\frac{1}{4}$ in. * * * to get below the *scale*" of tool steel, but we know from "practical" experience that it is often necessary to remove as much as $\frac{1}{8}$ in. from annealed tool steel to get below the decarbonized surface.—Editor.]

Adjustable Snap Gage

I refer to Mr. Henry's article on the adjustable snap gage, page 933, Vol. 44. While all he has to say about this tool is true, the design may be changed to good advantage without altering the principle—namely, the use of space blocks.

The gage shown in Fig. 1 possesses all the good features mentioned in Mr. Henry's article. Also, as the disks *B* are 2 in. in diameter, there is 6 in. of gaging surface to be worn before it becomes necessary to repair the gage,



ADJUSTABLE SNAP GAGES

which is also easy to handle. The operator may either hold it in one hand by the knurled handle or use it while it is lying on the bench, in which position it always presents a gaging surface to the operator.

While the initial cost of this gage may be slightly in excess of others, it will pay in the long run. The large extent of gaging surface will allow the gage to be used for a long time without repairs. If the sizes become obsolete, the various parts will serve to construct a gage with other sizes by substituting other space blocks *A*. It is essential that the greatest care be exercised in lapping these spacing blocks, or bushings, *A*, as any error in parallelism will be increased at the edges of the disks *B*.

Fig. 2 shows how the gage may be designed to permit rapid gaging, also how a gage of the dimensions in Fig. 1

may be used to gage two different dimensions of a piece. If a rectangular piece is to be tested for three sizes, the disks and space blocks, as in Fig. 2, may be mounted on an arbor and secured with a nut. This arbor, which is centered at the ends, should be permitted to revolve upon centers mounted on a cast-iron base.

Newark, N. J.

GUSTAVE A. REMACLE.

Oil-Ring Difficulties

Answering Mr. Wolf's criticism, page 914, Vol. 44, of my article, I do not believe that he fully appreciates the conditions as they existed in my case. The job was done about ten years ago, when I was an apprentice in a small job and repair shop back in the foothills, where it is usually difficult to find new and up-to-date equipment, as it would not always pay.

I agree that one of the most important things in a shop is to have all machines in good working order, which would have prevented the loose spindle of the drill. But it was rather hard to keep things up in that shop, as the machinery was all old and should have been in the scrap heap. I remember one lathe in particular that had been through a fire forty years before; and the rest of the machines had been purchased shortly after, so they were not in the best of condition.

Mr. Wolf's method is far superior to mine from a manufacturing standpoint, but for the small number of rings that I had to make, my method was satisfactory and about the only way out. The rings were also strong enough, as the threaded bushings would not pull out or split the ring before the screws, which were the weakest link, gave way.

JAROLD E. GREENE.

Ilion, N. Y.

Successful Suggestion Plan

I have read and reread W. J. Tewksbury's article on page 815, Vol. 44, and have come to the conclusion that the title he has chosen for the article is a particularly apt one from his, but not from the suggestor's, point of view.

On analysis the successful suggestion plan simmers down to this: The employees are prodded with every kind of goad that the management can devise. These incentives run the gamut of printed lead pencils, gentle reminders (Fig. 4), blotters (Figs. 6 and 7), time cards (Fig. 8) and calendars (Figs. 9, 10 and 11). These latter we are told are "blue or brown prints." It is reasonable to assume that they are made by the works drafting department. If so, is it not possible that the large zero in Fig. 11 is a subtle bit of irony on the part of the designer, inferring the suggestor's reward?

The last subhead reads "Assuring a Square Deal." To appreciate this thoroughly, let us "balance the books" of the suggestor and the concern. In column 2, page 817, we see that one suggestion netted the firm "\$6,700 in a single year." This is 6 per cent, on over \$110,000. "We have had several instances where the total value of all the suggestions made by one employee reached \$1,000 or more." Obviously there are many suggestions individually of less value than these, but probably representing in the aggregate a respectable sum.

Now what are the rewards? These vary in value from a meal ticket to "a 21-jewel gold watch." In between

the high and low are many items, including diamond rings that are miniatures of the company's product. Wearing these makes the proud possessor a perpetual sandwich man or woman carrying the firm's advertisement.

Gold watches with 21 jewels can be bought for \$40 or \$50 each; with filled cases, from \$20 to \$25 each. I assume that the author of the \$6,700 suggestion was given a watch (which he may not have wanted) costing a little over one-half of 1 per cent. on \$6,700, the annual value of his suggestion, and roughly five-hundredths of 1 per cent. on the estimated value of the suggestion. I, for one, fail to see the square deal. J. WATT.
New York City.

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Wasted Intervals in Small Shop

An article on reducing wasted time intervals, accompanied by some suggestions, is given on page 1069, Vol. 44. There are a few of those suggestions that should be used most cautiously or there will be disappointment.

The writer had a few years' experience under scientific management experts who made exhaustless efforts to cure some of the mentioned intervals—with partial successes and flat failures. During this period there was much cleansing and substitution of labor. The shops under consideration were contract shops and required all-around talent.

Take the centering operation for instance: In this shop many shafts were made, some square with journals in three places, others rough-turned forgings. The usual allowance was $\frac{1}{8}$ in. over all on diameters. Now the usual custom had been to let the machinist do his own centering. Under the new management boys and laborers were given the centering operation, the machinist only laying out and marking with a center punch. Here were the results: One piece in ten would be true to dimension, centers were drilled all depths, center drills were broken, center axes were not parallel. I have seen 40c. men spend several hours trying to fix up poor centering of 20c. men. Such things would not be tolerated in a jobbing or repair shop. Rapid and accurate work can only be done by careful centering. There is nothing that will disgust a good lathe hand more than poor centering.

Regarding the abuse of small tools such as drills, reamers, etc., those in authority are more to blame than those who use them. I know of several shops that have bulletins posted in conspicuous places about the plant stating the approximate price of each small tool. Yet these very same owners are always jollyng their drillers, especially the apprentices, by saying, "Don't be afraid of the drills, boys. If they break get another one. They are bought to be used up." The best system I ever came across for economy of small tools was in a woodworking machine-tool shop. Here every driller had his own outfit of drills, etc., in a cupboard under lock and key, the tool-room only making replacement of broken tools or giving out odd-size tools. Wages were based to a certain extent on this saving also.

Detailed minute instructions to repair- or jobbing-shop mechanics is the surest way to disappoint them. A foreman, no matter how good a workman he has been, after holding a foreman's position a few years gets out of practice. His duty is to steer and guide; to curb the strong and protect the weak—by the weak I mean apprentices,

or learners—from the outrages of the stronger fraternity. A careful and conscientious workman after a certain amount of discipline should be allowed to use his own judgment, for during this period he had got an idea of what his superior wants. It is said that contentment is half of life. This applies equally to jobbing and repair shops.

It is the Graces that win here, not minute instructions or elaborate cost systems. The jobbing- or repair-shop foreman who cannot make life pleasant and interesting without minute instructions has mistaken his profession and will fail.

G. STROM.

Brooklyn, N. Y.

[Mr. Strom has evidently missed the real application of some of the suggestions in the article he refers to, but his comments on shop conditions and limitations are interesting.—Editor.]

✱

Sponges That Only Absorb

On page 960, Vol. 44, Mr. Little writes: "One of the greatest pleasures in life is telling the other fellow how you did it," etc. I don't think Mr. Little has ever worked in a Kenosha, Wis., factory; he gives his address as Rochester, Minn. From the tone of his letter I am inclined to think his home is in heaven.

Some thirty-five years ago I began to learn the trade of pattern making. I started out on the lines suggested by Mr. Little, always willing and anxious to listen to and learn from the old journeymen. When I grew to manhood it "gave me great pleasure to tell the other fellow how I did it." That was thirty years ago; things have changed.

Today we have in every shop the wise young man mechanic. To undertake to tell him anything would be a waste of wind and time. Then we have the "plug" mechanic, the fellow who never reads, listens, or thinks, who knows the location of every saloon in the town, who can tell you at which end of the bar the free lunch is.

Standing at the bar, with a pig's knuckle in one hand and a glass of beer in the other, he can tell the other fellow more of that how-he-did-it stuff in five minutes than a regiment could absorb in a week. Mechanics of this class don't care to listen to anything that is elevating, broadening, improving.

After spending thirty-five years—divided up in the pattern shop, machine shop and the foundry—working with all kinds and classes of mechanics, I am convinced that the best plan to follow when you have anything worth telling to the other fellow is to send it to the editor of the *American Machinist*. If it has merit it will be published where every reader of the *American Machinist* will see it and profit by your experience.

Quoting from Mr. Little's article: "Help the other fellow and bring back to yourself information that you would not otherwise receive." I am led to believe, after reading Mr. Little's article, that his experience has been limited to shops employing only first-class mechanics. Such men always welcome from a brother mechanic how he thought out some little kink or saved time in doing a job. Not so with the "plug" mechanic. To tell him anything would be an invitation for slurs and sarcasm. Don't tell it to the other fellow. Tell it to the editor.

Kenosha, Wis.

M. E. DUGGAN.

Editorials

Why Not Same Hours for Office, Drawing Room and Shop?

Is not the principal cause of the suspicion and antagonism that exist among the office, drawing room and shop the special privileges given to the two former? Measured by shop standards, the office help come in late and go out early; in many places they do not have to punch the clock; in most places they are paid a salary and are not docked for tardiness or short absences and have a vacation with pay; no record is kept of how much work each one does; they have free use of the telephone, office stationery and numerous other small advantages. Measured by shop standards, the drawing-room help also have certain special privileges, the most important of which are short hours, vacations with pay, and no docking for lost time. It would be interesting to inquire into the origin of these special privileges, but space does not warrant such a discussion.

From the viewpoint of simple justice the question must be asked, Why should special privileges be accorded to the office and drawing room? Or striking more directly at the most important privilege, Why should not the shop, office and drawing room work the same hours?

This question has peculiar force at this time for the reason that there is a tendency all over the country to shorten the working hours in shops and factories. Thus an opportunity exists to hold the office and drawing-room hours where they now are and shorten the shop hours until they are equal or nearly equal to those worked in the other places. The best condition might be to have the shop and office hours identical, although in some cases it may be more practical to make them equal for the week rather than coincide for each day. Is it not possible to find substantial reasons for such a course?

If this course is carried to its proper and logical conclusion, all heads of departments should report at the same time that their employees enter the works. Everyone should get his weekly wages in an envelope the same as all others. In other words, no one should draw a "salary."

Some points in favor of this general suggestion have been sent to the *American Machinist* by a manufacturer who has had many years' experience in handling several hundred employees. At his request we are not revealing his name. He sums up his beliefs under seven heads, as follows:

1. The one big reason is the economic one. In the olden days the office force amounted to one or two people. It was relatively very small and humble. With better organization and better management, the office force has become relatively larger and larger and is today a big factor in costs. It is nonproductive. Now, then, all of our emphasis for the last ten years has been in connection with reducing the cost in the factory, and we have not given the proper consideration to the problem of the office.

2. We believe that almost all labor troubles arise from this feeling of privilege. We believe that one of the big-

gest objects an industry should set before itself is to abolish privilege wherever it exists and to the very utmost. The concern that succeeds in removing from its employees the feeling that privileges are granted to anyone is on a better basis than when conditions are otherwise.

3. As a matter of truthful fact the office force does not have to work nearly as hard as do the people in the factory. On the basis of real justice it is unfair that they should have shorter hours.

4. Obviously, what we propose will tend strongly to break down a fictitious class distinction. Office hours and factory hours once on the same basis, we will transfer people readily from the office to the factory and vice versa.

5. The same working hours naturally lead to social intercourse between factory and office employees.

6. It emphasizes very strongly that the company wants to deal with all of its employees justly and to deal with them as a whole.

7. It is certain to develop a greater feeling of democracy in the organization.

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Aeroplane-Propeller Problems

One of the most serious problems of aeroplane engineering today is that of the propeller. The laminated wood propellers used on the small machines with motors of 100 hp. or under gave practically no trouble. But with the increase in motive power up to 130 and 160 hp. and higher, propeller failures became much more frequent.

With aeroplanes of the pusher type, an accident to the propeller is almost sure to be serious as it is practically certain to cut the control wires even if it does not seriously damage the plane itself. With the propeller in front, as in the tractor type, this danger is almost eliminated, as the broken piece usually pulls itself ahead of the machine and falls clear of the planes.

There are different theories as to the causes for the failure of large propellers. One blames the jar due to the succession of blows from the explosion in the motor. These constant hammer blows are credited with causing fatigue if the wood fibers near the hub, resulting in the fractures at this point. This contention is based on the supposition of a constant succession of retardations and accelerations that stress the fibers at the fixed end of the lever arm.

The other theory, and one that seems to be more tenable, is that the stresses come from the leverage exerted by the tremendous power of the motor practically prying against the air at all times. The blades can be seen to deflect, as would be expected, and this stress continued finally strains the fiber near the hub and cracks develop. These can usually be discovered before breakage occurs, unless the flight is continued too long, although propellers on high-powered motors have failed after two hours of service.

As the flexing of the blade between the hub and the tip cannot be prevented, for there is a tremendous force exerted on a long leverage, the solution seems to lie in the

direction of stronger and better material. Steel, aside from its added weight, is said to become fatigued in a very short time and give way to the flexing action, and so far nothing has been found so satisfactory as wood.

Another factor, which is not always considered as carefully as it should be, is the perfect balancing of the propeller. Static balance is not enough, and yet the running balance involves a number of interesting questions, among them the problem of balancing with both blades flexed by the push against the air. This is aggravated by the two blades flexing a different amount, owing to the difference in stiffness between the two.

Whatever the solution, and the type of propeller is not here considered, the propeller is one of the many interesting problems before the aeronautical engineer at present, and he is not likely to run out of work for some time to come.

✱

Are You Keeping Step in the Shop?

Why is the tramp of marching men and the cleancut stepping of their ranks so inspiring? No such feeling is raised by a moving crowd of people, even though they may be massed together and proceeding in the same direction. But let a company of soldiers march along a busy street on some day—say Saturday afternoon—when the sidewalks are filled with people, and everyone will stop and watch the swinging stride of the men in uniform. That small group of soldiers arouses emotions that the crowd never can.

Perhaps one reason for this is the common purpose shared by each of the marching men. They are going to the same place, at the same time and in perfect order. They are obeying definite commands. Each is doing his full share toward a common result. Taken as a body, they present an example of perfect coöperation acting under military discipline. The expression of that purpose the crowd sees by the keeping in step.

Is it possible to arouse a similar enthusiasm in the shop? Is it possible to so get a shop organization working together with a close coöperation and striving for the same goal so that one may truly say "that shop is keeping in step"? Of course the shop cannot present the inspiring sight given by the marching men. But under the best conditions the spirit actuating the soldiers can also grip and carry forward the workmen.

✱

The Proposed Tax on Copper

The *American Machinist* reprints the following editorial for its sister technical publication, the *Engineering and Mining Journal*, and heartily supports the criticism of the class legislation that is under attack:

In commenting last week upon the proposed Federal tax on copper, we did not have the text of the measure before us and therefore had to be cautious. It was inconceivable to us at that time that copper alone among the metals should be taxed, yet mention of no other was made in the press dispatches. However, they prove to be correct. Out of the entire long list of crude commodities copper is singled for special taxation!

That Congress should have such a conception is dumfounding. Why copper and why not iron, lead, zinc and the rest? Why not coal and petroleum? Why not

wool, leather, wheat, corn and cotton? The one thing that badly stands out is the unfairness of this project. Here we have class legislation with a vengeance. Copper producers are right in standing aghast at the enormity of the idea.

But this is not the worst of it. The proposed act reads, "Every person smelting copper ore, refining metallic copper or alloying copper shall pay . . . an excise tax . . . (on) the gross receipts . . . from the sale or disposition of refined copper or copper alloys and from the sale or disposition of crude or unrefined copper if sold or disposed of for any purpose except for refining or alloying."

We interpret this as meaning that the miner does not have to pay anything unless he smelts and refines. The smelter does not have to pay anything unless he sells his pig copper for casting purposes. The refiner has to pay (of course he will throw back upon the smelter) and the brass maker has to pay again for the refined copper that he uses. If the profit be less than 10 per cent., nobody has to pay. This lets out the careless, little fellow. Of course it is only the small class of big fellows at whom Congress in its present spirit is aiming. The thing is bungling and monstrous.

Alas! Class legislation is the governing idea in the new revenue bill as a whole. The income tax is doubled in rate without there being any reduction in the exemption limit. This tax is thus kept distinctly as a class tax. It falls upon a very small percentage of the population of the country and chiefly upon the people of a few states. The proposed tax on copper is even more narrowly limited. There is talk among the producers of spreading it among consumers generally, but how is that going to be done when half of our copper production must be sold in foreign markets in competition with the copper of the rest of the world?

We find no fault with the principle that taxes must be raised. We advocate military preparedness and that is going to cost money, which must be supplied by the people, but let them do it on a basis of equality. We do find fault with plans for unequal taxation, for class taxation, that are made the cloak for all kinds of governmental extravagance. We grumble about a tax on copper to provide money to build marble post offices in Yahoo and shack-towns and to dredge creeks in the prairies. We object to the expenditure of public money to maintain and aggrandize the jobberies—the bureaus—in Washington that spend vast sums to prepare bulletins to print the mouthings of quasi statesmen.

Now that Congress has learned how easy it is not only to spend other people's money, but also to get it, how long is it going to be before the income tax is quintupled and a tax on copper is levied and quadrupled? And what is going to be the economic result if the earnings of profitable industry be sucked away to be wasted?

This copper tax may not be felt so keenly when copper is above 20c. as it will at the normal of about 15c. and under. Consider a producer whose cost is 12c. and whose output is 67,000,000 lb. at 15c. Gross output, \$10,050,000; net output, \$2,010,000; excise tax, \$191,500; rate, 9½ per cent. When the price for copper gets down to 14c., the determination of the 10 per cent. profit under the clause that grants exemption will begin to be interesting.

Shop Equipment News

Universal Machine for Small Shop

The different set-ups here shown are all variations in the setting or attachments of the same type of machine. This machine was designed and built by the J. L. Kunz Machinery Co., Milwaukee, Wis., for use in small shops

umn for different sizes of work. In this case a large, split wood pulley is used directly on the cutter spindle, though in other cases an iron pulley is used. Power feed is available from a train of gears attached to the spindle mechanism. The power feed is conveyed from the gears at the front by means of a belt to the drive at the rear. The use of this belt allows slippage in case anything catches, and

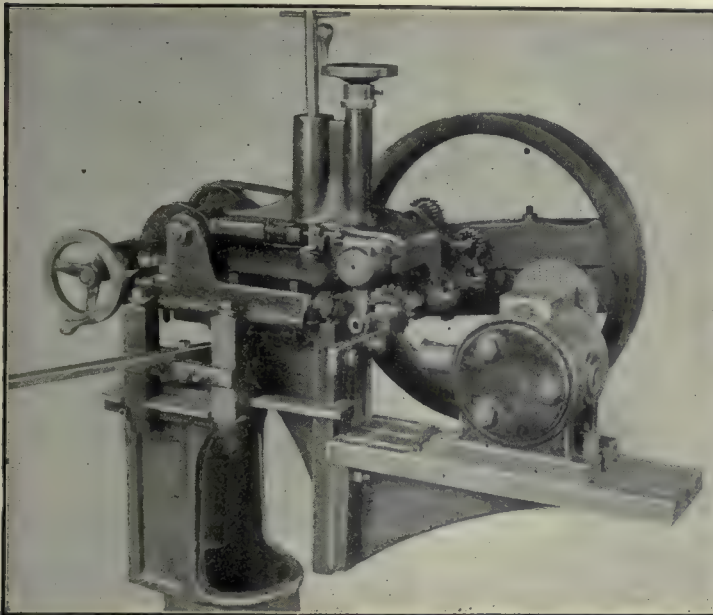


FIG. 1. UNIVERSAL MACHINE TOOL ADAPTED FOR SMALL SHOP APPLICATION

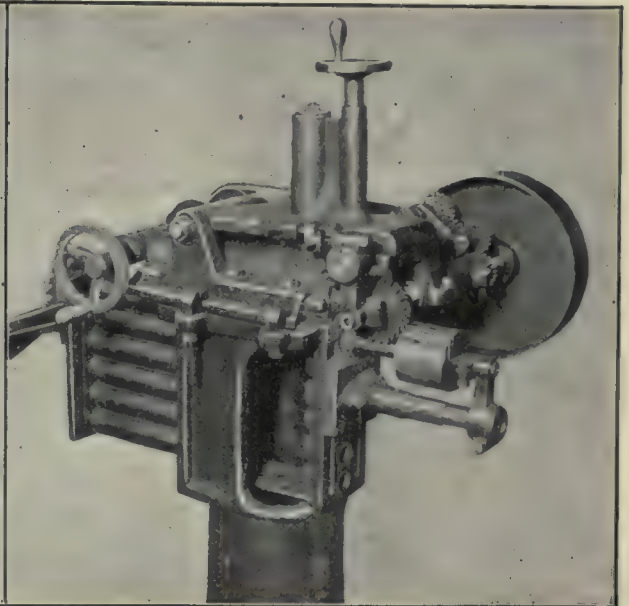


FIG. 2. MACHINE WITH GEAR-CUTTING ATTACHMENT

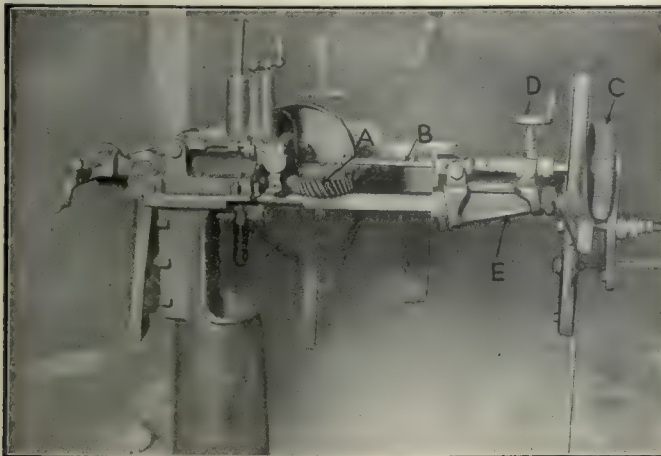


FIG. 3. THE KEYSEATING ATTACHMENT IN PLACE ON UNIVERSAL MACHINE

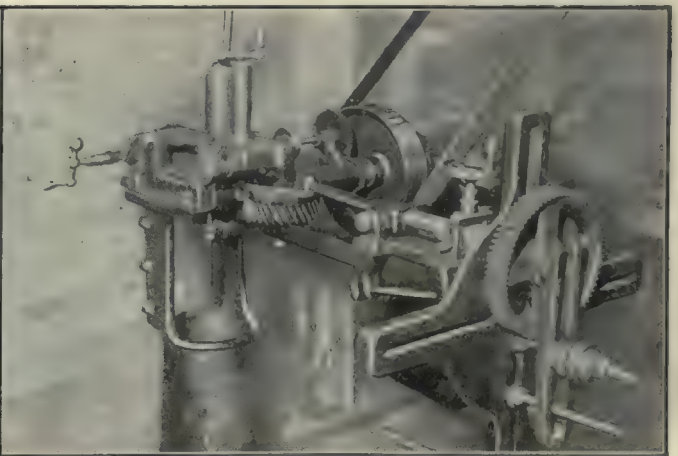


FIG. 4. ANOTHER VIEW OF KEYSEATING MECHANISM SET UP ON UNIVERSAL TOOL

where the amount of one kind of work is not sufficient to warrant the purchase of several single-purpose machines.

In Fig. 1 the machine is shown set up as a miller, with a dividing head on the table. It will be noted that the table is easily removable, for the use of special attachments, and it is also easily adjusted up or down the col-

prevents damaging the machine. Hand feed is available from the handwheel at the back. The vertical feed has a movement of 2 in., both power and hand. In the set-up shown, a hand lever is connected to the slide so as to convert the machine into a quick-movement hand miller. The entire top of the machine may be removed from the

stand and used for emergency work in almost any position. A feature worth noting is that the feed drive is always in line with the cut, making it possible to take a heavier and steadier cut with this machine than usual with a machine anywhere near its weight. The machine on its base is 4 ft. 8 in. high, and weighs about 650 lb., though this weight varies considerably according to the attachments used.

The machine set up as a gear cutter, or for other work of that kind, is shown in Fig. 2. The work shown on the arbor is a wood planer head, and the slots for the blades are being milled. The bracket holding the work arbor may be placed in six different positions, according to the holes in the holder that is placed under the upper part of the machine. These holes are so placed, that, with the vertical travel of the head, all center distances within the capacity of the machine are available. The arbor spindle extends entirely through one of these locating holes to the back of the machine, where a notched index plate is used to get the tooth spacing needed.

The attachment used for cutting keyseats is shown in Fig. 3. The keyseating mechanism is carried on a heavy bar clamped underneath the head of the machine and supported by a foot at the outer end. A V-groove runs the entire length under the head, and it is into this groove that the bar is clamped. This groove also makes it convenient for clamping the machine head onto a shaft for cutting special keyways, or special milling work may be clamped in it if needed. A worm is placed on the cutter spindle, and this drives a spiral gear *A*. This spiral gear is also an adjustable crank disk, to which is attached the connecting-rod *B*, fastened to the tool slide. The gear to be keyseated is clamped at *C* and the tool carrier works through the hole in the hub. The cutting tool is fed by means of the handwheel *D*. Relief on the return stroke is obtained by means of the slide *E*. Another view of this attachment is shown in Fig. 4, and will give a clearer idea of some of the details.

❧

Automatic Duplex Slotter

The duplex slotter shown is fully automatic, it only being necessary to put in the piece, and the machine will do the work without further attention, and stop cutting when it is finished. Working from both sides at once, the time is cut in two, or two separate pieces are handled at one time automatically.

The work table is moved back and forth at uniform speed by cam and adjustable lever, which can be conveniently and quickly set to any length of stroke within the capacity of the machine. Cone pulley and change gears provide changes of speed to suit different conditions, short slots being reciprocated quickly and longer slots more slowly. The cam has a large size groove and hardened roller, and is driven by worm gear, and both cam and driving gears are well protected.

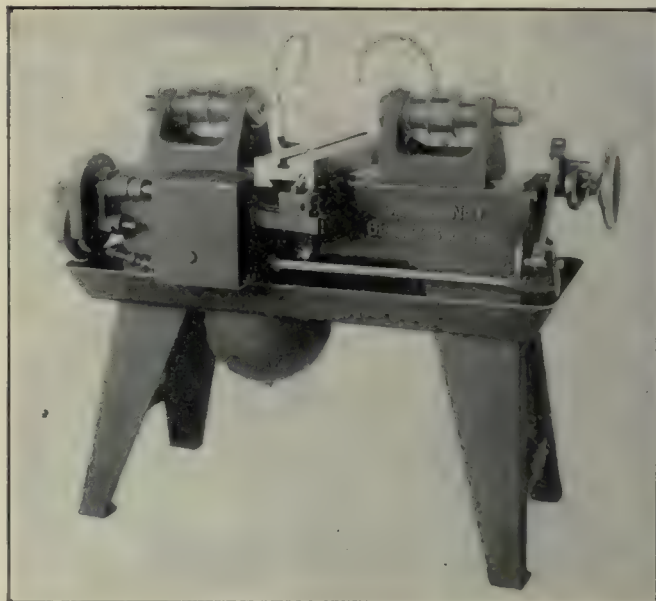
The spindle heads are designed for high speed, and the spindles are tapered at both ends and run in solid bronze boxes, provided with adjustment for wear and taking thrust on hardened step. Taper gibs are provided for the headstocks and work slide. The heads are fed in to cut automatically and simultaneously by right- and left-hand quick pitch screw, controlled by a ratchet wheel.

In milling a through slot, automatic provision is made to back away one head when the slot is almost through,

so that the other head can continue to advance and complete the slot, leaving no partition in the bottom, and requiring no special attention.

The feed by pawl and ratchet is adjustable, and can be set to automatically lift out and stop feeding when the required depth of cut is reached. Feeding takes place at each end of the stroke.

Each head is independently adjustable along the bed to suit different lengths and conditions of cutters, position



AUTOMATIC DUPLEX SLOTTER

Capacity, milled slots from $\frac{1}{4}$ to 4 in. long; $\frac{1}{4}$ to $1\frac{1}{2}$ in. wide clear through work up to 4 in. in diameter or 2 in. on a side

of the work on the table, etc. The headstocks are moved in and out simultaneously by handwheel and to any distance without interfering with the setting of the machine.

Work can be set at any angle on the table to produce a taper end of slot. Two prong fish-tail cutters are used. Adjustable fixtures to hold round work can be provided.

Changes of speed for different sizes of cutters are provided by a friction cone pulley on the countershaft. The spindle pulleys are driven by drums on the countershaft.

The machine is a recent product of the Garvin Machine Co., New York City.

❧

Copper-Band Turning Machine

In the illustration is shown the latest addition to the line of shell copper-band turning machines made by the Jenckes Machine Co., Ltd., Sherbrooke, Canada.

This machine has been proportioned to make it adapted for turning and finishing the bands on 12-in. shells.

The main spindle bearings are cast integral with the bed. The spindle is a heavy casting, finished by turning on the outside and boring the inside and finally finished on dead centers by grinding. The shell is held in this spindle by a collet-type chuck. This chuck is controlled by an air cylinder at the rear of the spindle and the jaws are positively closed or opened by means of a four-way valve.

The drive of this machine is through a heavy backshaft and cut gearing. An air clutch pulley is provided on this

shaft. This clutch is of the taper type with cork inserts, and is controlled by means of an air cylinder and three-way valve located near the operator's stand. Springs under compression release the clutch when the air is turned off. The tool arrangement for this work is massive. The main slide casting is bolted to the base by means of six studs and is not adjustable.

The rough shaping of the band is accomplished by means of two formed tools of high-speed steel. Each of the tools is held in dove-tailed fits in the steel tool block by two taper head bolts. Both tools are further supported

end. The feed of this tool is through rack and pinion on the block and thence through worm and gear to the handwheel at the front of the machine at the operator's right hand.

The shell is located in the chuck by means of a swing stop attached to the cap above the spindle. This stop swings down and is locked in position by means of a toggle lever, and the shell pulled back until the band bears against the stop, after which the operator turns on the air to close chuck, swings the stop up out of the way, turns the air on the clutch pulley which starts the machine, and proceeds to feed in the roughing tools.

Cold-Metal Sawing Machine

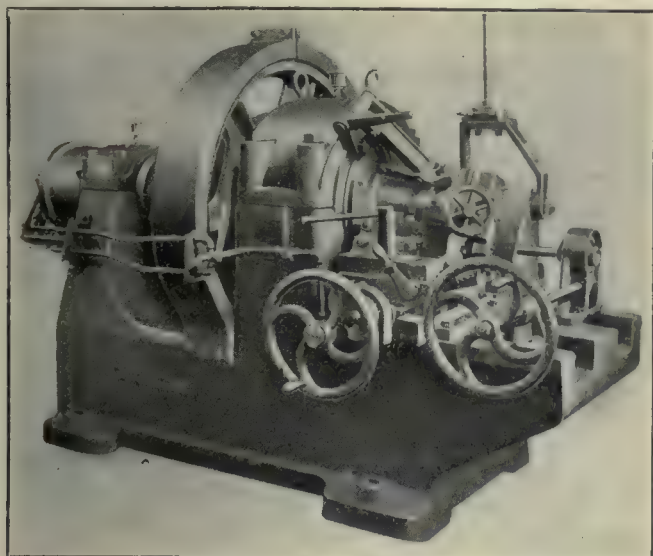
The illustration shows a cold-metal sawing machine marketed by the Vulcan Engineering Sales Co., Chicago, Ill. The saw arbor is of 60-point carbon hammered open-hearth steel, and has two driving gears formed integral with it. These gears are the same diameter and are situated close together. Their teeth are staggered by the amount of half their pitch. These gears are driven by pinions similarly formed on an intermediate shaft. The object of staggering the teeth of the gears and pinions is to reduce chatter. The saw arbor runs in hard bronze bearings.

The intermediate shaft is driven by worm and worm-wheel. The worm is of hardened steel and its thrust is taken by roller bearings. The wormwheel is of two-piece construction. The center is of steel while the rim is of bronze. Both the worm and wormwheel are incased and run in grease.

The carriage has a full-length bearing on the shears and is provided with taper gibs to take up wear, and has hand-adjustment automatic stop and quick-power return.

The feed is by a combination of a friction disk and gear train. The mechanism provides a range of feeds from $\frac{5}{16}$ to $2\frac{1}{2}$ in. per min.

Two instantly available peripheral speeds of the saw are provided for. These are 30 and 50 ft. or 40 and 60

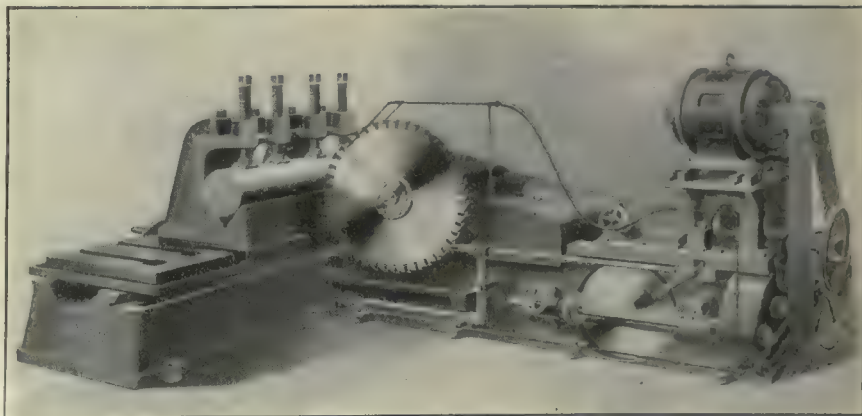


SHELL COPPER-BAND TURNING MACHINE

Capacity, 12-in. shells; front spindle bearing, 16 in. in diameter, 14 in. long; ratio of back gearing, $4\frac{1}{2}$ to 1; drive pulley, $20\frac{1}{2}$ in. in diameter, 13 in. face

by means of an adjustable jack so that the clamping effect of either tool helps to hold the other, and permits removing and replacing the tools with precision, after grinding. Each tool cuts approximately one-half of the band width. The tool block has a quick and convenient shift sidewise by means of a rack and pinion and is located accurately by a single stop rod and lock nuts. An accurate method of determining the depth of the cut is provided by means of a graduated dial and two adjustable pins, which can be screwed in or out, and which show flush with the face of the feedscrew housing when that tool has approached the depth of the cut. The exact depth is determined, however, by means of a pointer and the adjustable dial which makes it possible for the operator to hold the cut within close limits. The undercutting operation is by means of a separate tool and block mounted on the main or roughing tool block. This is in line with the undercut when the tool nearest the base of the shell has finished its cut, and has been slightly withdrawn.

The band is finally finished by means of a shaving tool which is arranged to feed down an incline block at the rear of the shell. This block is slightly adjustable to or from the shell, and means are also provided to rotate this block slightly to vary the diameters of the band at either



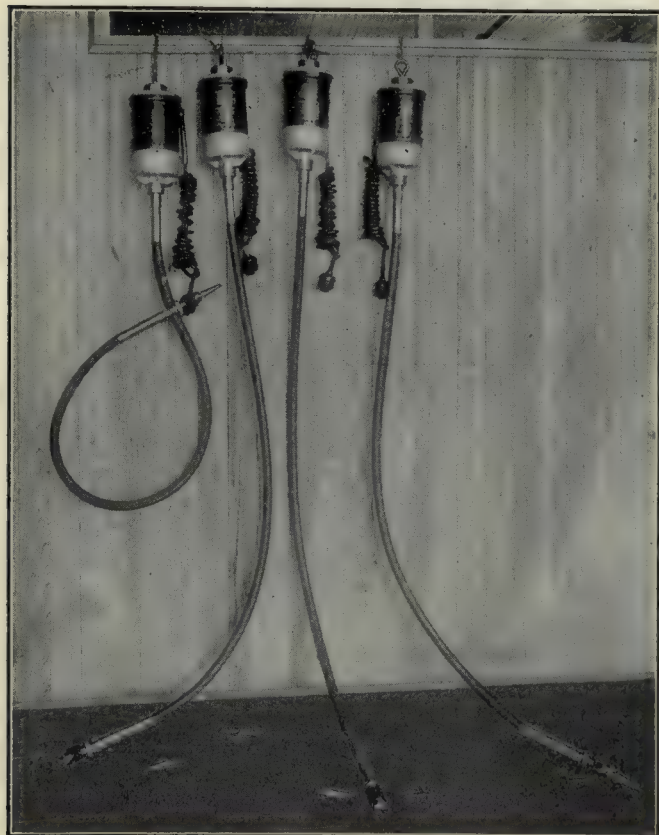
COLD-METAL SAWING MACHINE

ft. per min. respectively, according to the special requirements of the user.

The lever controls for the feed, peripheral speed and the return of the saw are placed conveniently for the operator. All gears run in oil and internal bearings are piped from the exterior of the machine. An oil trough extends around the work table. A geared pump supplies the cutting lubricant.

Flexible-Shaft Electric Portable Tools

The illustration shows some of the latest product of the Standard Electric Tool Co., Cincinnati, Ohio. The motors used are $\frac{1}{2}$ hp., 220 volt, 50 cycle, 3 phase, and run at 950 r.p.m. The speed reduction is obtained through a gearbox on the lower end of the motor case,

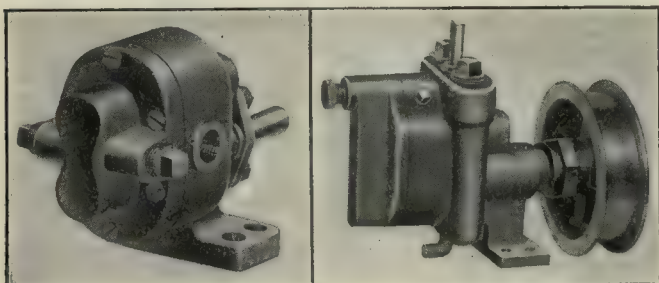


FLEXIBLE-SHAFT ELECTRIC TOOLS

carrying gears of the ratio of 4 to 1, which gives a machine great power. The flexible shafts on these particular machines are 6 ft. in length, but can be furnished any desired length. As the machines are used for both drilling and polishing, small arbors are furnished, shown in the two outside machines, which may be placed in the chucks to hold small polishing wheels. The machines weigh about 30 lb. each.

Oil-Circulating Pumps

The form of lubricant pump shown is the latest product of C. F. Roper & Co., Hopedale, Mass., and is designed to be an improved type to that shown on page 611, Vol. 44.



ONE-WAY AND REVERSING OIL-CIRCULATING PUMPS
Three sizes of each, capacities 8, 16 and 46 qt. per min.
at 500 r.p.m.

This pump was designed to meet particularly the requirements of machine-tool application where the delivery of the lubricant is varied to suit the work. Separate relief valves and the piping required for them are eliminated and a plain suction and discharge pipe is all the piping required. There are no valves to adjust to vary the delivery. The cock on the delivery pipe is simply closed until the amount delivered is satisfactory. The pump automatically takes care of the surplus and keeps the delivery at a constant pressure.

The pump is made in both the styles shown—one-way and reversing.

✽

William A. Warman

William A. Warman, in charge of the design of special machinery and research work for the Keller Mechanical Engraving Co., Brooklyn, N. Y., for the past twelve years, died at Saranac, N. Y., on July 2, 1916, after a lingering illness.

Constitutionally, Mr. Warman was of a type that belittled his own efforts and never assumed an aggressive attitude in regard to his own accomplishments; for which reason, although well known in mechanical circles, particularly the machine-building field, he had not become so conspicuous a figure as his mechanical ability and accomplishments should have made him.

Mr. Warman was born in Latrobe, Ohio, in 1861. It was thought that from his grandfather, who operated a foundry and machine shop in Latrobe, he had inherited his mechanical inclination, for early in life a natural bent toward mechanics took form. His first work as a young man was in the domain of invention and for several years he spent most of his time and effort in the development of a variety of mechanical inventions which eventually reached the world as commercially practical devices. The inventive faculty remained as one of his chief characteristics throughout his mechanical career, for in later pursuits, although associated with manufacturing propositions, he seemed to naturally turn toward those sides of his problem that possessed opportunity for original work. He had an utter disregard for precedent and was consequently an almost perpetual experimenter.

Probably Mr. Warman's strongest characteristic in the shop was mechanical resourcefulness. He had a peculiar faculty for overcoming mechanical difficulties and usually his methods were of a simple nature. Possessed of a searching mechanical mind, his realization of the difficulties involved in machine design and construction was a ready one and his practicability promptly suggested remedies that seldom failed to completely meet the case.

Before he became interested in the mechanical engraving development, he had been superintendent and designer for the Ritter Dental Manufacturing Co., Rochester, N. Y. Later on he became connected with the Dick Press Guard Manufacturing Co., which was reorganized at the time of his acquisition to manufacture press guards of Mr. Warman's design. This connection goes back some twenty years, and if Mr. Warman was not the first to conceive of a practical press guard, he was generally credited as one of the pioneers in modern press-guard construction. Although not generally known, it is believed that Mr. Warman was the inventor of the hollow setscrew, in the manufacturing methods of which he was especially resourceful.

It is not surprising to find in the ingenious type of mechanic that Mr. Warman represented, the extensive use of the slide rule in the solution of all classes of mechanical problems, and Mr. Warman was no exception in this direction. In fact, the slide rule with him was a hobby, and he designed many original forms to meet special requirements.

Through his experience as a designer of special machinery, he soon came to have a high appreciation of toolroom and other precision work. He was one of the first to realize the full possibilities of the microscope in toolroom processes and designed an especially practical mounting for toolroom application.

His mechanical engraving work antedated by a number of years his connection with the Keller Mechanical Engraving Co. For the manufacture of an engraving machine of his own design, he organized the Warman Co., which was subsequently absorbed by the Keller company in 1905.

In recent years Mr. Warman had given considerable study to gas-turbine and air-compressor work. In these fields, however, he had not fully completed his inventions and experiments.

NEW PUBLICATIONS

INVENTORS AND MONEY-MAKERS—By F. W. Taussig. One hundred and thirty-five $4\frac{1}{2} \times 7\frac{1}{4}$ -in. pages; indexed; cloth bound. The Macmillan Co., New York City. Price, \$1.

This is a readable, thought-stirring book, concerning which each one must form his own opinion. It contains the substance of lectures delivered by the author at Brown University, in connection with the celebration of the one hundred and fiftieth anniversary of the university's foundation. A part of the final paragraph sums up the author's conclusion. It is: "As regards the topics taken up in these lectures, we must be content to face and accept the complexity of human motivation, the interplay of conflicting instincts, a tantalizing uncertainty concerning the possibilities of modifying their relative strength. And yet we may cherish none the less a hope that in the future they may be made to work for human happiness more effectively than has been the case in the past."

Of the four chapters the first two deal with The Instinct of Contrivance; the third takes up The Psychology of Money-Making, and the last is entitled Altruism; the Instinct of Devotion. The author ably argues, with a wealth of supporting facts, that the propensity to contrive is a natural inherited instinct. He points out that this instinct is widespread in the animal world, the beaver and the bee being notable illustrations. He then leads us to this conclusion: "And among the inherited instincts, in men as in animals, we have to deal with that of contrivance and construction."

From this starting point it is easy to pass to a consideration of the controlling propensities in the inventor, and after questioning the need of a patent system to compel men to discover and contrive, he invites us to consider this opinion: "Men would invent anyhow; they obey the instinct and therein take joy."

Space forbids the reviewer to make more quotations in support of the compelling instinct to contrivance that the author discerns as a moving force in the lives of many great inventors from whose achievement he draws illustrations.

Some 70 pages of the book are devoted to this discussion, leading to the concluding paragraph of the second chapter—Comments on Wage Systems and Scientific Management. After expressing his belief that the familiar schemes for remodeling the wage system promise little relief from our difficulties, he speaks favorably of scientific management, saying: "On the other hand, there seem to be considerable possibilities in what is called scientific management. But the management must be not only scientific, but human."

The last two chapters discuss money-making and altruism as instincts or motives that complicate the following out of the instinct of contrivance and production. Concerning altruism, the author asks this question: "We come thus to the last named among the instinctive tendencies, that of devotion, or—since we have in mind the community as a whole—public spirit. How far is it also to be enlisted in the struggle?"

ELEMENTARY MECHANICAL DRAWING—By Charles William Weick. Two hundred and fifty 6×8 -in. pages; 154 illustrations; indexed; cloth bound. McGraw-Hill Book Co., New York City. Price, \$1.75.

Reviewed by A. L. Ormay*

The book is of an elementary nature, designed as a textbook for classroom use in vocational and trade schools. In entering an already overcrowded field it is assumed that the author has found, as the result of his experience in teaching the subject, certain features lacking in previous works when the main thought is for student requirements.

Although the book is calculated to cover the art of mechanical drawing from both the theoretical and practical sides, there are numerous indications that the practical considerations have suffered through a concentrated effort to keep the book within the scope of elementary students. For instance, the first two chapters, covering Instruments and Materials and The Use of Instruments, describe in minute detail, through 35 pages, the various operations in mechanical drawing, whereas Chapter V, on Drawing-Room Practice and Conventions, is rather incomplete and is poorly illustrated through overshadowed surface-shaded examples.

Similarly the chapter on Projections appears incomplete. To this subject, the most important from the practical point of view, only 17 pages are devoted, and here again the examples given to elucidate the principles of the various projections suffer in clearness through overshadowing. In itself this chapter appears decidedly insufficient, but it is possible that the author had in mind compensation for this brevity in the following chapter on Mechanical-Drawing Practice, in which some 70 pages are devoted to examples of projections of lines, planes and solids, with a few working-drawing subjects. On the latter point a conspicuous omission is an example covering the development of intersecting surfaces—an absolutely essential consideration in working drawings.

On the whole, however, the chapter on practice is one from which the student will derive much value. It is divided into the following five sections: Instrument Exercises, Projections of Straight Lines, Projections of Plane Figures, Projections of Solids, Working Drawings. Practical considerations should suggest a change in the order of the sections, so that the first one on Instrument Exercises would become the last, following that on Working Drawings.

Other chapters of the book, dealing with the Method of Procedure in Drawing, Lettering, Geometrical Problems, Mensuration and the Reproduction of Drawings, are comprehensive. In the chapter devoted to geometrical problems the treatment is justifiably elaborated, and likewise the importance of the chapter on mensuration is emphasized on the basis that in the development of working drawings draftsmen are continually required to calculate areas, circumferences, etc.

Although the reviewer considers the deficiencies pointed out herewith of importance, a broad viewpoint suggests that the book as a whole will fill a valuable place. For the most part the fundamentals are well covered, and the multitude of examples show careful consideration in the selection.

In reverting to the chapter on Mechanical-Drawing Practice—a chapter splendidly conceived and carried out for the student purposes intended—the method of dividing the problems into two sections, one dealing with wood construction and the other with metal work, is to be commended.

STEEL AND ITS HEAT-TREATMENT—By Denison K. Bullens. Four hundred and thirty-one $5\frac{1}{2} \times 9$ -in. pages; 223 illustrations; indexed; cloth bound. John Wiley & Sons, Inc., New York City. Price, \$3.75.

Reviewed by H. Diederichs†

This book is another addition to the rapidly growing literature on the heat-treatment of steel. It shows throughout the earmarks of having been written by an authority trained in both theory and practice, and will therefore, in the reviewer's opinion take a high place in this special field.

The book is divided into 18 chapters, of which the first, on the Testing of Steel, gives little more than definitions of terms. The second chapter, on the Structure of Steel, logically precedes the discussions on Annealing, Hardening, Tempering and Toughening in the three chapters following and gives in approximately 20 pages a generally satisfactory treatment on the inter-relation of the various constituents and the effects of temperature changes. Based upon this theoretical discussion, the chapters on Annealing, Hardening, Tempering and Toughening show concisely the why and wherefore of the various heat-treatments under these heads. The chapters on Hardening and Tempering also discuss briefly the methods and media used in quenching and the precautions required to prevent warping and cracking.

*Chief Draftsman, Hill Publishing Co.

†Professor, experimental engineering, Sibley College, Cornell University.

Chapters 6 and 7 treat fully of Case Carbonizing and Case Hardening. It is quite common in practice to designate these two operations collectively as case hardening. This is probably a relic of the older days when the need for a careful and separate heat-treatment after the carbon addition to form the case was not so clearly realized. The two steps of the process are quite distinct, and the practice of using the two terms can only be commended.

Having covered the various heat-treatments and their results upon the physical properties of the steels, the author now proceeds to discuss means of generating and applying the required degree of heat. Chapter 8 deals with Heat Generation. This is only a general discussion of comparative fuel costs, etc., and strikes the reviewer as being the least satisfactory chapter in the book. The following chapter, on Heat Application, is much better, showing a great variety of furnace constructions in the shape of conventional sketches and giving the good and bad points of each.

Chapters 10 to 15 treat in turn of the physical properties of straight carbon, nickel, chrome, chrome-nickel, vanadium, chrome-vanadium, manganese, silicon and other alloy steels as affected by composition and heat-treatment. Taken together, these chapters form a valuable and complete collection of a large mass of information on these now so important topics. The chapter on nickel steels covers approximately 40 pages, that on the chrome and the chrome-nickel steels about the same space. This does not mean that the author has followed the general craze which assumes that the alloy steels are a general cure-all. On the contrary, he does not slight the straight C steels; neither does he hold up one type of alloy steel as being the thing. He is particularly careful to take no decided stand in the case of nickel-chrome vs. chrome-vanadium steels and points out the limitations of the various alloy steels. The stand taken can only be commended.

The reviewer feels that the alloy-steel business has been overdone and that in many cases a good straight C steel of proper composition and with proper heat-treatment would fill the bill as well if not better. It is of course true that some failures of alloy steel in practice cannot be laid to wrong composition. But it is a fact that the proper handling of such steels in casting, forging and heat-treatment is a more delicate operation than with straight C steels. When it is considered that the conditions in many forge shops are anything but scientific (see pages 405 to 407 of the book under review), both in regard to temperature control and manner of forging, it is perhaps not surprising that failures should occur. The conclusion to be drawn from this, however, should be to go a little slow in the general specification of high-priced alloy steels for every conceivable purpose.

Chapter 16 treats specifically of tool steels and their heat-treatment. It gives a complete table of tempers for various purposes, discusses the relation between temper colors and hardness and ends up by giving specific directions for treating chisels, dies, drills, milling cutters, reamers, etc., etc.

Chapter 17, on Miscellaneous Treatment, is virtually a continuation of Chapter 16, discussing the proper treatment for gears, springs, oil-well bits, safe and vault steel, steel castings and steel wire. The chapter closes with a few remarks on present forging practice which are to the point.

The book ends with a chapter on Pyrometers and Critical Range Determinations. The extreme importance of the pyrometer is set forth, and the various types are described. Then follows a discussion on calibration and standardization of pyrometer equipment and the methods of finding the decalcescent and recalcescent points.

The figures throughout the book are generally good, and this is particularly true of the microphotographs. The entire book, with the possible exception of the chapter on Heat Generation, gives the impression of being a careful work. There may be several statements, particularly in connection with the theory of steel structure, to which exception might be made. But these things are of minor importance in view of the general excellence and are no doubt due to the fact that there are several schools of metallographists not in entire accord on the theory as a whole.

Increasing Base Diameters of Shells--Correction

In the article published on page 36, under the above title, it was erroneously mentioned that a pneumatic hammer was mounted in a special carriage of the lathe, whereas it was an electric hammer.

In the instance covered the electric hammer shown was the product of the Electro-Magnetic Tool Co., Chicago, Ill., to whom we are indebted for calling attention to the error.

BUSINESS ITEMS

Wagner Electric Manufacturing Co., St. Louis, Mo., announces the removal of its Detroit office to 1291 Woodward Ave., to continue in charge of Dean Emerson.

Crescent Co., 125 State St., Meriden, Conn., has equipped a plant at the above address and is making and marketing a line of hacksaw blades and frames. L. E. Jennings is general manager.

H. P. Mueller, brass founder, St. Louis, Mo., has enlarged his foundry to make provision for the manufacture of McAdamite metal castings for submarine-boat covers, pump pistons and aeroplane parts.

PERSONALS

L. W. Adams, for some time superintendent of the rolling mills of the Lehigh plant of the Bethlehem Steel Co., has been made superintendent of the Soukvis plant, succeeding R. F. Randolph, resigned.

J. A. Eden, Jr., for several years associated with the Baush Machine Tool Co., Springfield, Mass., has resigned. Mr. Eden was previously associated with United Engineering and Foundry and the E. W. Bliss companies.

James H. Zeller, until recently production engineer with the American Bronze Co., Berwyn, Penn., has become associated with the Penn Barrel Co., Philadelphia, Penn., where he will act as assistant superintendent.

E. A. Moore, formerly superintendent of the Fairbanks-Morse Mfg. Co., Beloit, Wis., and previously with the Bullard Machine Tool Co., has become works manager of the Union Switch and Signal Co., Swissvale, Penn.

Henry M. Sonnenthal and **Frederick M. Sonnenthal**, directors of the Selson Engineering Co., Ltd., London, England, with an American branch at 78 Broad St., New York City, in charge of Henry M. Sonnenthal, have changed their surnames to Selson.

H. E. Streeter, until recently works manager of the Precision Tool and Machine Co., Montreal, Canada, and previously Canadian representative of the Heald Machine Co., has joined the sales organization of the Gronkvist Drill Chuck Co., Jersey City, soon to be known as the Swedish Gage Co.

FORTHCOMING MEETINGS

American Foundrymen's Association and American Institute of Metals. Annual meeting, September 11-16. Cleveland, Ohio. A. O. Backert, secretary, American Foundrymen's Association, Cleveland, Ohio.

American Society of Mechanical Engineers. Monthly meeting first Tuesday. Calvin W. Rice, secretary, 29 West 39th St., New York City.

Boston Branch National Metal Trades Association. Monthly meeting on first Wednesday of each month, Young's Hotel. W. W. Poole, secretary, 40 Central St., Boston, Mass.

Providence Association of Mechanical Engineers. Monthly meeting fourth Wednesday each month. J. A. Brooks, secretary, Brown University, Providence, R. I.

New England Foundrymen's Association. Regular meeting second Wednesday of each month. Exchange Club, Boston, Mass. Fred F. Stockwell, 205 Broadway, Cambridgeport, Mass.

Engineers' Society of Western Pennsylvania. Monthly meeting third Tuesday; section meeting, first Tuesday. Elmer K. Hiles, secretary, Oliver Building, Pittsburgh, Penn.

Rochester Society of Technical Draftsmen. Monthly meeting, last Thursday. O. L. Angevine, Jr., secretary, 857 Genesee St., Rochester, N. Y.

Superintendents' and Foremen's Club of Cleveland. Monthly meeting third Saturday. Philip Frankel, secretary, 310 New England Building, Cleveland, Ohio.

Western Society of Engineers, Chicago, Ill. Regular meeting first Wednesday evening of each month, excepting July and August. J. H. Warder, secretary, 1785 Monadnock Block, Chicago, Ill.

Philadelphia Foundrymen's Association. Meetings first Wednesday of each month. Manufacturers' Club, Philadelphia, Penn. Howard Evans, secretary, Pier 45 North, Philadelphia, Penn.

Technical League of America. Regular meeting second Friday of each month. Oscar S. Teale, secretary, 35 Broadway, New York, N. Y.

Jigs and Fixtures Used in Automobile Work

BY FRED H. COLVIN

SYNOPSIS—While the first cost of jigs and fixtures is not particularly important if it can be distributed over a large enough output, the smaller shops must study this first cost carefully. The jigs and fixtures shown here combine in a marked degree economy of product with low first cost and suggest that adaptations of them can be of value in many places.

There are many interesting jigs and fixtures in the shop of the Moline Automobile Co., East Moline, Ill., some of which are illustrated herewith.

The first fixture, Fig. 1, is for milling the seats for the connecting bolt head and nut and is used in con-

The mandrel *A* has a fairly deep groove *B* turned near one end, to receive the open or *C* washer after the connecting-rods have been slipped into place. With the mandrel in the position shown, the rods are slipped over the left-hand end one at a time; and when the three are in place, the mandrel is pushed to the left so that the open washer may be inserted between the last connecting-rod and the left-hand mandrel support. The flattened mandrel, or locating bar, *D* is turned on the edges to fit the bore of the small end of the connecting-rods, holding them in line and locating them in the fork of the uprights *E* at the front of the fixture, as can be seen in the loaded fixture under the milling cutter.

When the rods are properly located, the nut *F* is tightened, drawing the three rods against the right-hand mandrel support by means of the open collar *G* and holding them firmly during the milling operation. While the rods in one fixture are being milled, the other fixture is loaded, so that this makes practically continuous milling and has proved very satisfactory after continued use. Another milling fixture is shown in Fig. 2. It is for the sides of the bearings of the sleeve connecting-rods. This fixture carries three rods at one setting, the sides being milled by the gang of four cutters *H*. *A* and *B* show the short and long connecting-rods, both of which are of bronze cast solid. One is shown in

position at *C*, being centered by the stationary V-block *D* and the movable V-block *E*. The screw *F* adjusts this toward *D*, centers the rod and holds it firmly in position

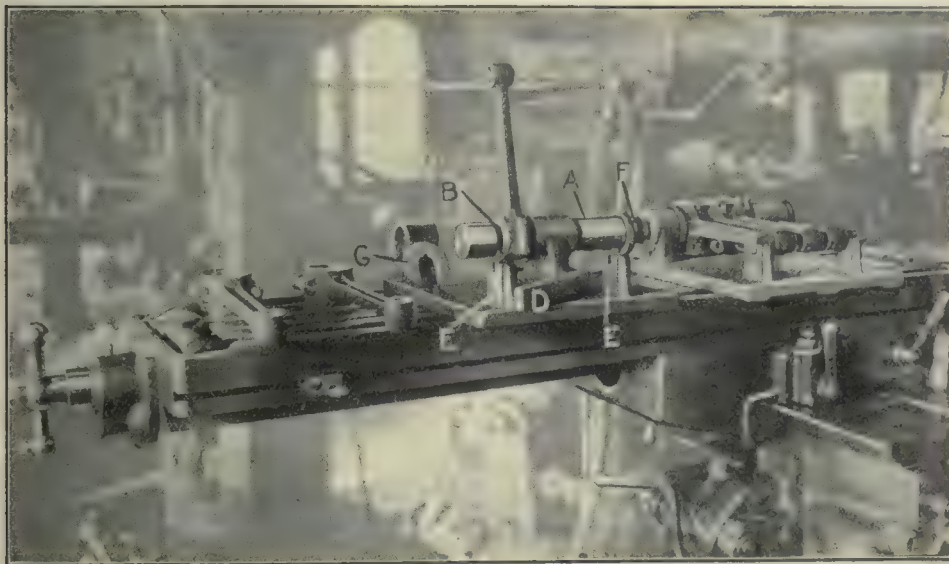


FIG. 1. MILLING CONNECTING-RODS

nection with a heavy knee-type miller. There are two fixtures, each holding three connecting-rods, positioned on the table by means of a key that fits one of the table

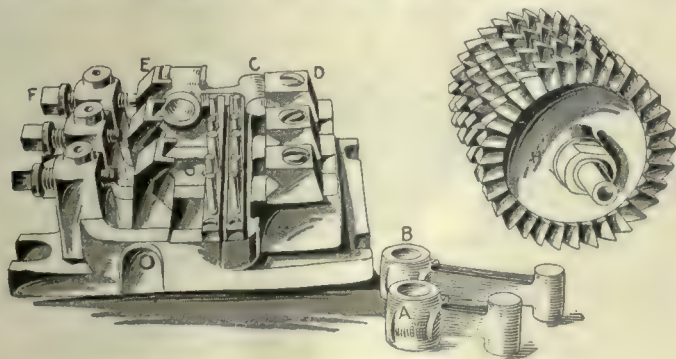


FIG. 2. MILLING CRANK BOSSES

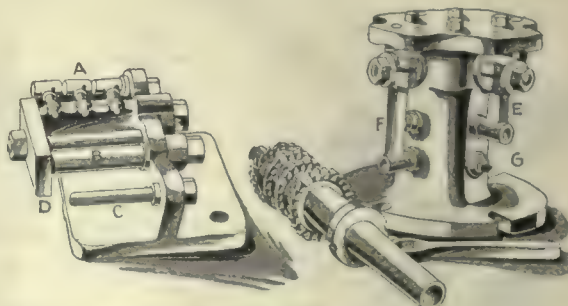


FIG. 3. MILLING AND DRILLING VALVE RODS

slots. This key is directly beneath the mandrel that supports the large end of the connecting-rods while they are being milled. The plates carry substantial bearings for the mandrel *A*. The operation is simple and rapid.

while being milled. The pins *G* locate the rod sidewise. A similar fixture is used for both rods.

Fig. 3 shows two later operations on the connecting-rods, after the bearing ends have been milled. The

milling fixture is for facing the seats for the bolt heads and nuts, in a manner similar to that of the first fixture shown. The difference is that the rods, as shown at *A*, are slipped over the mandrels *B* and *C* and held in position by the clamp *D*, while the gang of milling cutters

crankshaft so as to revolve with it and support it against strain. In order to locate these chucks exactly opposite each other, for it must be remembered that the holes in the chuck are eccentric with the lathe spindle and with the crankpin that is to be turned, the rod *D* comes into

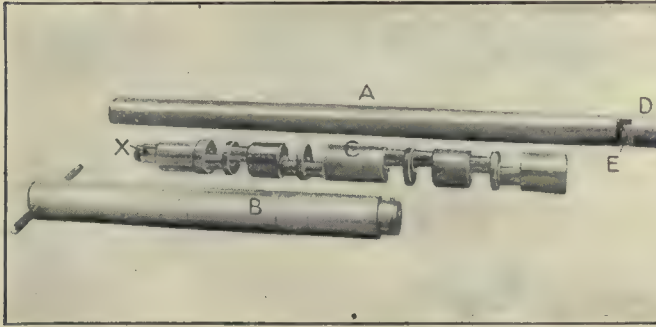


FIG. 4. VALVE CRANKSHAFT AND SLEEVES FOR HANDLING

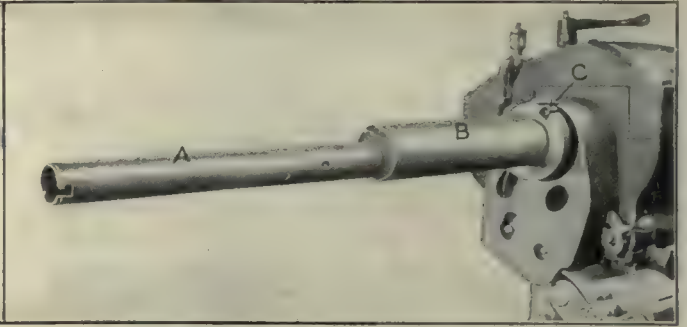


FIG. 5. INDEXING EXTENSION FOR CRANKSHAFTS

straddle-mill two sets of connecting-rods at the same time.

The rods are then drilled for the bolts, in the fixture shown at the right, this same fixture accommodating either the long or short rods, as may be desired. A short rod is shown at *E* and a long rod at *F*, the small end of the rod fitting over a stud *G*, so as to hold the connecting-rod straight for drilling. By having two sets of these stop pins *G* either rod can be held on the fixture in any one of its four positions. The valve crankshaft

play. This is normally held out of sight in the chuck *C*, as can be seen in Fig. 7, where the end has been left sticking out in order to indicate its position.

After it is certain that the two chucks line up, as they

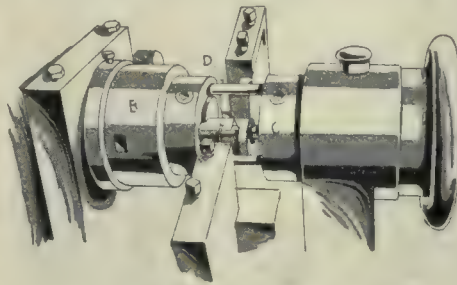


FIG. 6. SETTING CHUCKS IN LINE

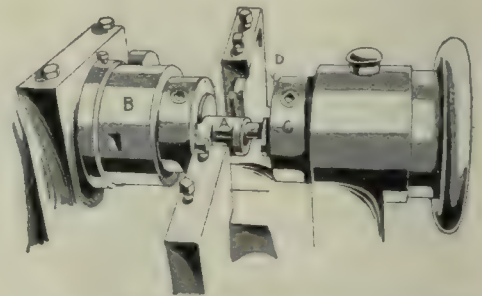


FIG. 7. TURNING VALVE CRANKSHAFT

that corresponds to the camshaft of a poppet valve motor is illustrated at *C*, Fig. 4. The method of machining is interesting and involves several ingenious contrivances in connection with a Lodge & Shipley lathe, which is kept exclusively for this work. The positions of the crankpins are all determined by the keyway *X*, which is used for locating the shaft in the end of the indexing bar *A*. The end of the crankshaft is slipped into the bar *A* at *D*, Fig. 4, so that the keyway meshes a locating key. Then the nut *E* screws on the end of the shaft and draws it tightly into place, so that it practically becomes part of the indexing bar itself. The unturned crankshaft and the indexing bar are then pushed through the extension of the lathe spindle shown at *B*, Fig. 5. The wrench *B*, Fig. 4, locks into the end of the indexing bar by means of a bayonet joint, making it easy either to turn the bar or to move it in or out for successive crankpin turnings.

The indexing is done by the pin *C*, Fig. 5, fitting into the holes of the index bar and so locating the position of the different crankpins both as to relative angles and lengthwise position.

In order to support the crankshaft while turning, special chucks are used on both the headstock and the tailstock, as can be seen in Fig. 6. Here the crankpin *A*, which has already been turned, is concentric with the lathe spindle. The tailstock spindle carries a chuck *C* similar to the main chuck *B*, both being clamped to the

do when this bar enters both holes freely, the rod is slipped back out of the way, and the crankpin is ready to be turned. The turning is done in the usual manner by tools both back and front, and the work is performed quickly and accurately, ready for the finish by grinding.

A line reaming fixture for the crank-case bearing is illustrated in Fig. 8. The crank case is bolted face down on this fixture, and the bearing caps are tightened

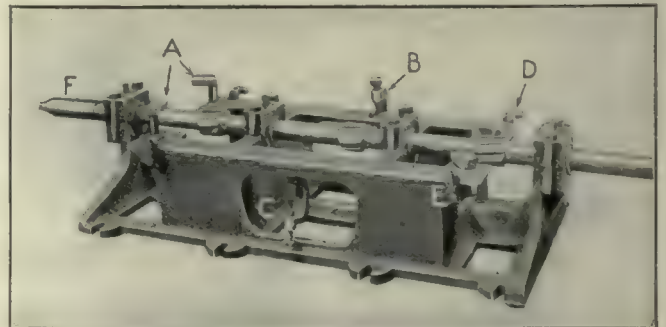


FIG. 8. FIXTURE FOR LINE-REAMING BASES

in position. The case is held firmly on the finished surface by the clamps *A*, *B*, *C*, *D* and *E*, which are especially designed to suit this particular crank case, but can of course be easily modified for any other conditions. The somewhat unusual feature of this line-reaming fixture is the use of hardened-steel bushings in the

fixture for guiding the reamers, so as to insure accurate holes in the crank-case bearing. The line reamer is driven by any form of power that may be available, by means of the taper shank and tang at *F*.

The timing gear has 24 holes, to allow it to be adjusted in either direction to secure just the timing which may be thought necessary by any individual motor

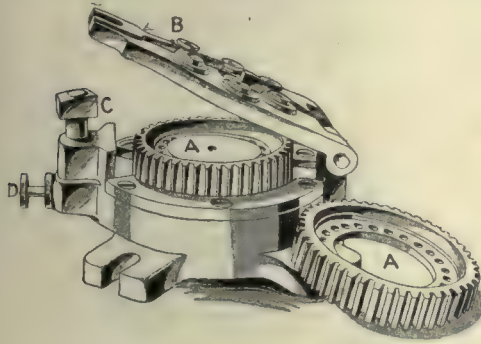


FIG. 9. HINGED-LID DRILLING JIG FOR TIMING GEAR

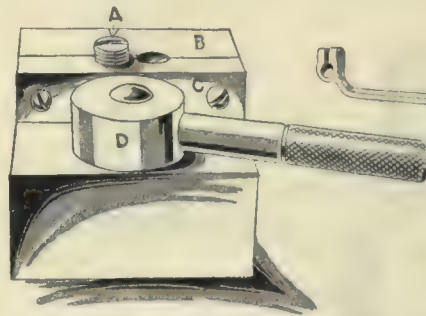


FIG. 10. CLAMP FOR SLOTTING SCREWS

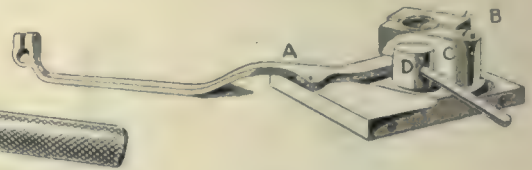


FIG. 11. BORING BOSS ON AWKWARD LEVER

owner or driver. This drilling is performed in the jig seen in Fig. 9. It is of the hinge-lid variety, the lid *B* being held in place by a thumb-latch *C* and the indexing done by the pin *D*. Six holes are drilled at

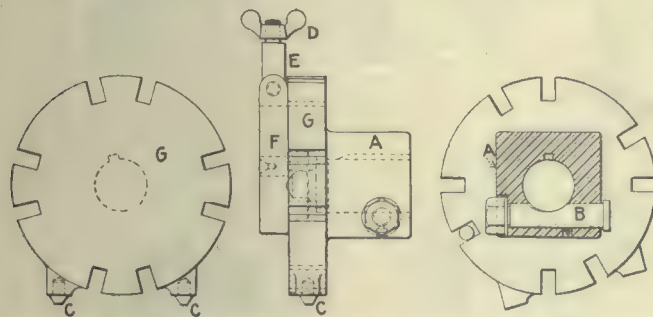


FIG. 12. FIXTURE FOR INDEXING VALVE CRANKSHAFT

each setting; then the lid is raised, the gear *A* indexed around one tooth by means of the pin *D* and the next series of six holes drilled in this way. Four settings complete the operation.

TWO CAM-OPERATED FIXTURES

Two cam-operated fixtures are illustrated in Figs. 10 and 11. The first is for milling the slot in some small, special, headless screws *A*. Two of these are usually done at one setting, but the second hole has been left empty

A. Here the fixed block is shown at *B*, while the movable jaw *C* is hinged. The closing cam *D* is not fastened to the fixture, but has a projecting stud that fits into a hole in the proper position. By simply lifting this out of the way, the jaw *C* can be easily swung to one side for taking out and putting in the work. This makes a rapid-acting fixture for such work.

Fig. 12 shows a fixture for grinding the pins of the eccentric shaft that actuates the sleeve valves. This operation can be readily understood by referring to Fig. 13, which shows the complete shaft with its eight crankpins, alternately numbered and lettered. The outside of the shaft is 2.16 in. and the pins 0.998, with a maximum of 0.9985. The crankpin bearings are 1.252 in. long. The shaft is first ground 2.1375 and then finished to the size shown.

The keyed end of the shaft fits into the holder *A*, Fig. 12, being located by the keyway and clamped by the drawbolt *B*. To locate the fixtures on the shaft, the keyway at one end is used. The center is slipped on the other end and the whole mounted on a faceplate, indicating from the legs *C* of the indexing fixture. In this way perfect alignment is secured between the work and the fixture. The clamp bolt *B* has a section of a circle cut out, as shown, and is drawn against the shaft, holding it firmly.

After the work is placed in the fixture and locked in the machine, it does not have to be removed until all eight pins have been ground. To index from pin to pin, it is only necessary to loosen the thumb nut *D* on each end, lift the latch *E* out of its notch and revolve the lock *A* by means of the offset centerpiece *F*, these being connected through the plate *G*. This indexing must be performed for each end. The shaft is turned

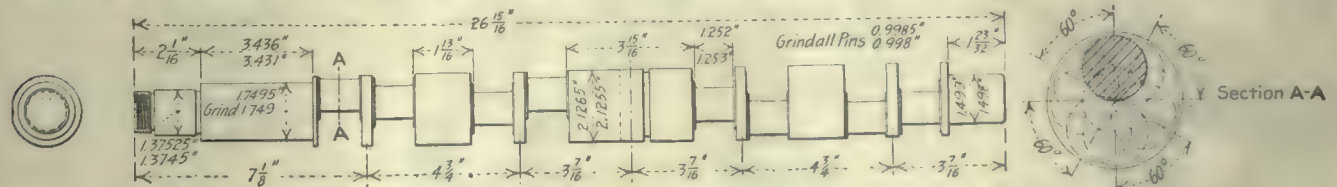


FIG. 13. THE COMPLETE CRANKSHAFT FOR OPERATING VALVE

for illustration purposes. The screw is held between the fixed jaw *B* and the movable jaw *C*, which is clamped by the cam, or eccentric, *D*. This is a very simple fixture which has worked out satisfactorily in connection with a small hand miller.

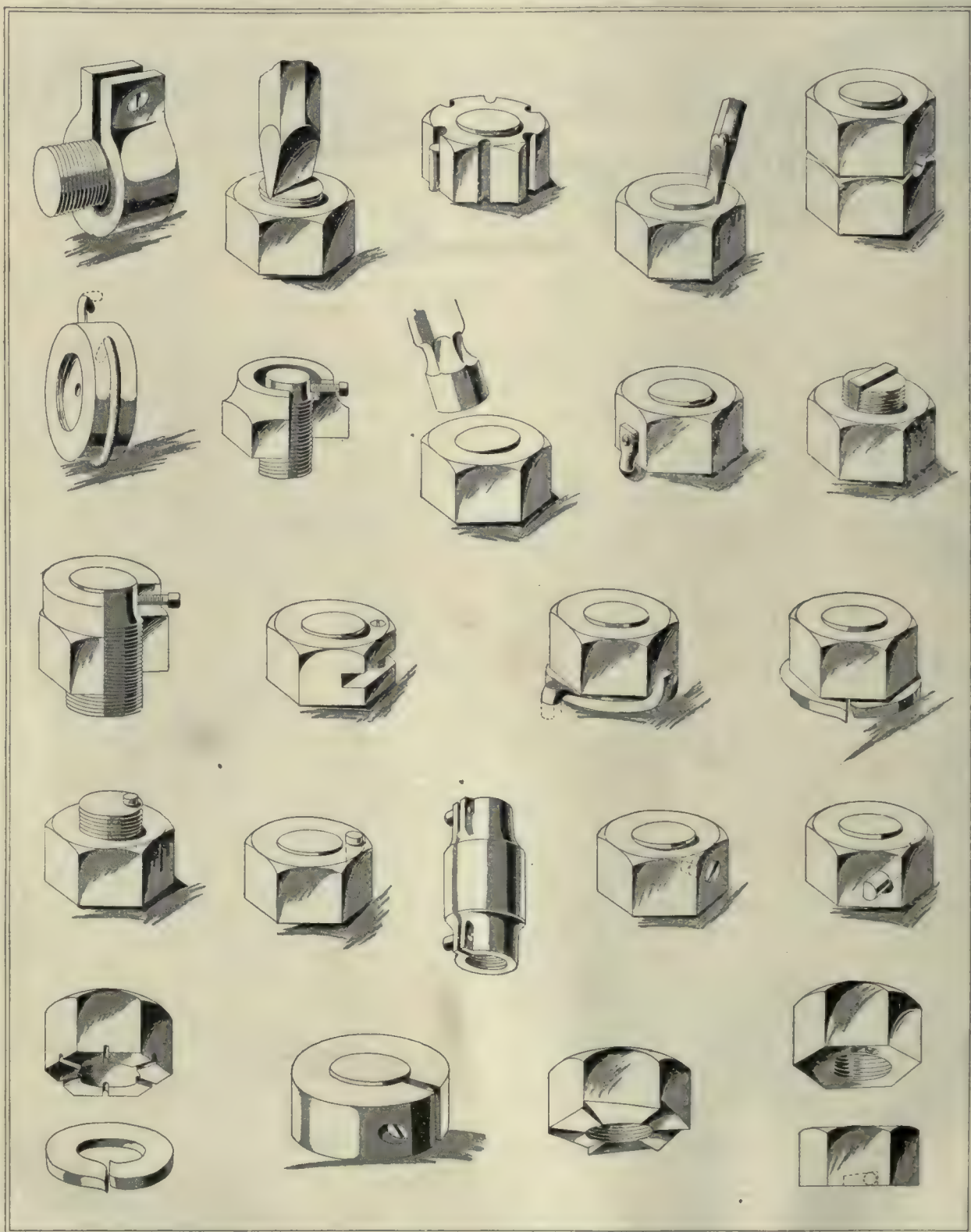
The other cam fixture, Fig. 11, is for drilling and reaming the large hub of a rather awkward-shaped lever

to the next notch and the corresponding pin ground to suit. The notches are numbered from 1 to 8 on both fixtures to avoid mistakes in indexing.

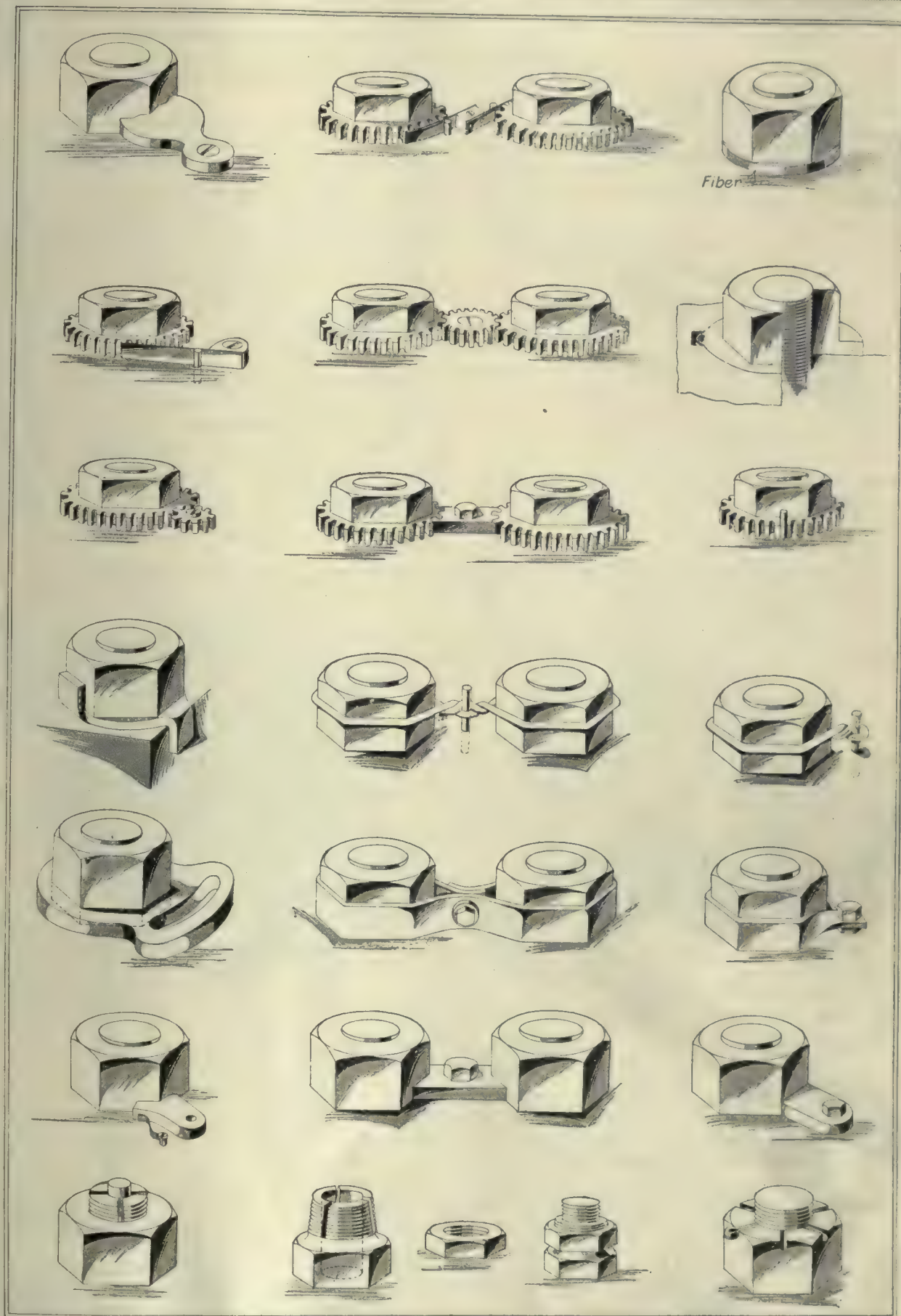
Many of these fixtures are applicable in other shops where more complicated devices would not serve the purpose nearly so well and would not be as economical to build.

From a Small-Shop Notebook

BY JOHN H. VAN DEVENTER



A WIDE VARIETY OF LOCKNUTS AND LOCKING DEVICES FOUND TO



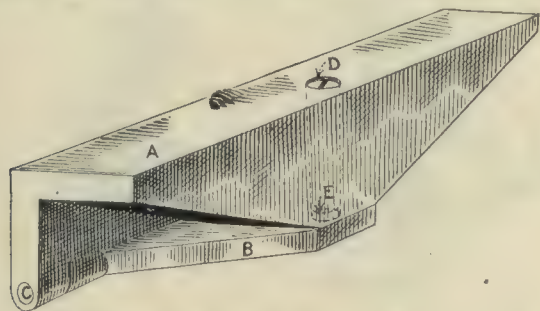
MEET PRACTICAL REQUIREMENTS IN VARIOUS CLASSES OF WORK

(Two pages of similar devices will appear next week)

Hinged Tilting Parallel

By FRANK V. DICKERMAN

Having a number of armature slot gages of various sizes and tapers to make, I devised a hinged tilting parallel, as shown in the illustration. The top *A* is hinged to base *B* at *C* and is tipped to the desired angle or taper per inch by the hardened slotted screw *D*, the rounded end of which rests on the plate *E*. Parallel lines indexed lengthwise on the face *A* aid in determining the taper per



HINGE TILTING PARALLEL

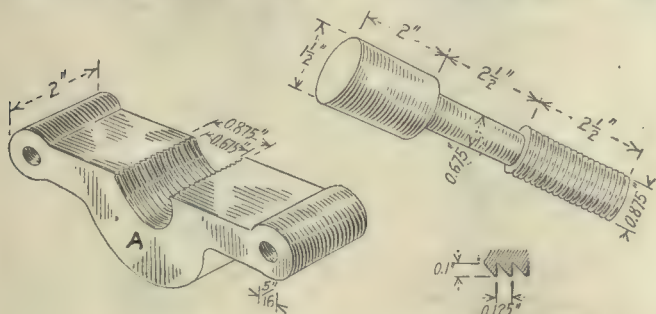
inch. By using hold-down grips, any angle from a plain parallel to 15 deg. or over and any width or length within its range can be shaped. After carbonizing and assembling, the top and bottom faces should be ground parallel.

The quickness of adjustment, lightness, rigidity and range of this tool make it ideal for toolroom use. The dimensions of this size are suitable for the average small shaper. For larger machines they could be changed in proportion.

Hobbing Half-Nuts

By WILLIAM C. HARVES

Half-nuts similar to that shown at *A* were to be produced in lots of two hundred. They were of cast iron, made large enough in the center to allow boring and tapping a full hole. The castings were first ganged on a suitable fixture and the end faces straddle-milled to size. The two $\frac{5}{16}$ -in. pin holes were then drilled and reamed. The half-nuts were located by these pin holes in a turret lathe and bored and tapped, an undersized taper tap and



THE HALF-NUT AND THE HOB

a finishing tap being used. The final operation—removing the superfluous half of the nut—was also performed in gangs in a milling fixture.

The operation of boring and tapping, however, was unsatisfactory; the threads were rough and broken in places, the taps did not follow the hole, and in addition to the poor product four taps costing about \$10 each were broken or worn out on the first two hundred pieces. It was decided that a better means must be devised for the

threading operation, and the following successful method was the result:

As shown, a six-spiral grooved hob was made straight except for the first inch, which was tapered 0.025 in. and "backed off" slightly at the top and both sides of the thread.

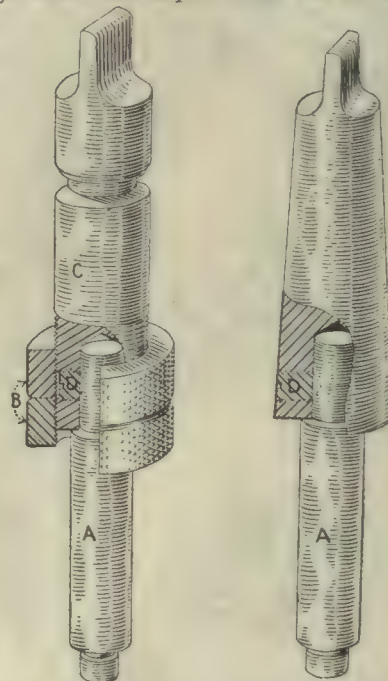
The job was done in a Le Blond lathe with a compound rest. The hob is held by the large end in the chuck and indicated true. The fixture for holding the work consists of a 90-deg. angle plate with $\frac{5}{16}$ -in. projecting pins for locating the work and a strap and bolt for holding it. A tongue at an angle of 6 deg. projects from the base of the angle plate and fits the tool-post slot. This was found to be the proper angle to clear the angle of the thread.

As a half-nut of this form cannot be removed from a screw at right angles to the axis, the hob could not be fed in square with the lathe without injuring the thread. The 6-deg. angle used in this case gives the necessary clearance and permits the hob to take about an equal cut on both the 90-deg. and 45-deg. sides of the thread each time through. Six cuts are taken to complete the job, which occupies half the time consumed in running two taps through in the turret lathe. The product is all that could be desired, and the hob, after cutting two hundred half-nuts, shows practically no sign of wear.

A Counterbore

By MICHAEL L. PAESAY

Herewith is shown the design of a counterbore which was recently found to be good for counterboring forgings and castings where the depth could not be measured on



A COUNTERBORE

account of the rapid production that must be maintained. It is also economical of high-speed steel.

The counterbore is marked *A* and is of high-speed steel. The two collars *B* are set for the proper depth and are threaded to lock on *C*, which is a Presto shank. The headless screw *D* holds the counterbore *A* in place. The other illustration is simply the same plan followed out on a No. 4 Morse shank counterbore.

Features in Designing the Noiseless Typewriter

BY FRANK A. STANLEY

SYNOPSIS—The features of design incorporated in this typewriting machine involve some most important principles, with a unique pendulum-controlled toggle motion, whereby a uniform degree of pressure is applied through toggle action independently of the primary force due to the touch of the operator upon the keys themselves. This, in conjunction with a flat steel printing bar presenting a fixed surface for backing up the paper, allows the printing of the type character upon the surface of the paper to be done with a definite degree of pressure, due to the control of the type bar, which comes to rest at the moment of impact upon the ribbon.

There is something a bit uncanny about seeing a person operating the keys of what seems to be a typewriter without the noise which usually accompanies it. The novelty of the machine, as well as the methods used in its manufacture, make it of special interest to the mechanic.

the process of thought leading up to the development of this typewriter mechanism, a number of novel features were evolved, each of them of prime importance in the construction of a machine to operate noiselessly.

One of these features which at first may seem paradoxical, is the use of the hard-steel printing bar in place of the rubber roll or platen, the cylinder being retained solely for the purpose of feeding the paper, but having of itself absolutely no connection with the typewriting operation. Another feature incorporated with this is the type-bar mechanism, which with gradually accelerated and retarded motion carries the type swiftly forward, impresses the ribbon against the surface of the paper, then instantaneously returns the type bar, the printing action of the type being one of firm pressure instead of the usual hammer blow. This type-bar mechanism is so designed that the printing pressure is uniform, practically regardless of the blow struck by the operator upon the keys.

Moreover, the construction permits such adjustment in the assembly of the carrying mechanism that with uni-



FIGS. 1 AND 2. THE NOISELESS TYPEWRITER WHICH INCORPORATES A UNIQUE PENDULUM-CONTROLLED TOGGLE MOTION

It is generally a fairly easy matter after a machine has been perfected to explain its operation and how it accomplishes certain results: One part of the mechanism does this thing, another that, and there you are. It is not so simple a matter for the designer of a novel machine to set forth definitely or to visualize to himself at the beginning just how he is to proceed to accomplish any desired end.

Undoubtedly the designer of the Noiseless typewriter, which has now been manufactured at Middletown, Conn., in its finally perfected form for the past two years, could not for a long time determine to his own satisfaction just what course to follow to make the rapid printing action of hard steel type silent in a typewriter. But whatever

form action upon the keys the requisite degree of pressure is applied to suit the different characters to be printed upon the paper. In this connection it may be mentioned that the actual tension upon the bank of key levers is easily variable by the turning of an adjustable nut to conform to the individual ideas of various operators as to what they prefer for delicacy of touch in the operation of the keyboard.

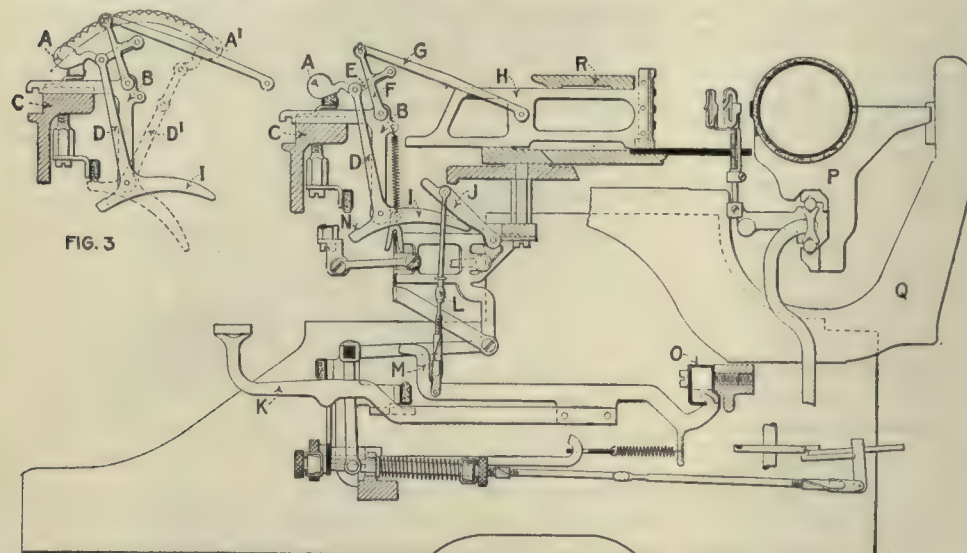
The operating control and the method of guiding the type bar are such that permanency of alignment is secured at the actual point of printing. The top and bottom of the type fit in the guide, through which each type passes and in which it is prevented from deviating up or down or to either side under this guiding principle. To allow for

various thicknesses of paper and for different numbers of sheets in manifolding operations, the design embodies a carriage-mounting system which is adjustable forward or back—that is, toward or away from the extreme forward point of the type—to correspond to the total thickness of paper placed in the machine. This adjustment is attended

of the toggle, which is shown at *A* in the diagrammatic views referred to.

The adjustable bracket *B*, upon which the toggle and its controlling apparatus are mounted, is adjustably attached to the top plate of the typewriter at *C* and consists of a rocker-arm *D*, which is attached by a link *E* to the shorter member *F* of the toggle motion, *E* carrying at its rear end the small pendulum weight *A*, from which the mechanism derives its name of pendulum toggle. The longer member *G* of the toggle is pivoted to the central portion of the type bar *H*. The lower portion *I* of the rocker-arm *D* is in the form of a cam or wiper, which provides a contact surface for the lever *J*, which is drawn down when the key lever *K* is depressed under the touch of the operator's hand. The connecting link between the key lever and *J* is indicated at *L*, with the necessary means of adjustment.

The action between the swinging arm *J* and the rocker arm *I* is a rolling contact, there being no sliding motion whatsoever. The curve on the upper, or bearing, surface of *I* is laid out to give a rolling contact without sliding friction. When this arm *I* is depressed under the pull of the key lever, the upright portion *D* travels forward and the pendulum link *E* forces the toggle open, carrying the type bar *H* rapidly ahead, as indicated in Fig. 5. As the



FIGS. 3 AND 4. TYPE-BAR TOGGLE AND TYPE BAR WITHDRAWN

to by a graduated indicator at the front of the typewriter, which is set to one, two, three or more sheets, in accordance with the thickness of the paper itself.

THE NOISELESS ACTION

Briefly stated, the principle of the noiseless action is that the printing-type character is pressed upon the paper instead of struck as with a blow. In this respect it may be considered as practically identical with the printing of a character in the printing press, where the pressure is maintained mechanically, when once determined, and not varied with each type according to the individual pressure of the operator's fingers. To secure this pressure action under the conditions of uniformity referred to, the mechanism is arranged as illustrated.

Of these illustrations, Fig. 1 gives a clear idea of the general appearance and proportions of the noiseless typewriter. Fig. 2 shows the machine with the top plate removed to show the type-bar mechanism and carriage mount. Figs. 3, 4, 5 and 6 illustrate clearly the type bar and its actuating mechanism in various positions under the operation of the key levers.

Figs. 1 and 2 show that the type bars are placed horizontally and travel radially toward a common central point, where they are guided for fixed accuracy of position. The movements of these type bars are produced by an ingeniously designed mechanism which may be called a pendulum toggle, and is distinctly outlined in Figs. 3 to 6. Of these views Fig. 4 shows the type bar in extreme backward position; Fig. 5 shows it with the toggle nearly straightened out and its type character therefore almost in contact with the paper; Fig. 6 illustrates the type bar in extreme forward position with the toggle joint dead on center line. With this toggle movement the type bar, which is very light, has a free floating action, and the bar is always under the control of the pendulum member

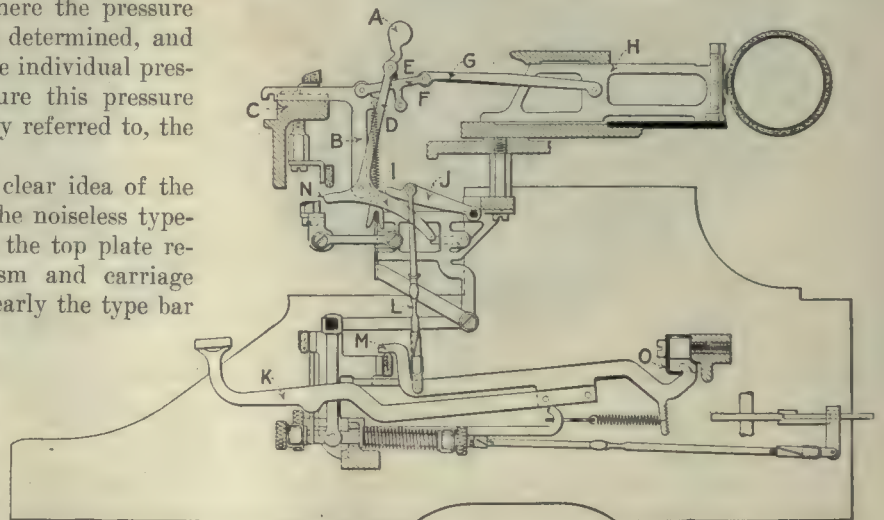


FIG. 5. TYPE BAR FORWARD

toggle approaches the full-open point, or center line, the motion of the type-bar race naturally diminishes appreciably until it comes to a dead stop with the toggle on center, as in Fig. 6. It is obviously impossible with the toggle mechanism in this position for the type bar to be further advanced. Therefore, with the machine properly adjusted and with the carriage set for any given thickness of paper or for any given number of the sheets, the desired amount of pressure is applied by the type upon the ribbon and paper. This pressure cannot be exceeded, for

if it were possible to carry the toggle joint past the center line by any device whatsoever or by abnormal pressure upon the key levers, it would bring the type character back from the ribbon rather than advance it.

A little study of the diagrams in Figs. 3, 4, 5 and 6 will show just what the pendulum portion of the toggle

Without going into an elaborate explanation of each feature of the machine, it is of interest to note the simple but effective way in which the key levers are hung up by their rear hooks under the tubular support at *O* and refer to the spring connections by which easy though definite action of the part is assured. Further attention may also

justifiably be called to the layout of the contact curves on rockers *J* and *I*, which are actually very accurate cam surfaces giving a true rolling contact where the slightest sliding friction would be a positive objection. Not only are these curves laid out graphically to assure the desired contact under rolling motion, but elaborate tests have been made after the completion of the manufacturing tools to test these members under observation to determine the accuracy of this rolling movement. Similarly, the dimensions of pendulum *A* and of all other parts of the toggle mechanism have been determined with precision to assure a very rapid, positive action to produce the gradually accelerated and retarded motion desired in sliding the type bar

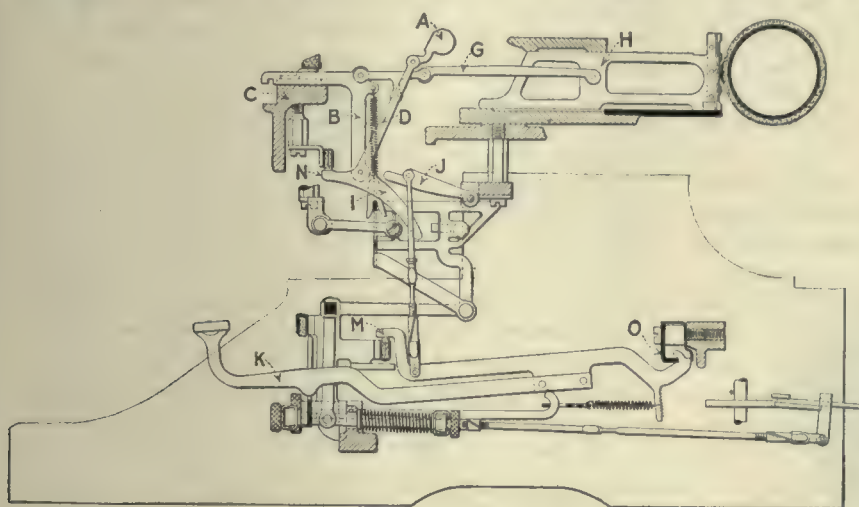


FIG. 6. TYPE BAR IN PRINTING POSITION

accomplishes in the way of applying a definite pressure upon the type bar. The full throw, or arc, of movement of the rocker-arm *D* is represented in Fig. 3, *D*¹ indicating the extreme forward movement of travel with the pendulum straightened out in line with the vertical arm *E*. The weight of this pendulum has been accurately determined and its mass, in conjunction with the length of its lever arm, is such that when the rocker *D* is brought forward through the action of the key lever upon the cam surface *I* the pendulum *A* itself rises toward the vertical line. After advancing a certain distance the further progress of the type bar through the opening of the toggle joint is derived from the momentum of the pendulum *A*, which carries it forward until the toggle is dead on the center line, as in Fig. 6.

Here the depressing lever *J*, which is drawn down by the action of the key lever, is no longer in contact with the cam surface *I* of the rocker-arm *D*, the downward travel of *J* being limited by a stop under the auxiliary arm *M* attached to the key lever *K*. To make sure that this pendulum alone shall act as the final pressure agent in bringing the type character against the ribbon and paper—that is, to exclude from operative action the momentum of connecting parts leading from the key lever upward—the forward advance of the swinging arm is stopped at the predetermined point *D*¹, Fig. 3, by the lug *N*, which comes in contact with the under side of a pad attached at the front of the top plate of the typewriter.

The return of the type bar is produced by the combined action of the tension spring shown and the toggle itself, the members coming to rest in the position indicated in Fig. 4, with the back of the pendulum resting upon a pad at the top of the casing.

All the members involved in this pendulum-toggle mechanism and in the connecting apparatus, from the key lever upward, are made of thin, tough, sheet-steel stock, from which are produced light parts which are stiff and sufficiently durable to withstand the wear and tear of service exacting typewriting.

into action and bringing it to rest with the character against the surface of the paper and other desirable features of operation.

The pressure normally required to print a full-faced character on a sheet of paper is naturally very much more than that required for the small area of a punctuation point, say a period or a comma. If these characters were hammered home against the ribbon and paper under a system of hammer blows of approximately uniform intensity, the broader-faced characters, like some of the capitals, would produce a satisfactory impression upon the paper, while the characters of small area, like the punctuation marks referred to, would be driven clear through the paper, the degree of impression or embossing upon the back of the sheet varying very nearly in exact proportion to the area of the type character itself.

However, under the system here applied there is no hammer-blow action. The contact of the type character is that of an evenly applied pressure, the intensity of which has been established in the assembling of the machine



FIG. 7. THE POINT WHERE THE PRINTING IS DONE

so that with the toggle joint straightened fully out and the type characters in their extreme forward position each of the characters prints equally upon the paper.

Each type bar as it is carried forward is passed into a positive guide that holds it top and bottom so that devia-

tion from true alignment is impossible. Few people outside of professional printers realize what a small actual deviation in type alignment is necessary to produce on the printed sheet a condition indicating a bad lack of alignment. A thousandth of an inch deviation is ordinarily very conspicuous, and two or three thousandths with a clear-faced type will often appear to be a real lack of alignment of $\frac{1}{64}$ in. or greater. Similarly with the typewritten sheet, even the most minute deviation from vertical alignment is instantly detected and in the human eye ordinarily magnified considerably over its actual deviation.

How positive alignment is maintained at all times on the Noiseless machine will be understood from Figs. 4, 5, 6, 7 and 8. The former illustrates the manner in which the

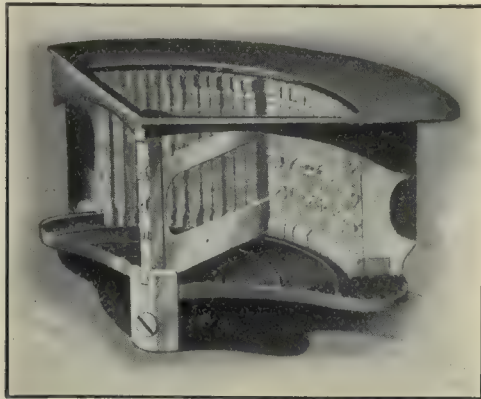
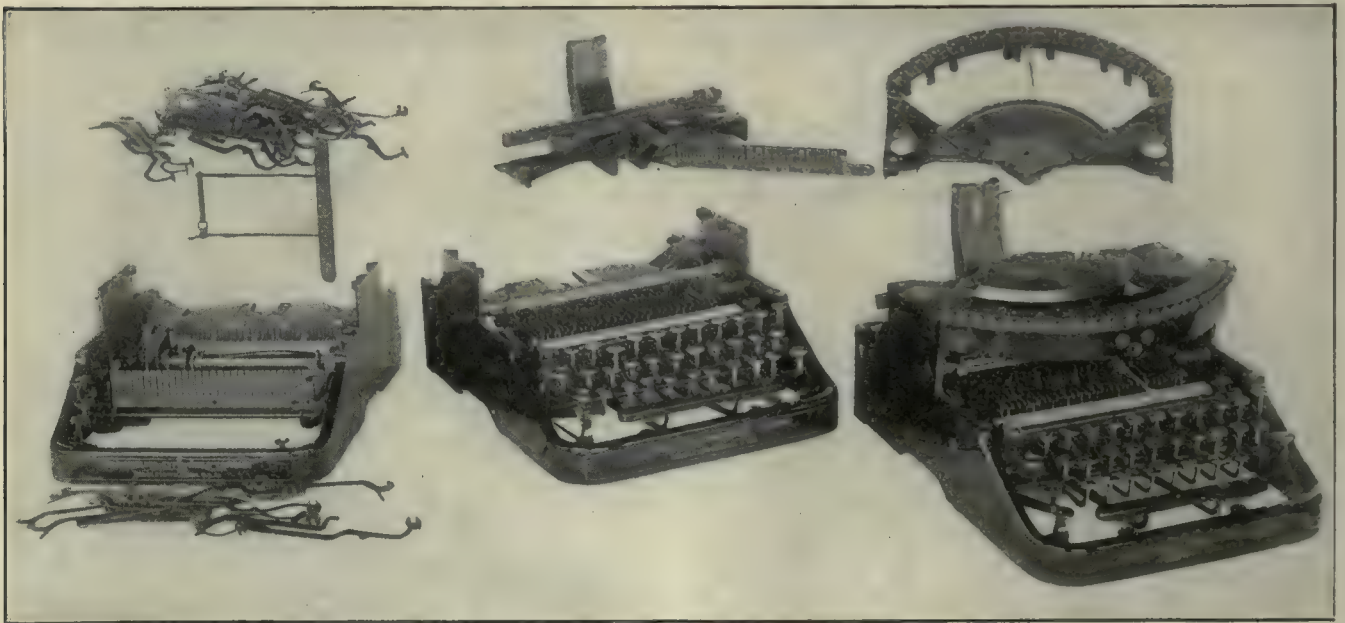


FIG. 8. METHOD OF LOCKING TYPE BAR AT POINT OF PRINTING

maintains always a suitable surface for feeding the paper uniformly through the machine.

At this point it may not be out of place to make brief reference to the method by which the carriage with the flat printing platen is brought forward or moved backward to suitable position to accommodate varying numbers of sheets of paper, or paper varying in thickness, as is often the case with different classes of correspondence. Referring to Fig. 4, it will be seen that the carriage indicated diagrammatically at *P* operates upon ball bearings in a guide supported by a bracket called the center tie, an adjustable member fitted transversely of the typewriter frame and adjustable forward and back by the indicator screw at the front of the machine. In its adjustment forward or back, while moving smoothly under the action of the adjusting screw, it at the same time retains the rigidity desirable for properly supporting the carriage and connecting parts. The indicator screw and dial will be noticed at the front of the machine in Fig. 1.

Whatever adjustment is made in the position of the center tie and carriage to provide for the requisite number of sheets of paper, the type bar is always locked at the point of printing, as in Fig. 8. In its construction the type bar itself rests upon a hardened and ground steel plate, and at the top is guided against lifting by the top plate *R*, Fig. 4. The center guide, Fig. 8, receives the central one of the group of 28 radially disposed bars at right angles, and the type is therefore the width of the opening in the guide itself. The other members of the set of type bars all come in at an angle greater or less, according to the distance from the central member of the group.



FIGS. 9 TO 11. IMPORTANT STAGES IN THE PROCESS OF ASSEMBLING THE TYPEWRITER

flat printing bar is extended across the full face of the rubber platen, but in front of it, so that the paper to be written upon as it is fed around by the roller is carried outside of this bar, presenting a flat surface to the inked ribbon and type. The steel printing plate cannot wear under the action of the type bars upon the paper; nor does the rubber roll, as it is used solely for feeding of the paper.

An important feature at this point relates to the preservation of the rubber roll itself, which, serving always as a paper-feeding device and never for a printing platen,

The thickness of the type at the point of contact in the guide must therefore be determined according to the angle at which the type bars operate. These angles have all been figured out and the type for each character is ground to an absolute thickness, so that when passed in at the given angle it will fill the guide and be correctly supported against being thrown out of alignment.

In connection with the type bars there are two interesting features which are brought out clearly in the illustrations and which may be referred to briefly in this

article. It will be seen from Figs. 4, 5 and 6 that the type is riveted to the type bars in such a manner that it cannot become loosened or work out of alignment; furthermore, each type is made with a protecting shoulder that projects sufficiently to make it impossible for two or more bars to come in collision so as to injure the type faces themselves. These features, in conjunction with the fact that the type is properly hardened, assure in every possible way accuracy of impression and make really a per-

NOTE. Dimensions shown are finished Dimensions

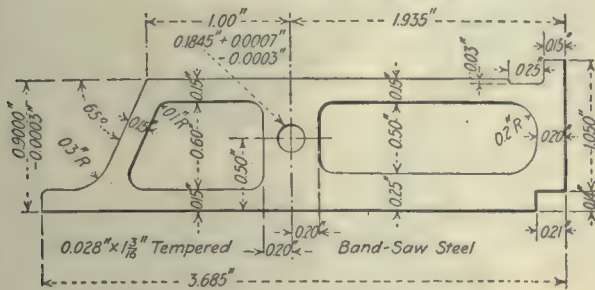


FIG. 12. TYPE BAR BLANK

manent element of each type, so that, incorporated with fixed alignment, it is an indestructible type.

It will be seen from the general views, that the mechanism of this machine is entirely inclosed except for certain parts at the end of the carriage platen. The type bars themselves, the type, the connecting toggles, the key levers, the ribbon motion, the escapement action, the spring barrel for the carriage feed and the attendant mechanism are all covered in by neatly designed plates.

The important members of the typewriter and the general process of building it up are pretty well shown in Figs. 9 to 11, inclusive. These might well be called the six high points in the process of assembling the machine. There are of course a great many intermediate phases, but these give a clear idea of the general line of progress in the process of building up the complete typewriter.

Fig. 9 shows the frame put together, for this frame is made of two separate side plates—right and left—a rear-frame brace, front-frame brace and a part-frame tie. These parts are firmly fixed together by screws and dowel pins, none of which are visible in the finished machine, so that to the unsophisticated observer the frame appears to be one solid casting. The so-called front and rear combs for guiding the key levers and connecting mechanisms are also shown in position, as are certain other parts. This and Fig. 10 show the accurately machined guide for receiving the center tie, which carries the typewriter carriage. This guide and the center tie which it receives and which is shown in the background in Fig. 10 are machined and fitted up with the same care that would be given to a precision machine-tool slide. These guiding surfaces in reality constitute the working points for a great many subsequent operations in the machining of the respective castings. The general character of the center tie in Fig. 10 will be apparent, and this view also represents the appearance of the frame after the key levers have been put in place.

Fig. 11 shows a further extension in the assembling process, where the top plate is attached, the center tie is in place at the rear, and the type-bar plate and guide are also in position. The top plate, as indicated, is slotted radially to receive the different type-bar carrying brackets.

Various important details required in the construction of these typewriters are illustrated in these half-dozen views, as they appear before assembling in the machine itself. Some tools and processes devised for the production of these parts remain to be discussed at some later period.

It may be well here to call attention to the fact that the machine is of the double-shift type; that is, all characters are combined on three rows of keys, and there are three characters on each type face, so that with this compact form of keyboard a corresponding diminution in the number of type bars is obtained. The carriage is merely shifted up for capitals, down for numerals and remains central for lower case, or small letters.

The general method of mounting the type-bar mechanisms, the adjusting screws and clamps for securing them in the assembling process at the desired distance from the point of printing are clearly shown. The cast-iron top plate already referred to carries a hardened and ground steel guide plate for supporting the under side of the type bars as they slide back and forth. There is also attached to this top plate an inverted comb in the form of an arc for guiding the sliding type bars against lateral deviation from true radial travel. This comb is primarily to control the movement of the type-bar body, the type itself having an absolute guide at the point of printing for both lateral and vertical alignment.

Directly over this is another arc-shaped member or segment, known as the type-bar plate. This is a gray-iron casting and forms a cover and top guide for the body of the type bars. To this segment-shaped casting is secured a steel plate extending over the front of the type bars and forming at its extreme forward point the lateral alignment guide for the type itself. The lower guide for the type is an auxiliary part attached to the inner point of the top plate proper, as illustrated in Fig. 8. These various members are all shown conspicuously in some one or other of the different views illustrating this article.

PROPORTIONS OF PARTS

While it is not the intention to here enter into a description of any of the manufacturing processes under which this machine is made, it may not be out of place, in order to give a definite idea of the proportions of the mechanism for rapid operation of the type bars forward and back, to show a detail of the bar itself. There are 28 of these bars in each typewriter, all made exactly to the same dimensions, as in Fig. 12. This shows general overall dimensions, also illustrating the manner in which the bar is lightened by blanking out the greater portion of the center. The material is 0.028 in. in thickness by 1 1/8 in. wide and is of tempered band-saw steel.

A fair indication of the lightness of these parts is found in the fact that 30 of them are blanked from a single pound of stock. The finished weight of the bar is even less than half of this after the central portion has been blanked out from the body, and the top, bottom and ends formed to size.



Heat Treatment of Carbon-Steel locomotive axles was made the subject of a paper presented before the American Society for Testing Materials in which the author pointed out that the generally accepted theory that a water-quenched carbon-steel forging will have a higher tensile strength and greater reduction of area for the same elongation than a similar forging which has been oil quenched was not consistently borne out by the results of conducted tests, individually, except as to elastic limit.

Jigs Used in Machining Turret-Lathe Details

By ROBERT MAWSON

SYNOPSIS—On this and its companion page are shown jigs for machining some of the smaller parts of a turret lathe. These tools are of simple, rugged construction. In each case the drilling operations follow the milling. By such a procedure it is possible to have a fixed surface for locating purposes, which is found a decided aid in producing interchangeable results.

On page 1007, Vol. 44, was described a turret lathe made by the Blake & Knowles Steam Pump Works, East Cambridge, Mass. Some of the tools for machining parts for this lathe were shown on page 54. In this article are shown and described jigs for other parts of this machine tool with the necessary details of design, construction and production to suggest other application.

The jig used in drilling the back arm bracket employs two dowel pins that fit into cored slots in the casting as the locating means. Thumb-screws and knurled-head screws are tightened against the casting to hold the jig in position. The jig for machining the swivel block is of the box type. The casting slides in from the end against a stop. The piece is then readily located by a tongue that fits inside of a machined groove in the swivel block.

The tool for drilling the cam bracket is provided with a cover. After the milled casting has been placed in the

jig and forced against stop surfaces with screws, the cover is dropped down and held with a thumb-nut. The tool is then ready for use. The swing-arm jig is of the open type. The casting is slid over a pin that fits into a previously bored hole. The outer end of the piece is pushed against a stop with a setscrew, and the casting is held in position with an open-sided washer and nut.

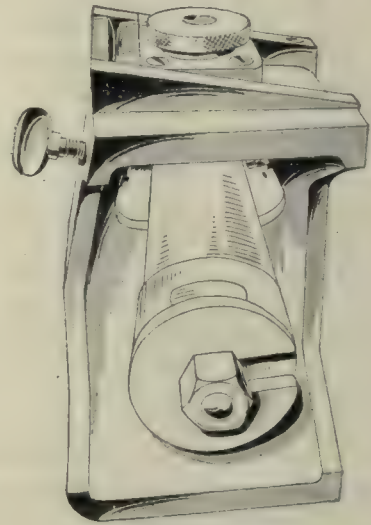


FIG. 8. JIG FOR SWINGING ARM

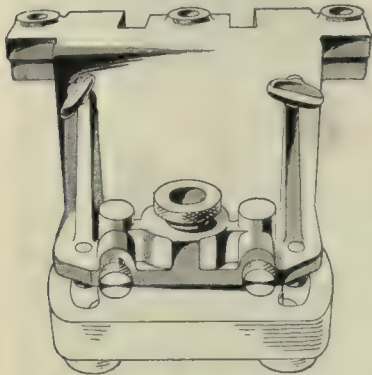


Fig. 2

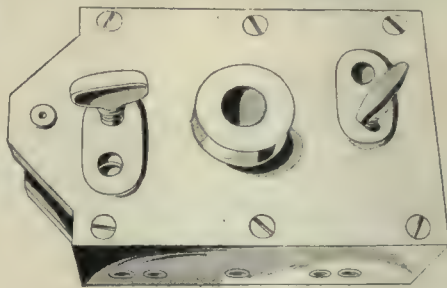


Fig. 4

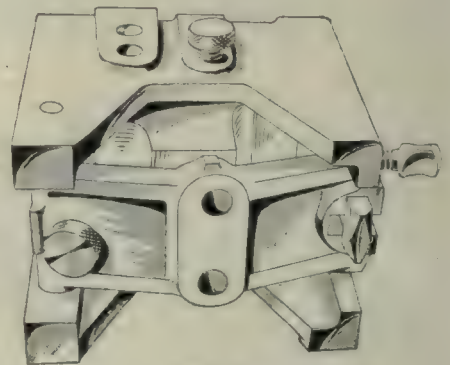


Fig. 6

DRILLING JIGS USED IN MACHINING TURRET-LATHE PARTS, WITH WORK SHOWN IN POSITION

FIGS. 2 AND 2-A

Operation—Drilling and reaming the back-arm bracket, Fig. 1. The jig is located on the casting by means of two pins that fit into cored slots. Two thumb-screws on the upper surface hold the jig in position. Two plungers on the lower surface assist in holding the jig against machining strains.

Holes Machined—Three $\frac{3}{8}$ -in. drilled and one $1\frac{1}{4}$ -in. spot-drilled and reamed. The latter hole is then counterbored to $1\frac{1}{2}$ in. for $\frac{1}{4}$ in. deep.

FIGS. 4 AND 4-A

Operation—Drilling back-arm swivel block, Fig. 3. The milled casting is slid in from the end of the jig to a stop pin. The casting is located by tongues $2\frac{7}{8}$ in. apart, which fit into the milled slot. Two thumb-screws tightened on the part hold it in position.

Holes Machined—Three $\frac{3}{8}$ -in. drilled and two $\frac{1}{8}$ -in. drilled. The latter holes are tapped with $\frac{3}{4}$ -in. U.S.S. threads out of the jig.

FIGS. 6 AND 6-A

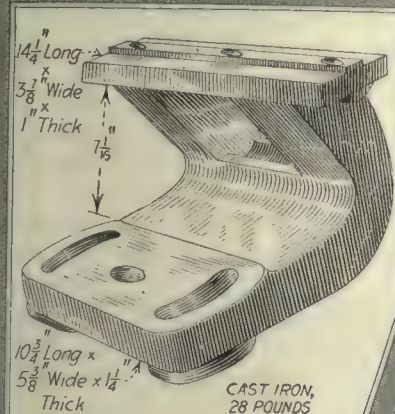
Operation—Drilling carriage hook latch and forming cam bracket, Fig. 5. The milled casting is located in a V-surface and forced back by means of setscrews. The cover is then swung down and locked with a wing-nut. A knurled-head screw tightened on the casting and passing through the cover assists in holding it during the drilling operation.

Holes Machined—Five $\frac{1}{8}$ -in. drilled and two $\frac{1}{2}$ -in. spot-drilled and reamed.

FIGS. 8 AND 8-A

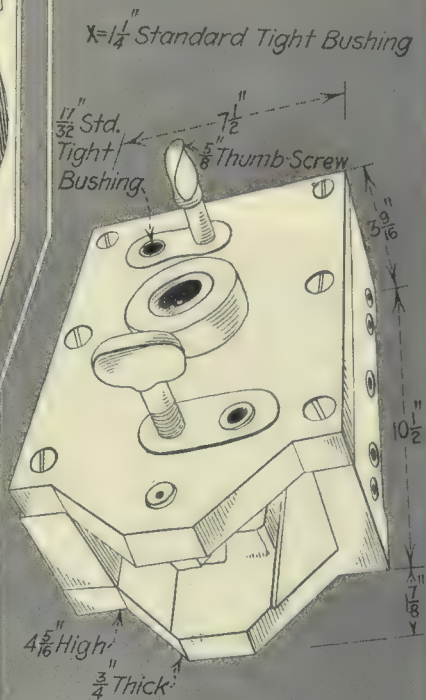
Operation—Drilling back-arm swinging arm, Fig. 7. The casting is placed on a $3\frac{1}{2}$ -in. pin that fits into a previously bored hole. The end of the piece is then swung against an adjustable stop with a thumb-screw. An open-sided washer and nut hold the casting firmly in the fixture during the operation.

Holes Machined—One $\frac{1}{8}$ -in. drilled and one $\frac{3}{8}$ -in. drilled.



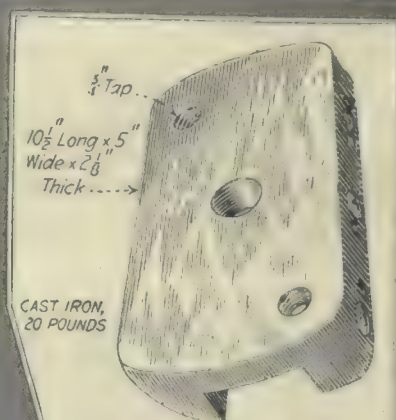
BACK-ARM BRACKET

FIG 1



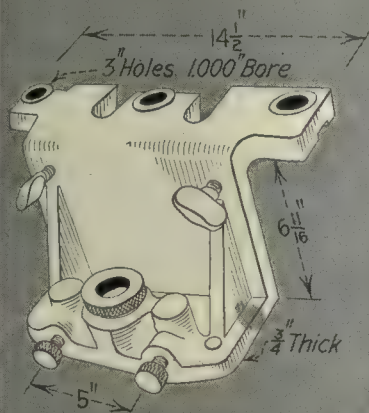
TIME OF OPERATION,
10 MINUTES

FIG 4-A



BACK-ARM SWIVEL BLOCK

FIG 3



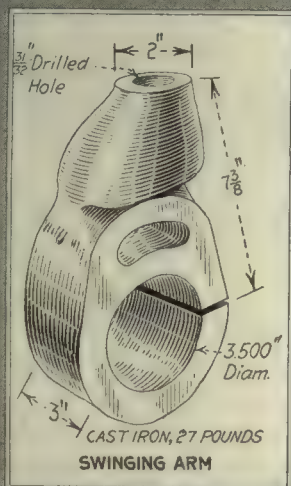
TIME OF OPERATION,
6 MINUTES

FIG 2-A



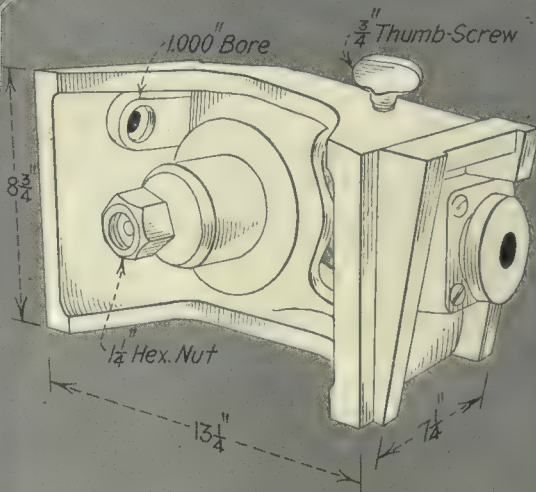
TIME OF OPERATION,
15 MINUTES

FIG 6-A



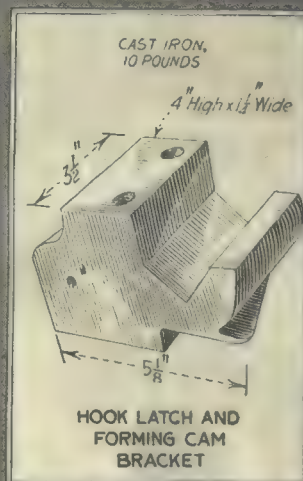
SWINGING ARM

FIG 7



TIME OF OPERATION,
20 MINUTES

FIG 8-A



HOOK LATCH AND
FORMING CAM
BRACKET

FIG 5

ALL BUSHINGS USED FOR GUIDING TOOLS ARE BLACKENED. ALL JIG AND FIXTURE BODIES ARE CAST IRON. STRAPS AND FASTENINGS, MACHINERY STEEL; GUIDE BUSHINGS ARE TOOL STEEL, HARDENED AND GROUND

while placing the concrete. The bottom of the excavation was then filled to a depth of 8 in. with 2 in. of broken stone to assist the drainage. Large holes were also bored in the sheet piles opposite the sump for the same purpose. The salty seepage water was in this manner kept away from the concrete to permit setting for a few hours. The drainage pump was kept in operation while pouring the concrete and for about four hours afterward.

After the sump had been completed and the fill of crushed stone had been made, the reinforcing steel was placed. The lower rings were blocked up 6 in. above

and clumsy to handle if made in one piece. The overall dimensions of the form were 12 ft. 6 in. high by 7 ft. 9 in. in diameter. It would have been much more difficult to place the concrete properly at the bottom, particularly in view of the interference from the reinforcing rods, had the entire form been in position. Thorough ramming would have been impossible, and there would probably have been some separation of the stone from the mixture, due to the height of the drop. The concrete, in view of the water-tight requirement, had to be placed carefully and rammed thoroughly.



FIG. 3. DRIVING SHEET PILES FOR OUTER FORM OF CRANE FOUNDATION

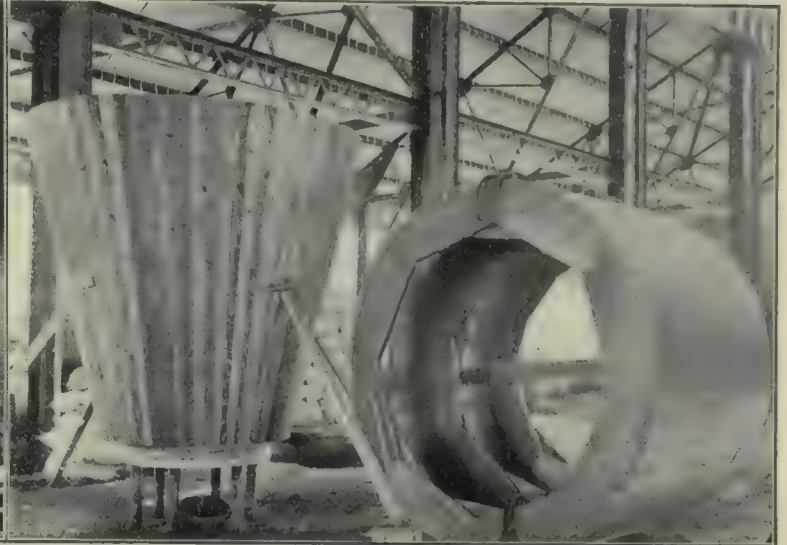


FIG. 4. UPPER AND LOWER SECTIONS OF INNER FORM FOR PILLAR CRANE

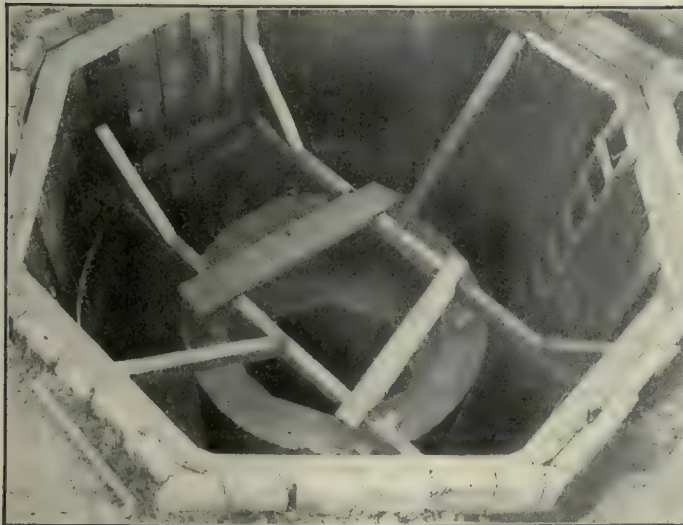


FIG. 5. LOWER HALF OF FORM ANCHORED READY FOR POURING CONCRETE



FIG. 6. CENTERING THE ROTATING RACK FOR PILLAR CRANE

the bottom, and the radials were wired to them. From the sketch it will be noticed that the radials are bent up so as to become the vertical reinforcing rods in the side walls. The side rings were then wired to the radials for about half the distance up from the bottom.

The inner form was built in two sections, as illustrated in Fig. 4. There were several reasons for following this procedure rather than building the complete form in the excavation. In the first place the form could be built much more cheaply on the shop floor. It was made in two sections, because it would have been very heavy

The difficulty of anchoring the form if made all in one piece would also have been considerable.

The lower half of the form was made sufficiently high to bring the joint between the upper and lower sections well above the water line, so as not to expose the resulting joint in the concrete to seepage. This section may be seen at the left in Fig. 4. It will be observed that the anchor bolts for the pivot casting were secured to the bottom of this section. Before placing this half of the form the bottom octagonal brace ring was slipped up to a point about 18 in. above the joint between the

two sections. A trap door was provided in the bottom of the form, so that the concrete could be well puddled around the anchor bolts from the inside. After the concrete had been poured to this depth, the trap was closed and nailed down. Fig. 5 shows this half of the form anchored in place ready for pouring.

The mixture used for the water-tight section of the foundation was 1 part cement, 2 parts sand, $3\frac{1}{2}$ parts of crushed stone. To this was added 10 per cent. by volume of hydrated lime, further to insure water-tightness.

After the lower portion of the foundation had been poured, it was allowed to set thoroughly before the bracing that anchored the lower half of the form was

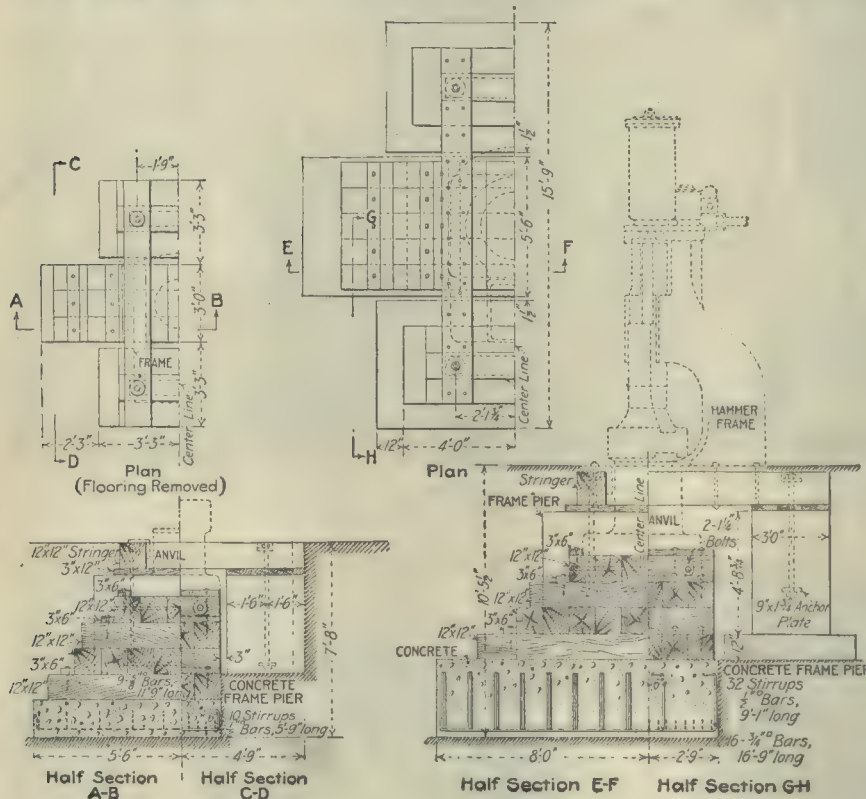


FIG. 7. FOUNDATION FOR
1,100-LB. HAMMER

FIG. 8. FOUNDATION FOR
2,500-LB. HAMMER

removed. The upper surface of the concrete was then wire-brushed and roughened, so as to insure a good bond with the fresh concrete. The upper half of the form was bolted to the lower section after having been lined up carefully from below. Just before pouring, dry cement was sprinkled over the joint surface. The upper half of the foundation was poured with a $1:3\frac{1}{2}:6$ mixture, and the whole foundation was allowed to stand three weeks before the forms were removed. In reinforced-concrete construction it is always well to allow three weeks for setting, if that much time can be spared, before stressing the concrete, so as not to impair the bond between the steel and the mixture. The form was removed piecemeal, to prevent injury to the concrete.

The foundation was found to be perfectly water-tight on removing the forms, except for slight leakage around the anchor bolts of the bottom casting. These bolts had been placed in pipe sleeves, as may be seen from Fig. 4, so as to allow for slight springing in connection with lining up. After grouting around the bolts and under the casting, all traces of leakage disappeared.

The thrust ring at the top, which carries also the rotating rack of the crane, was placed approximately concentric with the foundation. A plank was then secured across the top, as illustrated in Fig. 6. A hole that had been bored in the plank at approximately the center of the ring was covered with a sheet of tin, and on it the exact center of the ring was scribed. A small hole was punched through the tin at this point, through which a plumb line was dropped. The necessary adjustment between the ring and the bottom casting was then readily made, so as to insure concentricity. The bottom casting and the thrust ring were grouted and allowed to set before installing the crane.

The difficulty in arriving at a satisfactory design for steam-hammer foundations lies in the numerous assumptions that must be made in the empirical formulas used to get at the probable load which the foundation must stand. Where it is possible to use piles to support the anvil foundations, the simplest and best practice is to drive a sufficient number of piles to insure no settling, even when the tup is allowed to strike the bare anvil at full stroke. No steam hammer should ever be treated that way, but it is the correct, because the safest, assumption to make. Even after making this assumption the engineer cannot in the drafting room lay out the number of piles that should go into the foundation; but after locating the foundation he can drive one or two test piles and from the data ascertained determine upon the number necessary to carry the load under the most severe service conditions. In other words, the total number of piles required to support the foundation need not be fixed until after a few have been driven. As mentioned previously, the ground in the forge shop at Pearl Harbor offered practically no resistance to the penetration of short

piles. Supporting the anvil foundations on piles was therefore not feasible, because of the extreme length needed in order to bring them to a substantial bearing. It was decided to use reinforced-concrete slabs of sufficient area to reduce to safe limits the calculated pressure per square foot. Spreading the anvil foundations involved, however, moving the piers for the hammer frames considerably farther apart than is customary, with consequent increase in the span and size of the timbers carrying the frames. The slabs carrying the anvil structures could therefore be spread in a transverse direction to only a limited extent. Most of the increase in area had to be obtained by lengthwise extension. The calculated loads coming on the anvil pier of the 1,100-lb. steam hammer are as follows:

CALCULATED LOADS FOR 1,100-LB. STEAM HAMMER	
Assumed Loads on Anvil Pier:	
	Lb.
Weight of tup	1,100
Weight of anvil	9,000
Weight of timber	3,660
Weight of concrete	8,448
Weight of impact	10,080
Total	32,288

Load per square foot of ground.....	980
Stroke of hammer, 28 in.; coefficient of impact, 80.	
Assumed Loads on One Frame Pier:	
Frame timber, etc.....	5,500
Concrete	11,000
Total	16,500
Load per square foot of ground.....	850

The inertia of the concrete slab is a considerable factor in absorbing the impact load. The foundation as installed, giving the amount of reinforcing material in the concrete, is shown in Fig. 7 for the 1,100-lb. hammer. The calculated loads coming on the anvil foundation of the 2,500-lb. steam hammer are as follows:

CALCULATED LOADS FOR 2,500-LB. STEAM HAMMER	
Assumed Loads on Anvil Pier:	
	Lb.
Weight of steel hammer	2,500
Weight of steel anvil	18,000
Weight of timber	8,000
Weight of concrete	41,000
Impact	27,000
Total	96,500
Load per square foot of ground.....	1,100
Stroke of hammer, 3 ft.; coefficient of impact, 100.	
Assumed Loads on One Frame Pier:	
Frame timber, etc.....	12,000
Concrete	25,000
Total	37,000
Load per square foot of ground.....	740

The foundation for the 2,500-lb. hammer is illustrated in Fig. 8.

Toolroom Bench Lathe

BY GUSTAVE REMACLE

The toolroom bench lathe with all its accessories will perform a more extensive and varied number of operations than any other machine tool. The cone pulley contains a series of equally spaced holes that will allow for equally dividing work in operation.

In Fig. 1 is shown a simple raising block. This is often used to increase the swing in machining pieces which are too large for the lathe without the raising block, but which come within the scope of the bench lathe. It requires only a few moments to adjust the block in place.

A somewhat similar block, Fig. 2, is used for adapting

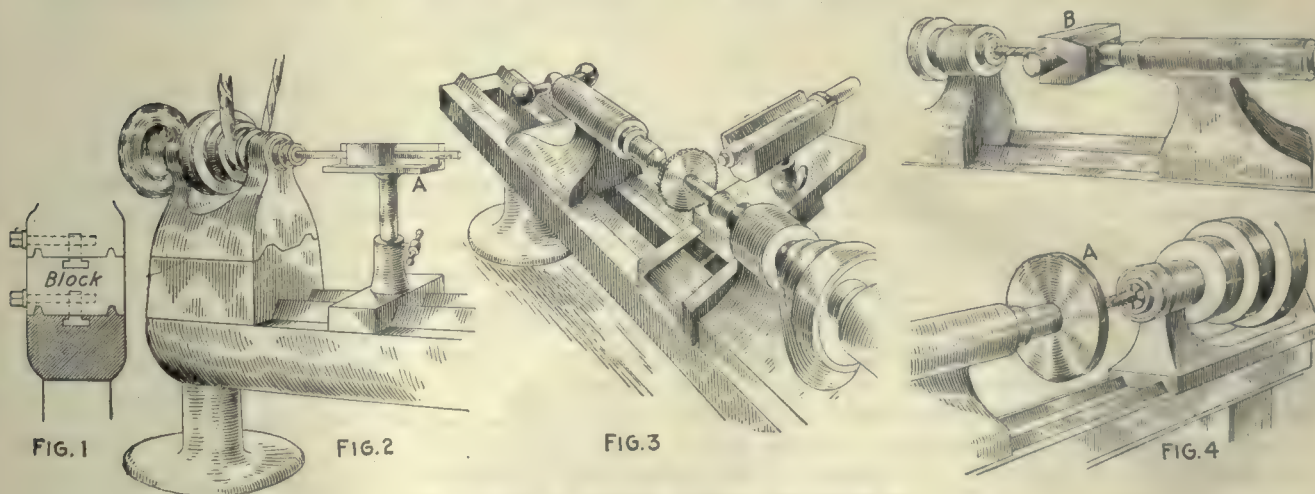
Small wire or rod may best be lapped in this manner. If there is a high-speed pulley rigged with the lathe for grinding purposes, it may be utilized for rotating the spindle. If this means is not available, a small portable motor set upon the bench will prove satisfactory for the purpose.

The application of the V-rest for slotting screws is shown in Fig. 3. This device is easily set up and screws in such numbers as occur in toolwork may be rapidly slotted. The holder is drilled to receive the screw. After the V-rest is set in proper position, the stop collar is adjusted. It is then simply a matter of inserting the screw, pushing it against the saw, dumping it and inserting another.

In Fig. 4 are illustrated a drill pad and V for drilling purposes. The drill pad *A* may be used for drilling for a resting place for stock and die in threading and for many other purposes. V-pad *B*, if properly made, will accurately locate a round piece of rod for drilling.

In Fig. 5 is shown the "bob-tail" center for grinding between centers in the bench lathe. Glancing at the plan view one may readily see the superiority of the bob-tail center over the ordinary tail center. The ordinary tail center is quite long and must necessarily be placed outside the slide rest. Thus in order to grind a piece between this and the head center, it is necessary to use a large wheel, if the spindle of the slide grinder is to have room. At best the ordinary tail center is very much in the way. The bobtail center contains sufficient rigidity for grinding purposes and is so small that it may be placed between the headstock and slide rest.

When grinding a piece that is simply held in the chuck, particularly a long slender piece as in Fig. 6, vibration should be carefully avoided. This is simply accomplished by inserting a bit of drill rod in a piece of wood and tapping the wood into the slot in the lathe bed, as shown. It is only necessary that the drill rod rest against the piece being ground. If this precaution is not taken, vibration will occur as soon as the wheel touches the work and, increasing with remarkable rapidity, will result in the



FIGS. 1 TO 4. BENCH-LATHE ACCESSORIES

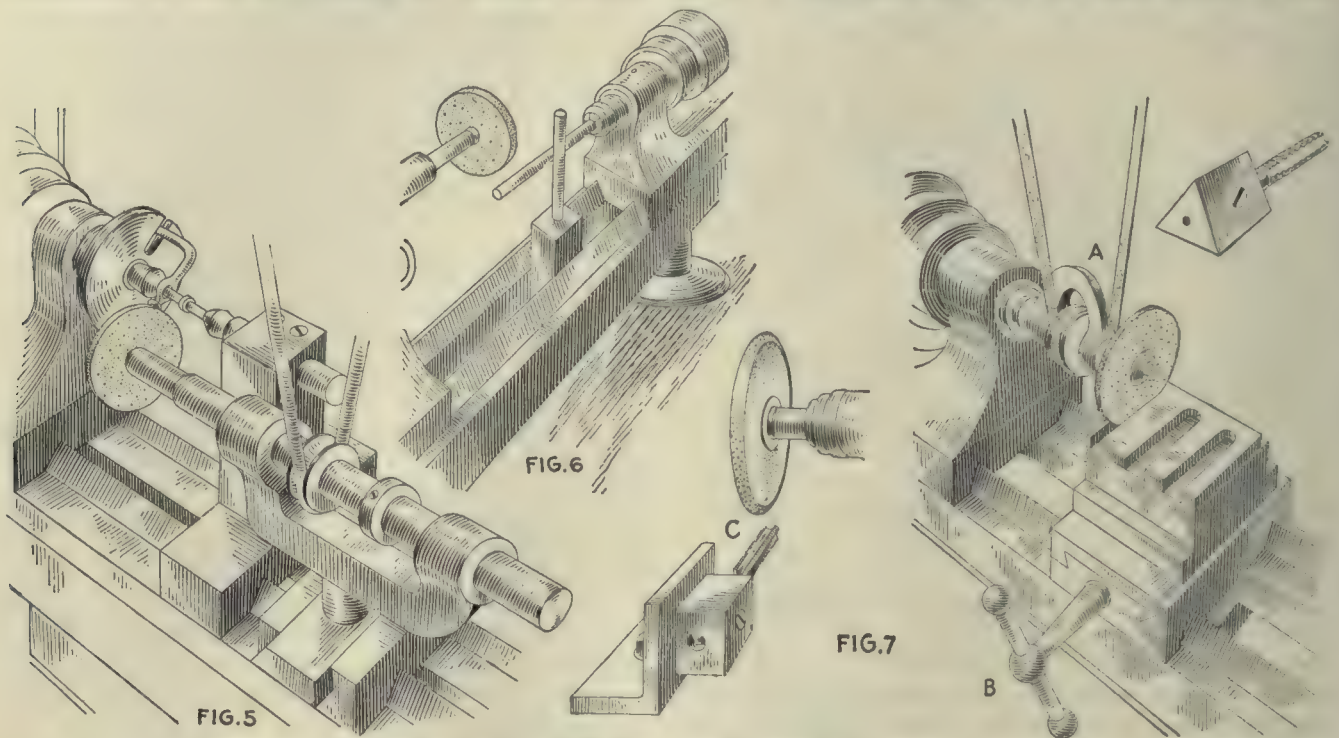
a watch-lathe head to the bench lathe. It is particularly desirable to use such a head in lapping small wire to size. The valuable feature of this application is that wire small in diameter may be rotated truly and at high speed. The table *A* is fitted in the T-rest holder. It may be adjusted to any desired height, and upon it the lap is operated.

almost immediate breakage of the piece. It seems that the slender bit of drill rod resting against the work counteracts the vibration.

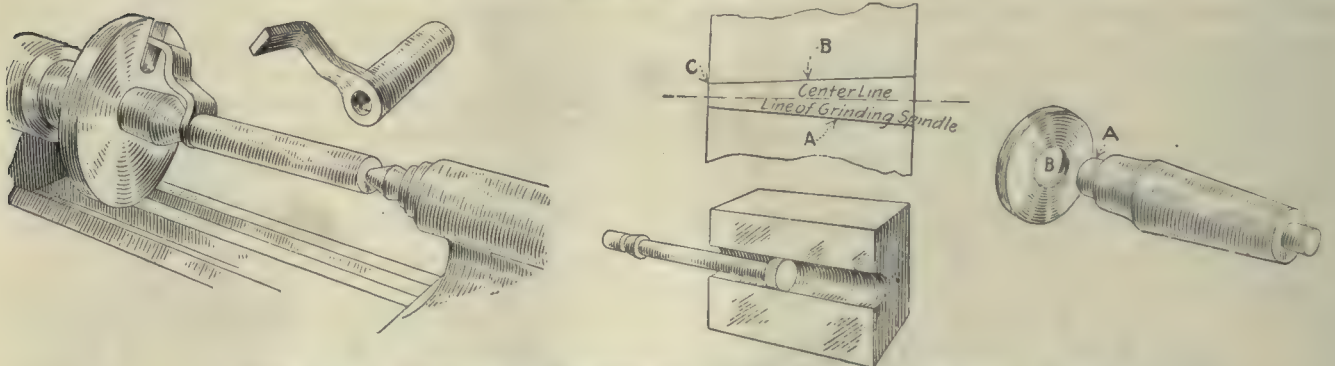
In Fig. 7 at *A*, *B* and *C* is shown the high-speed grinding attachment for the bench lathe. As at *A*, this attachment is held in the spindle of the lathe, which is locked

when this tool is in use. While the uses of this tool are many, only a few are shown. With the addition of a special cross-slide, snap gages may be set up and ground and lapped, as shown at *B*. Since this grinding attachment may be adjusted to reduce vibration and end play to a minimum, its value for grinding the openings in snap

the hole in this way it is necessary that the spindle be parallel to the center line of the lathe. This is determined as in Fig. 9. After the hole has been ground so that the lap or wheel touches all points at *A*, the lap should be brought over to the side *B*. If the grinder is improperly set, with the result shown—a hole



FIGS. 5 TO 7. GRINDING IN THE BENCH LATHE



FIGS. 8 TO 10. INTERNAL AND EXTERNAL GRINDING ON THE BENCH LATHE

gages may readily be seen. At *C* is illustrated the application of this attachment for grinding the flutes of taps after hardening. The block holding the tap is square or three-sided, according to the number of flutes, and the hole is central to the sides. The angle plate is clamped to the lathe bed and the block properly located when in operation by sliding against the angle plate. The flutes are ground by hand in quick order.

For grinding a piece in the bench lathe it is desirable to grind to a finish without reversing on centers, as the piece may not run dead true when reversed. If an ordinary driving dog is used, the piece cannot be ground at one setting unless a projecting lug is left on the piece, and this is sometimes objectionable. By bending up some sheet metal, as in Fig. 8, and soldering to the piece as shown, the latter may be ground over the entire length without reversing it on the centers.

A very trying task for the toolmaker is grinding a small hole to uniform diameter at all points. To grind

larger at the front—the lap when moved transversely will touch only at *C*. By testing in this manner the slightest error may be detected.

While a diamond-charged lap is preferred for grinding very small holes, grinding wheels may be used as small as $\frac{1}{16}$ in. in diameter. Fragments of broken wheels can be drilled a little larger than *A*, Fig. 10, and cemented on *A* with shellac. Care should be observed that the shellac does not get on the cutting surface of the wheel. A good feature of this way of holding the wheel is the absence of a nut and washer at *B*, thus allowing the face of the wheel to be used if necessary.

While speaking of the slide grinder as an accessory to the lathe, I think it well to say that many operators do grave injury to this tool by using oil on the spindle. Owing to the construction of the tool, there is no compensation for wear other than relapping the spindle and making new bearings. The oil catches particles, thus converting the spindle into a lap.

Profitable Factory Costs*

By W. ROCKWOOD CONOVER†

SYNOPSIS—A study of the basic principles of factory costs from the threefold viewpoint of labor, material and expense. The important items under each head are listed. Foundry costs should be separated from all others. The importance of accurate estimates of the probable costs of new work.

So much has been written upon the subject of cost accounting and correct methods of compiling costs that it is doubtful if any new ideas can be advanced that would possess more than a relative value, except in isolated or individual cases. Nearly every factory manager and every expert accountant has his own distinct views of the work of cost accounting and costs compiling. There is great divergence of opinion as to what constitutes general expense, or overhead expense, as it is commonly called, and its relation to direct labor or to material as fundamental bases of computation. Development, cost of tools and patterns and many special items are factors that influence to a greater or lesser degree the various processes of reasoning controlling the numerous systems in vogue. And the system adopted and followed in any given factory is usually largely dependent upon and governed by the opinion of some individual expert or department head.

All this may or may not be for the best interest of the business concerned. It may seriously handicap sales and influence profits adversely. Sometimes the practice followed, although arbitrarily set up, continues to be retained notwithstanding arguments in favor of its abolishment, because of the conviction of the management or chief accountant that it serves the purpose of the individual factory most efficiently. It is evident that any system to be successful must be fully applicable to local conditions in the factory where it is installed; and when this fact has been well established, the practice should not be disturbed by changes in official or department heads. One of the chief drawbacks to modern systems of cost accounting is the lack of judgment shown by their promulgators in attempting to install them in factories where they do not apply. And this element of inapplicability in these instances frequently brings condemnation upon a system that under other conditions would successfully operate to the profitable conduct of the business.

It is proposed to confine the discussion to several important features constituting what may be termed proper, or profitable, costs and to factors that directly affect and influence the building up of such costs, such as administrative expense, commercial, purchasing, engineering and some general items of expense. The successful and permanent continuance of an industry manifestly depends upon the correctness of the fundamental data upon which the selling prices are based. This places a large degree of responsibility upon the manager and various department heads. High costs may be due to a lack of wise judgment and experience on the part of administrative

heads or to a tendency toward too great expansion of what may be termed purely official supervision. In our readiness to place the responsibility upon the shop foreman and upon direct labor we may be not only committing an act of injustice, but it is quite probable that we are only partly discovering the source of our trouble and are imputing wrongdoing where only a modified form of evil exists.

We must first analyze our official and executive departments and determine whether or not the forces of these offices have been expanded beyond a point of actual requirement or beyond a profitable ratio to other functions of the business that enter into our yearly cost account. The salaries paid may be high when measured by the degree of responsibility imposed or by the kind of ability secured, or higher than the annual profits warrant when compared with other similar lines of business. Then, too, improper conditions of labor in the shop and other influences tending to reduce the general efficiency of the working forces may be the result of lack of insight into modern industrial conditions on the part of executive heads.

SOME OF THE THINGS THAT MUST BE ANALYZED

Our analysis must go farther. It is necessary to look into our commercial and accounting offices, size up the force of clerks and men in charge and see what are the results of their work as compared with the outlay in salaries. Their methods of routine, duplication of effort or of record, consumption of supplies and many other items need attention. The purchasing department and all its functions should receive consideration. The practices observed in buying, the kind of contracts made and their duration, where materials can be obtained in the open market—all bear a most important relation to costs. We must investigate our engineering and drafting offices and study the size and qualifications of the force of assistants and the character of their work in its relation to labor and materials used in the manufacture of product in the shop. All the various classifications of expense labor in the factory, from foreman down to floor labor, also require critical analysis.

In establishing a new business we may go so far as to charge the expenses of organization, advertising and selling of stock, interest on investment and on funded indebtedness, and similar items into our commercial costs before fixing the selling prices of product. It is evident under any conditions that we should include in overhead expenses such items as administrative expenses, cost of commercial advertising, selling, telegraph, telephone, freight and express, receiving, shipping, light, heat and power, transportation, fire protection, insurance, taxes, factory supervision, clerical and other labor in the shop not classed as productive.

There are also the maintenance-of-property items, such as repairs to machinery and tools, repairs to cranes and other conveying apparatus, piping and wiring, electrical apparatus, miscellaneous office and shop fixtures and equipment. Making and repairing of nondurable expense tools and other tools not commonly considered as proper

*Prepared for the author's forthcoming book on "Industrial Economics." Copyright, 1916, Hill Publishing Co.

†Factory economist, General Electric Co.

development charges in compiling costs, as well as the repair and upkeep of patterns, dies, molds, etc., all constitute important factors in the sum total of the factory's overhead charges. Labor in the engineering and drafting departments, which cannot be classed as development, as well as experimental work and similar classes of unproductive labor, must also be included in the classification of general expense.

In some factories one or more of the items enumerated are excluded from the regular list of overhead charges usually embodied in the factory costs and are deducted at the close of the year from the profits of the business, as are also such items as correcting factory errors and defects, royalties paid for the use of patents, forfeits on contracts, welfare work, maintenance of restaurants, hospitals, social and benefit clubs, etc. If we prorate the yearly expenditure on these classifications against individual lines of apparatus or against decentralized sections of the factory or departments, we need to possess some equitable basis upon which to make a proper subdivision of the charges and to know whether this basis is correct in actual practice. Otherwise, we may be loading certain classes of product with overhead expenses that are not necessary or incident to their manufacture and in this manner be limiting the power of the sales department in securing business. If all these special charges are accumulated and prorated against all classes of product on the basis either of direct labor or of material, it is obvious that some individual types of apparatus will stand a greater percentage of overhead burden than properly belongs to them.

It is this phase of cost accounting that is leading some manufacturers to seek a method of determining the exact overhead expense directly chargeable to a given product, separate and apart from these indeterminate factors, which are usually either prorated over the several classes of apparatus as a whole or deducted from the year's profits as shown on the ledger in the final accounting. Not direct labor nor material nor machine tool furnishes a wholly satisfactory solution to the problem or a basis sufficiently accurate and flexible to meet all conditions.

RELATIVE IMPORTANCE OF LABOR AND OTHER EXPENSE ITEMS

Where the labor consists chiefly of machine processes, the operating cost per hour—that is, the maintenance of the machine tool, cost of power, lubricating oils and compounds and also the cost of cutters, drills, taps or other expense tools, labor grinding, sharpening, etc.—is an overhead element directly assignable to these machine-made parts, but does not bear any direct relation to parts on which no machine operations have been performed. In other cases bench work and assembling processes constitute the major portion of the direct labor; and here the machine tool, its upkeep and the power charges do not enter into the overhead expense connected with the production of such apparatus except as a negligible factor. The labor moving and handling may also be relatively small, so that we may be placing too large an overhead burden upon this apparatus if we use a flat percentage of direct labor as a basis, which includes all expense charges of the factory as a whole.

In the big machine-building and construction plants material often constitutes a large fraction of the cost, the labor operations being few or short, with the exception of

the labor handling, which in the case of castings of heavy tonnage is out of all proportion to the labor handling the smaller detail pieces and may sometimes exceed the cost of machining. In the production of all this type of heavy apparatus the labor handling by the crane and floor gangs goes into overhead expense, while the machine processes, often relatively small, constitute the direct labor charge. It is also true that in the manufacture of small devices consisting of valuable or precious metals the material may constitute the greater proportion of the cost.

The space occupied in a building for the manufacture of a specific line of product, such as space for bench work, assembling or machining of parts or for storage and handling of materials, is also a factor deserving consideration in its relation to maintenance of property, or interest and taxes on investment and real estate, as elements of overhead expense.

It will be recognized that any single basis used for determining the percentage of overhead charge to be included in the cost will not be uniformly applicable to a large variety of product and will represent the true condition in comparatively few instances. It is necessary, therefore, for the manufacturer to study carefully all the conditions in his factory which bear a relation to this question before determining upon a system that may simplify the work of allocation and insure correct and profitable costs.

FIND AS MANY EXACT EXPENSE DATA AS POSSIBLE

It is well, as far as possible, to obtain exact data of all expense capable of direct application to a given line of product or device and prorate only such miscellaneous items of expense as are plainly applicable to the factory as a whole, such as light, power, heat, taxes, insurance, transportation, receiving, shipping, etc.; also to ascertain by careful analysis what are the conditions that bear a definite relation to the cost of each specific device and by this means establish a sufficient variation in the schedule of overhead expense percentages to render possible a more exact application of these overhead charges to the several lines of product manufactured.

If we go too deeply into these analyses, however, the expense of obtaining the desired data will be excessive and out of proportion to the benefit to cost accounting derived. It is this fact that leads many manufacturers to use a flat percentage for overhead, applying it to all the product of the shop, or at least a separate overhead percentage for each individual line or classification of product. This latter practice is obviously necessary in the case of decentralized departments or shops in large industrial plants where the flat-percentage plan is followed, if we are to avoid overloading one class of product with expense burden that may properly belong to apparatus of a different class. A proper amount of analysis undoubtedly tends to more strongly defined lines of application and to more intelligent and careful investigation and study of expenses on the part of each department head. Just where to stop in the process of segregation and begin pooling for general application is a problem that is bothering many manufacturers today.

The foundry should be handled as a separate manufacturing department and credited with its product like any other shop. All direct and indirect charges may be ascertained without difficulty, except such general items as administrative and some few special expenses that have to

be prorated in any case. The value of real estate and buildings, machinery and tools, amount of power, heat and light, productive materials and general foundry supplies may be recorded and computed as easily as for the machine and assembly shops. The productive labor should be divided into the four principal classifications of (1) melting, (2) molding, (3) core making, (4) chipping and cleaning, which permits a proper segregation of all labor and materials employed in connection with these processes, except such items as come under the head of nondivisible and require to be prorated on the basis of direct labor or tonnage output. Most of the labor and materials employed in the foundry can thus be separated and applied where they belong and a correct cost per pound obtained for each division of the productive work, which renders the computing of the final total cost per pound more accurate and satisfactory than can be obtained under any other method.

The segregation of expense items in the foundry is important in order to obtain as far as possible a correct allocation of overhead charges against the four classes of productive labor. It is evident that certain expense items, such as supervision, crane service, floor labor, etc., are not applicable alike to all classes of castings. There must be a difference in the amount of overhead charge that may be correctly applied to large and small castings in making up the cost per pound to use in charging out to the several shops or to outside customers. The time of supervisors on molding, core making, melting, chipping and cleaning can easily be segregated, as can also the time of cranemen and laborers engaged directly on these processes and not performing service of a general nature. There are also certain maintenance-of-property items, such as repairs to ovens and furnaces, pattern repairs and alterations, that may be subdivided among melting, molding and core making in the first instance and between molding and core making in the latter. Making and repairing wooden flasks and templets are also expense items that are subject to allocation.

There are in the foundry several classes of expense labor that must necessarily be considered of such a general nature as not to be capable of subdivision and specific application. Some of these are general supervision, stock keeping, unloading cars, packing, shipping, general clerical labor in the foundry office, handling patterns, mixing sand, cleaning up, etc., and all general maintenance-of-property items. We have also to consider under the head of general or nondivisible such items as insurance, taxes, depreciation, unassignable freight, inventory work, traveling expenses, errors and defects, welfare work, etc.

The consumption of expense materials in the foundry, such as coke, and miscellaneous shop supplies, except such as are nondistributable, can be kept account of to good advantage and applied to the processes of melting, molding and core making.

A proper system of timekeeping and records should be established, which provides a series of separate account numbers covering the different classes of labor performed and materials used on the various lines of foundry production work. By this means a considerable percentage of the foundry's overhead charges can be rendered capable of analysis and correct application to the several direct labor processes and a more satisfactory and just basis of cost accounting and compilation secured than is possible when all expense labor, materials and miscellaneous over-

head items are pooled and a flat general expense percentage used. The advantages of this method will be readily perceived in charging out castings to the other manufacturing departments and also in establishing selling prices when competing for outside trade.

MATERIALS AS AN ITEM IN FACTORY COSTS

Material constitutes one of the chief fundamental elements of factory costs. Some manufacturers use this item as the basis for applying overhead expense. Whether it is used for this purpose or not, it is obviously one of the factors in cost accounting that deserve our careful study and attention. From the conception of the design, through all the phases of engineering, drafting, molding and machining, we have to consider the important relation it bears to profitable costs.

The purchase of raw materials is a function directly affecting the work of establishing proper costs. In addition to the instructions of the engineer, specifying the use of the correct kinds of material, the purchasing department, with its purchasing powers, bears a definite relation to economical shop production. This is true not alone in reference to those materials known as productive, which enter into the manufactured product as a component part and are accounted for as one of the basic items in the factory cost, but it is also true in reference to other classes of materials, such as miscellaneous shop supplies, materials for maintenance of property, general repairs, etc., which enter the cost as elements of the total overhead charge.

The consumption of this latter class of materials often does not receive the attention that it merits in its relation to profitable factory costs and is often looked upon as a relatively unimportant matter. The purchasing department is not only able to secure advantageous prices through competitive bids in the open market, but it is also in a position to render valuable assistance to the engineer, factory chemist and foreman in making substitutions of materials of equal or better value and often at a reduced purchase price. Buying materials in stock lots, where it does not involve the tying up of valuable capital for too long periods, often aids in reducing costs, not alone through the advantage gained in initial price, but also through enabling the shop to produce in quantities at lower labor prices.

In this connection it should be mentioned that the provision of adequate stockrooms, as well as an ample supply of accumulating racks, conveying apparatus and other equipment that facilitates the procuring of materials quickly by the workman, bears a distinct influence upon factory costs. When large quantities of productive materials are carried in stock, the interest on the investment in such materials deserves consideration in its relation as an overhead charge to the cost of the apparatus for which the materials are purchased.

It is always desirable that the design of the engineer, as far as practicable, should call for standard commercial sizes of materials. Special dimensions and grades that involve the making of special tools and equipment by the producer always mean increased purchase price and are to be avoided. When the commercial sizes cut to waste, it is desirable to have the contract call for special dimensions, if this can be done without undue increase in price. Frequently the increase in price is more than offset by the material saved.

The consumption of all classes of shop supplies and expense repair materials should be reduced to the lowest limit consistent with manufacturing conditions. All these items can be kept within the limit of economy by a proper system of control. The foreman should know what materials his men are using and to what advantage they are being used, as having a direct bearing upon the cost of the product of his department. He should teach the workmen the economical use of the various fabrics employed and should make it clear to them that wasteful practices not only tend to increase cost, but may result in loss of business and consequent loss of employment to themselves.

Excessive stock on castings or bar shapes demands consideration. Any material in excess of that required for properly cleaning up and finishing the part necessitates increased machine labor and higher piece prices paid to the workman. It not only involves a loss of a portion of the original purchase cost, but also involves the tying up of valuable machine tools for a longer period than is necessary, delays production and causes waste. All patterns should be constructed with a view to avoiding these unnecessary losses.

CONTROL OF SHOP SUPPLIES AND REPAIR MATERIALS

Castings often show a considerable variation in weight. It is important, therefore, to see that the correct weights are ascertained and used in the cost accounting. Castings purchased from outside foundries should be checked as to weight when received and should be tallied by the receiving department. All defective castings and defective materials of whatever kind should be accounted for and recorded on the reports of the inspector. Every item of this kind bears some relation, either directly or indirectly, to manufacturing costs.

The scrap from productive materials should receive attention. In some cases this represents a large fraction of the year's profits. Where a considerable portion of the casting or material is cut away in machining, it is often desirable to deduct the value of this scrap from the cost of the original piece.

Nothing in the shape of material is too small to merit the manufacturer's attention. When it is discovered that the sales department is losing business and orders are going to competitors, it is an indication that conditions in the shop need investigation in relation to costs. Extravagant and wasteful practices in the use of materials and neglect to adopt proper measures of economy are usually found to be the underlying causes of a large percentage of the losses of trade.

DIRECT LABOR PRODUCTIVE

We now have the direct productive labor to consider. Many manufacturers use this as a basis upon which to apply the overhead expense. In certain lines of factory product the basing of indirect labor and expense upon the direct labor works out satisfactorily on the average. Where a number of machines of a given type are operating on the same kind of product or product which is closely similar in design and character or where the manufacturing conditions are of a generally uniform character, this method of basing overhead is sufficiently accurate to merit its adoption. Under these conditions the amount of expense to be applied to an individual type or design can also be determined within reasonable limits.

This method is simpler and less expensive to operate than the practice of determining and recording the exact amount of overhead charge involved in the performing of individual operations or in making complete individual parts of apparatus.

Where the product is of a varied and miscellaneous character and where there are few machine tools of like design and capacity, the factor of tool-operating cost and other elements involved in the various shop processes bear so little relation to each other and present so many features lacking in uniformity that it is sometimes desirable to determine, even at greater expense, the exact amount of overhead that may be applied with comparative accuracy to each detail part. In a majority of industries there are numerous instances where more exact data on the overhead expense that correctly belongs to an individual piece of apparatus would place the manufacturer in a better position to secure business which, because of the lack of such information, often goes to his competitors in the trade. Some jobs are charged with more expense than justly belongs to them, while in other instances the apparatus does not bear the full share of burden proper to have been assigned to it.

The direct productive labor is evidently a large controlling factor in costs. It may be said to be one of the chief controlling factors in successful business operation, and in some degree the productive workman in the shop ultimately exerts a directive force in all business enterprise. Outside the sphere of purely automatic machinery the manufacturer is entirely dependent upon the employee, individually and collectively, for his product. In automatic work he is only partly a negligible factor. The workman has more to do with successful manufacturing than we are ready to recognize; he is a prime factor in the yearly profits. How to direct productive labor with the highest degree of efficiency and how to make it a permanent, effective element in establishing profitable costs are problems the managers of the big industries of the present day are striving to solve. In this effort they are dependent in a marked degree upon the assistance of superintendents and foremen and under executive heads.

INFLUENCE OF WORKING CONDITIONS ON LABOR COST

It is of prime importance to establish proper conditions of labor in the shop and to supply the workman with proper tools and facilities for the performance of his tasks, if we are to secure advantageous labor rates on the various productive processes. The securing of these conditions is one of the functions of the administrative heads; and here is where the selection of a superintendent or foreman who is not only a good business executive, but who has had extended shop training and possesses a knowledge of the essential features of production directly bearing upon the subject of costs is of the utmost importance. It is vitally important to see that all machine tools are operated at the highest speed commensurate with safety and economy in operation, also to see that all tools are kept busy and not allowed to stand idle, that materials are supplied to the workman within easy access and with the least amount of physical labor on the part of the operator in handling. It is necessary that the foreman make wise selection of his men for the various tasks and change them to other tasks where advisable and if greater output and better quality of workmanship may be secured. He should study the different machine and

assembly processes and discover where it is of advantage to recommend manufacturing detail parts or complete apparatus in stock lots and where new or special tools and devices will result in lower labor costs.

Finally, the labor prices, whether day or piece rate, must be just and equitable and the method of remuneration such as will stimulate the workman to increase his productive output as far as possible consistent with health and contentment in his work. Reports on investigations of labor conditions, conducted by the Government Industrial Commission, tend to show that the lowest factory costs exist in those industries where the most liberal system of wage remuneration prevails.

We must next see that a proper system of job cards is employed to cover the various tasks and that the time occupied on each separate operation is correctly reported. It is advisable to issue a separate job card for each operation or combination of operations to be classified as an individual unit or task. In this manner the exact time spent on the several machine and assembly processes can be more accurately obtained for purposes of cost accounting.

There is sometimes a tendency to put in extra time in the shop on machines that do not vary essentially from an established standard type, such as machines with lengthened shaft or other minor changes. The cost may be increased abnormally where the changes are but slight. Such extra time for changes in design, which do not involve additional labor, is to be guarded against. It requires no longer to assemble and test a motor having a moderately increased length of shaft than it does to assemble and test the standard machine, and yet just such instances of variation as this and similar modifications are often the cause of additional time creeping into the cost.

Counting, checking and weighing of parts as they come off the machines, careful inspection, reporting of defective work, etc., all have a direct bearing upon accurate costs.

Too much emphasis cannot be laid upon the necessity for careful investigation and attention to all the productive processes of the shop. No detail is too small for consideration in the vital relation it bears to the problem of establishing profitable and successful costs.

Finally, it will be recognized upon critical analysis that it is not the correct accounting and compilation of costs which is of supreme importance to the manufacturer, but the securing of such economic conditions in all offices and shop departments throughout the entire organization as will render possible, in connection with proper accounting, the establishment of costs insuring a continued and profitable business.

ESTIMATES ON COST OF NEW WORK

The work of preparing estimates should be done with care and judgment. It is not sufficient to compare new designs with previous types of standard apparatus and make allowances for certain variations on a guesswork basis. A small and apparently unimportant change in the design may involve the making of one or more new patterns, dies, molds or other tools, or some modification in machine-tool equipment. It is therefore necessary to investigate the present tool equipment available and to ascertain what new tools, patterns, etc., are required or what changes in present tools are necessary to be made.

The cost of engineering, drafting and other developmental and experimental labor should be looked into carefully, so that none of these items are lost sight of in the preparation of the estimate. All these factors of development should receive special attention, and the labor and material in connection with them should be estimated with the greatest accuracy possible, as they will later be checked up during the regular work of cost compilation, and if inaccurate the final result may show a loss.

Materials must also be considered as having a bearing upon the estimated cost. If the materials needed to produce the changed design are not in stock, it is important to learn the prices that will have to be paid for raw stock and whether sufficient quantities can be obtained to keep up production and meet the shipping requirements.

In preparing estimated costs of entire new designs it is important that the estimating clerk consult with the engineer, pattern and tool foremen and the foreman of the foundry and machine shop and obtain the fullest data possible before going ahead with his work. These men are often able to suggest some modification in the prospective customer's specifications or drawings that will permit a reduced cost figure and help in securing the business. This phase of cost estimating is not always given the attention that it merits. Sales are undoubtedly lost in some cases through a too hasty preparation of the estimate.

The work of preparing estimates cannot be superficially done and secure accuracy. It requires an extended and thorough experience in cost accounting and a fair degree of knowledge and judgment of shop processes. If the estimating clerk is fortunate enough to have had several years of shop training along mechanical lines, he is in that respect much better equipped to pursue his work and secure the practical results desired.

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Master Plates and Their Use in Gage Work

By A. R. EVATS

As this article is simply for the purpose of describing the methods of procedure in manufacturing gages, numerous gaging points, the making of which has been described before, have been omitted by the writer.

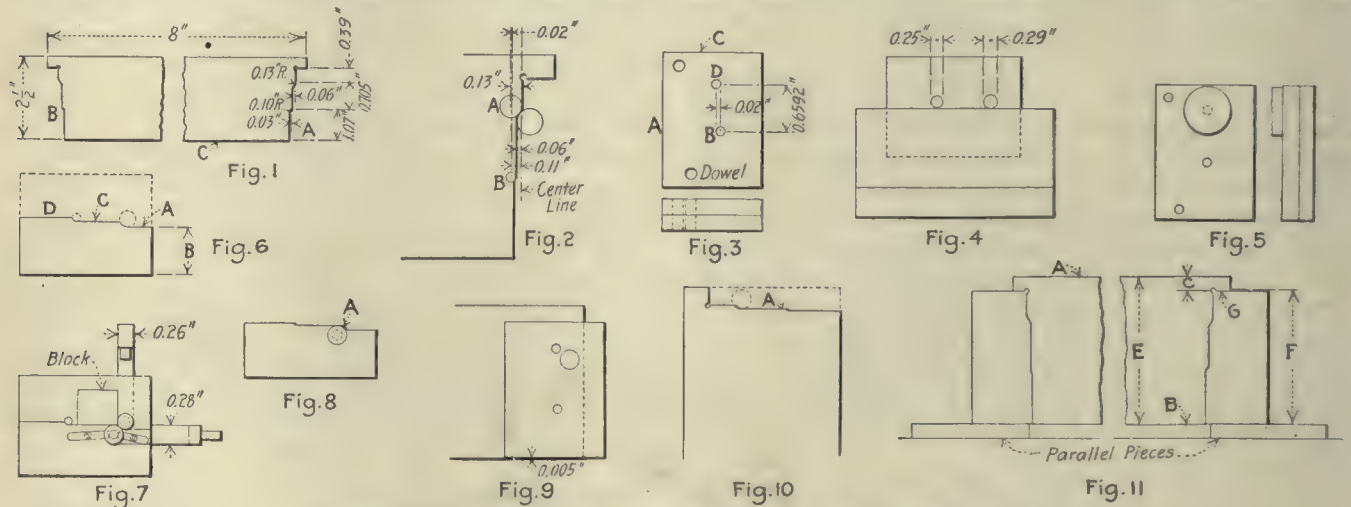
Some of the dimensions at *B*, Fig. 1, were the same as at *A*, while others were only 0.001 in. smaller. Thus the gage maker was held to very close limits when working the gaging points, which need not be located in any relative position to other points of the gage except the part *C*, Fig. 1.

In Fig. 2 the center of the circle *A* is 0.130 in. from an imaginary line running parallel to other surfaces of the gaging point. The center of the circle *B* is 0.110 in. from the line, while the location of the third circle is unknown to the gage maker. It was beyond his ability to figure the location of this center; but as will be seen, the difficulty was easily overcome by making the master plates.

Two pieces of flat stock were machined and ground, as shown in Fig. 3. They were somewhat longer than the entire length of the gaging part *A*, Fig. 1. The pieces, after having been doweled together, were swung in the bench lathe, and the hole *B*, Fig. 3, was reamed approximately in the desired location. This hole was reamed exactly 0.100 in. in diameter. A ground parallel was then

strapped to the faceplate and against the side *A* of the pieces. A block was also clamped to the faceplate and against the side *C* of the pieces, which were then re-clamped for boring the hole *D*. By placing a 0.020-in. feeler-gage blade between the pieces and the parallel, also measuring the distance between the block and the side *C*, the pieces were located, clamped, bored and reamed to 0.100 in. in diameter. Studs were then inserted in the holes, and upon measuring with the micrometer an error of 0.0005 in. was detected. The piece was relocated and the error corrected by re-boring to a larger size.

The amount and direction of relocation were determined by means of the test indicator. The location of the holes to the sides was obtained by grinding the sides of the pieces in relation to the holes. A pair of shoulder studs were turned to fit the holes *D* and *B*, the larger portion of the studs measuring 0.250 in. and 0.290 in. respectively. By inserting the studs and clamping the pieces to an angle plate that had been ground at the top, Fig. 4,



MASTER PLATES AND THEIR APPLICATION IN GAGE WORK

one side was ground parallel to the center line. A button was then turned to 0.770 in. in diameter and inserted in the hole *D*, Fig. 3. The side *C* was ground away until the wheel just grazed the button, Fig. 5, thus establishing the dimension 0.390 in. minus 0.005 in. for grinding after hardening. The opposite side was ground so that the distance to *C*, Fig. 3, measured 2.160 in.

The top plate was removed from the other plate and swung in the bench lathe. The hole *D*, Fig. 3, was re-bored to exactly 0.260 in. in diameter. This same plate was then milled and ground as shown by the dotted lines in Fig. 6. The surface *A* was ground to a finish first, until the surface was tangent to the remainder of the hole. Then the dimension *B* was determined, and the points *C* and *D* were easily brought to the desired form by measuring their position with relation to the dimension *B*.

It now remained to obtain the 0.140-in. radius on the top plate and a 0.280-in. diameter hole in the bottom plate. The plates were reassembled and a 0.260-in. stud inserted as in Fig. 7; also, the block was placed against the side of the top plate and clamped. The button, 0.280 in. in diameter, was clamped in position so that it touched the block and stud. Swinging in the bench lathe, this button was trued. After removal from the plates a 0.150-in. hole was bored and reamed through both plates. The top plate was removed without disturbing the other, and the 0.150-in. hole in the bottom plate was enlarged to

0.280 in. in diameter. The button seen in Fig. 7 was then reversed, the small end inserted in the hole, Fig. 8, and the stock removed at *A*.

While the bottom plate was made along with the top plate for the purpose of obtaining the radius 0.280 in. previously mentioned, it was also useful for transferring the hole to the gage proper. It was applied as shown by Fig. 9, 0.005 in. being reserved for grinding at the bottom of the gage after hardening. When clamped as shown, the hole was reamed through the gage. The gage was then clamped to an angle plate in the duplex miller; and with the spindle set vertically and armed with a good end mill, the stock was removed as in Fig. 10, *A* being milled until the bottom of the radius had almost been reached. The other steps were milled in relation to the step *A* by means of the graduated dials on the miller.

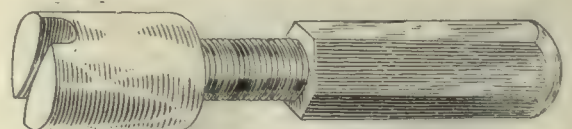
After milling, the gaging points were carefully worked by hand to fit the master templet. After hardening and grinding the faces, the gaging points were lapped to fit

the master templet. The gage was then ground as in Fig. 11. Set up as shown and clamped to a small angle plate, the side *A* was first ground; then reversing the piece so that the side *A* rested upon the magnetic chuck, the side *B* was ground away until the templets were flush. The dimension *F* was obtained by grinding at *G* until the dimension *C* equaled *E* minus *F*.

Rig for Inserting Oil Pipes

BY WALTER J. ORME

A simple but efficient rig for inserting oil pipes in transmission cases or gear boxes is shown herewith. A jack can be made of hexagonal stock, one end slightly convex, the other end turned and threaded. The threaded



RIG FOR INSERTING OIL PIPES

end may be fitted into a round piece of cold-rolled stock, concave at one end to avoid bruising the oil pipe. These jacks can be made of various lengths to accommodate cases. Pipes can be jacked against the walls of the case and bent as desired below the point of the jack.

Manufacturing the 1-Lb. High-Explosive Shell--I*

By ROBERT MAWSON

SYNOPSIS—In this article are shown the various operations followed in the manufacture of the 1-lb. high-explosive shell. The various machine tools are illustrated by photographs. The different attachments, special tools and other equipment used are shown by detailed drawings. The times of production are included.

The present European struggle has seen the development of many forms of warfare and many types of equipment. The first kind of shell that was made extensively was the shrapnel. The chief purpose of this shell was to break down the wire entrenchments and protect the attacking infantry by spraying the front with bullets between the attacking force and that being attacked. High-explosive shells, to be used in blowing up the trenches where the soldiers were entrenched, were then manufactured. This form of shell was found necessary because

Gas check must be a tight fit in the shell and must be set home so as to require great force to start out again

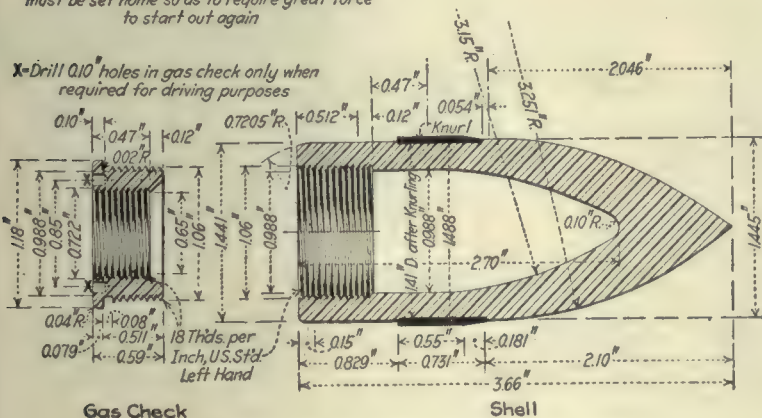


FIG. 1. DETAIL DRAWING OF 1-LB. SHELL

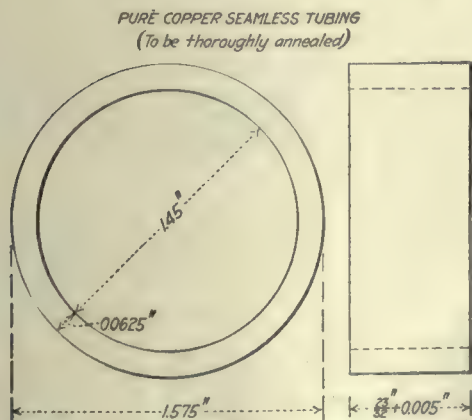


FIG. 2. DETAILS OF COPPER BAND

of the highly developed types of dugouts and defenses that the present war has produced.

This article describes the manufacture of the 1-lb. high-explosive shell. This shell is being used chiefly for

two purposes—in marine warfare, on a light type of boat used for patrol purposes to guard against attacks of submarines, and in a light type of artillery gun, where

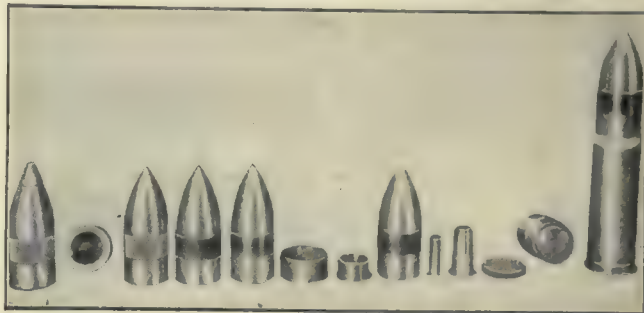


FIG. 3. PROGRESSIVE STAGES IN THE MANUFACTURE OF A 1-LB. SHELL

it is used to great advantage as a machine-gun destroyer. This gun has a range greater than a machine gun—3,750 yd. at 15-deg. elevation—and as it is light in weight can be handled with great facility.

In Fig. 1 is shown a detailed illustration of the 1-lb. shell and its gas check. A detail of the copper band as it is received at the factory is shown in Fig. 2. Fig. 3 shows samples from each operation followed, also the elements used in the manufacture of a shell.

The shell is made from cold-drawn bar steel $1\frac{1}{2}$ in. in diameter. The tensile strength of the stock is 70,000 lb., with an elongation of 20 per cent. and a reduction in area of 40 per cent.

The chemical analysis is as follows: Silicon, 0.03 per cent.; manganese, 0.66 per cent.; phosphorus, 0.094 per cent.; sulphur, 0.107 per cent.; carbon, 0.17 per cent.

In Fig. 4 is shown one of the automatics performing the first operations on the shell. The stock is fed against a stop for length. This stop is placed between the fourth and first stations on the turret of the automatic. The

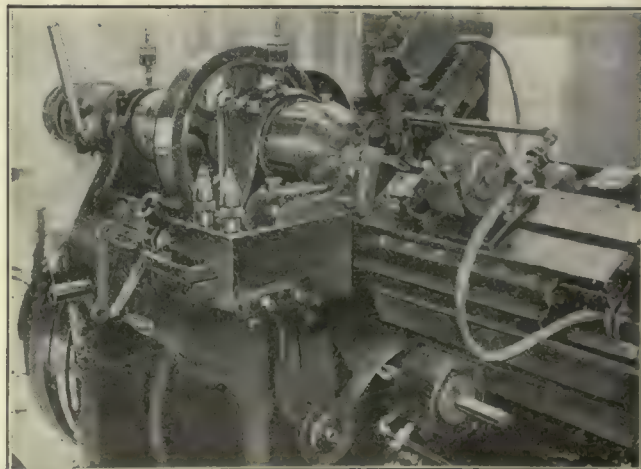


FIG. 4. GRIDLEY AUTOMATIC MACHINING SHELL

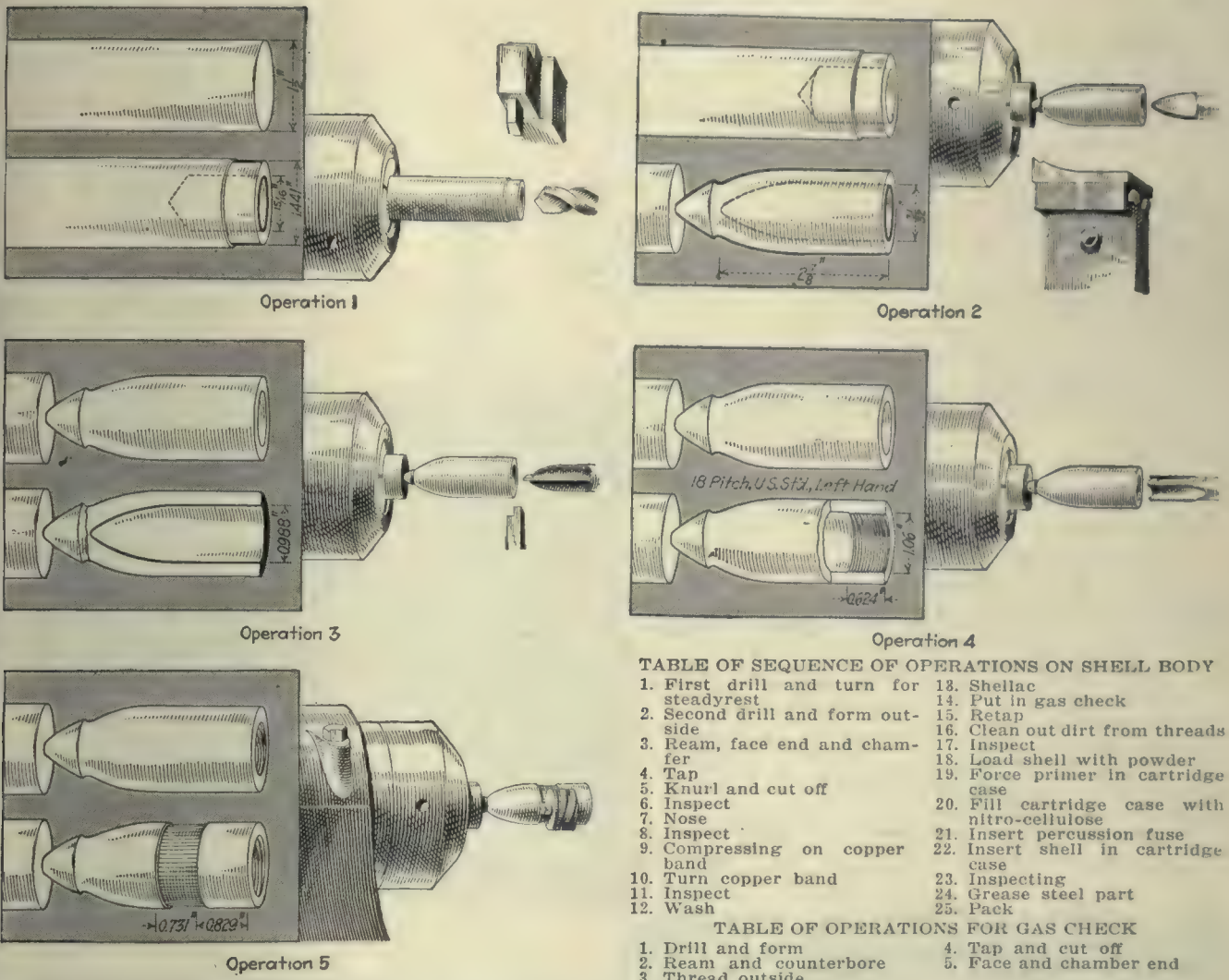
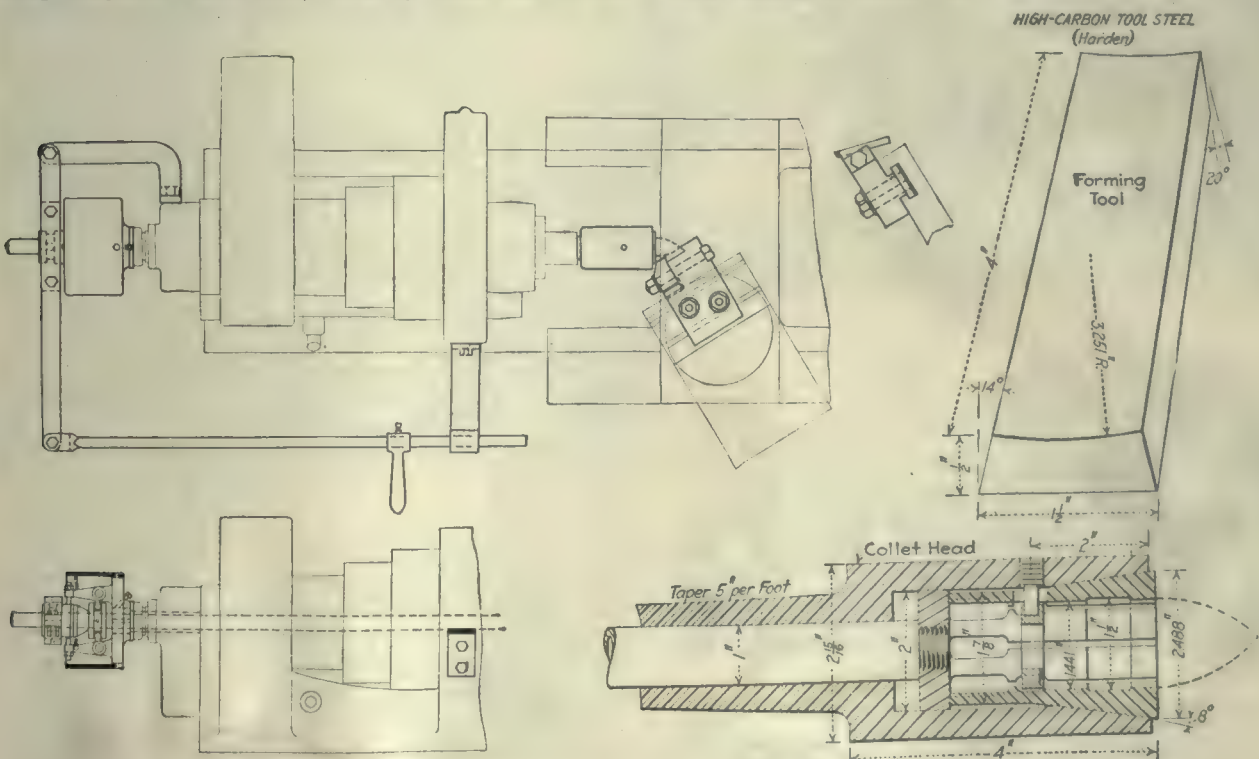


FIG. 9. OPERATIONS 1 TO 5: MACHINING BODY

Machine Used—2½-in. Gridley single-spindle automatic.
Production—12 to 15 per hr.
Cutting Compound Used—"Alco," made by Texas Fuel Oil Co.

References—Figs. 4, 5, 6, 7 and 8.
Note—Speed of machine when turning and forming, 180 r.p.m.; when tapping, 80 r.p.m.



FIGS. 12 AND 13. DETAILS OF TOOLS USED IN NOSING OPERATION

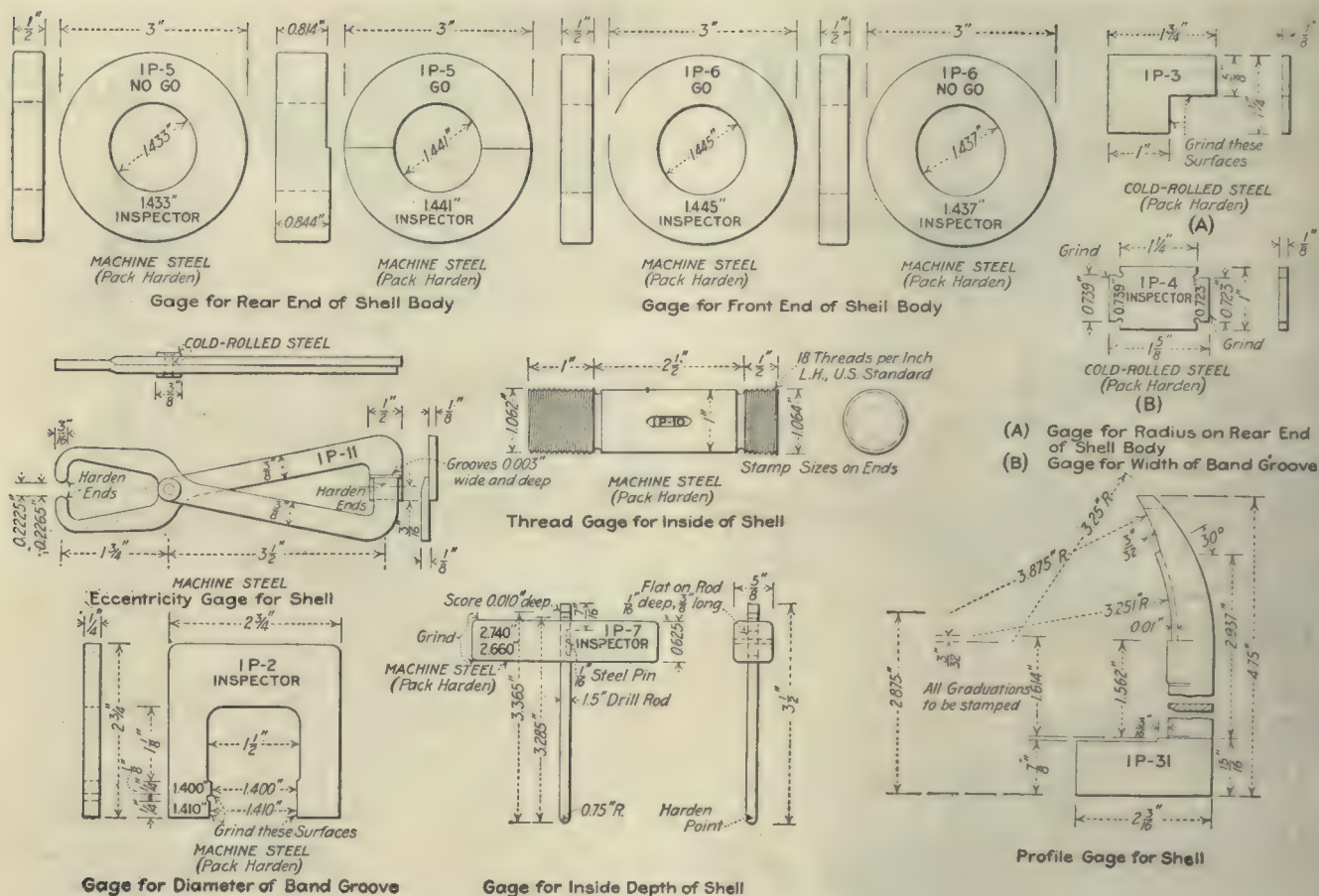


FIG. 10. GAGES USED IN INSPECTING THE SHELL BLANK

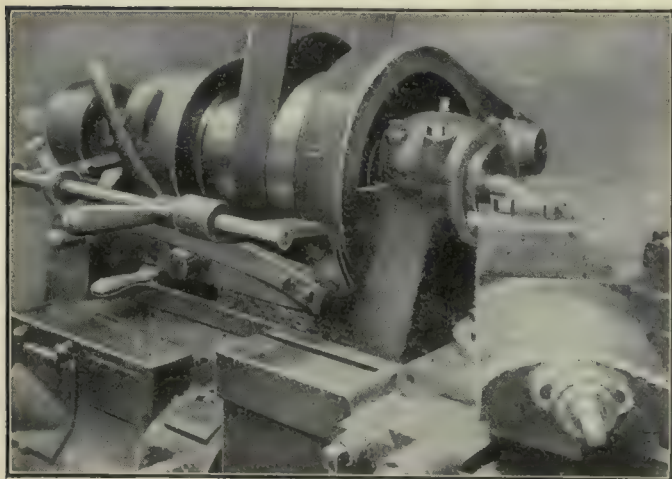
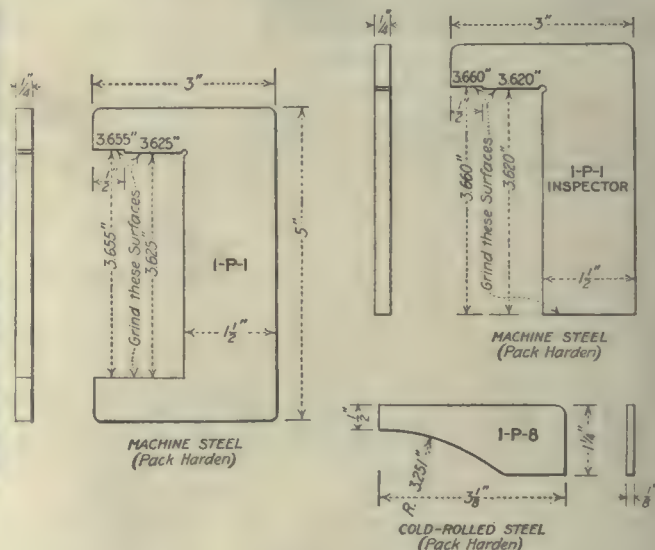


FIG. 11. NOSING THE SHELL



FIGS. 15 AND 16. GAGES FOR SHELL LENGTH AND NOSE CONTOUR

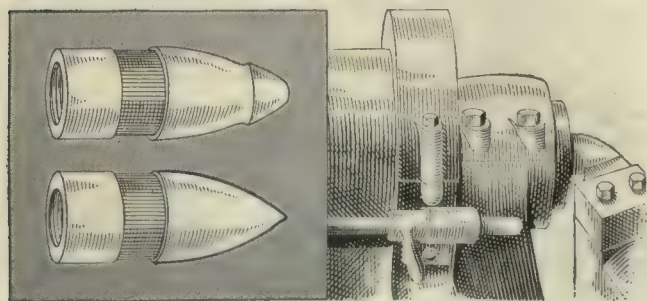


FIG. 14. OPERATION 7: NOSING

Machine Used—16-in. Reed-Prentice lathe.
 Production—70 per hr.
 Cutting Compound Used—"Alco," made by Texas Fuel Oil Co.
 References—Figs. 11, 12 and 13.
 Note—Speed of machine, 450 r.p.m.

the turret the hole is first tapped as the fifth operation. The recess for the band is then knurled and the shell blank cut off. During these operations the blank is again supported with the steadyrest. The reader's attention is directed to the type of cutting-off tool used. This is made with a contour similar to the nose of the shell, as by so doing, the amount of stock to be removed in the next operation is reduced.

Details of the tools used in the Gridley automatics are shown in Fig. 5. The gage used to test the drill when grinding is shown in Fig. 6 and the gage for the

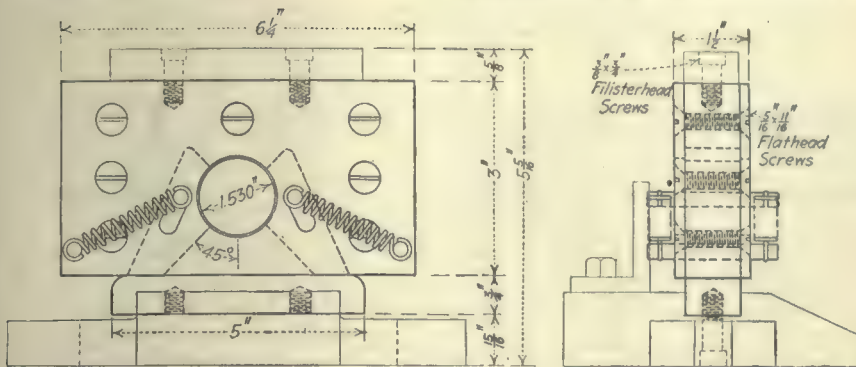


FIG. 18. DETAILS OF BANDING DIE

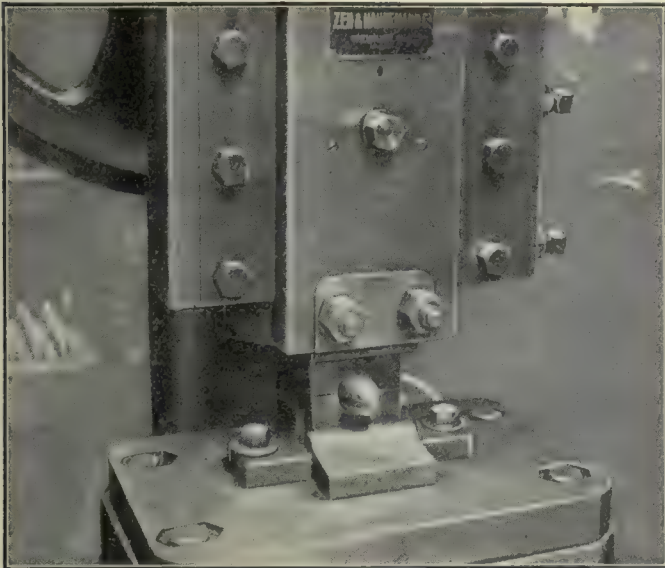


FIG. 17. COMPRESSING BAND ON SHELL

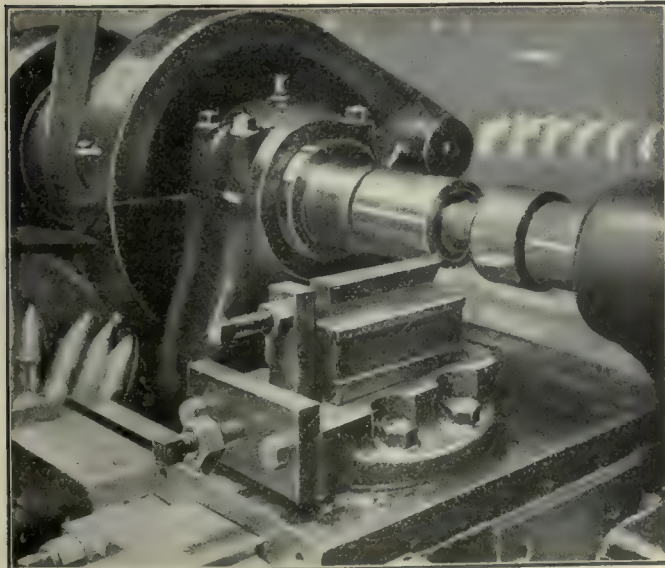


FIG. 20. MACHINING THE COPPER BAND

reamer in Fig. 7. The gages used on the automatic are illustrated in Fig. 8. The machining operations are also shown in diagrammatic form in Fig. 9. The shell blank is then inspected, using the gages, Fig. 10. The next operation is nosing, and a view of the machine performing this work is shown in Fig. 11. Details of the tools used for this operation are shown in Fig. 12.

It will be observed that the forming tool is made with the contour machined the entire length. By this proce-

ture the only thing necessary when the tool gets dull is to grind the end and raise the tool to suit. The grinding does not change the contour of the tool, as is obvious from the design.

When nosing, the shell is held by a drawback arrangement operated by hand. Details of this attachment are shown in Fig. 13. A diagrammatic illustration of the nosing operation is shown in Fig. 14 in detailed form.

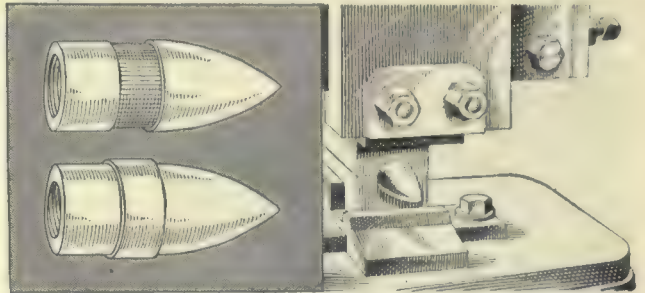
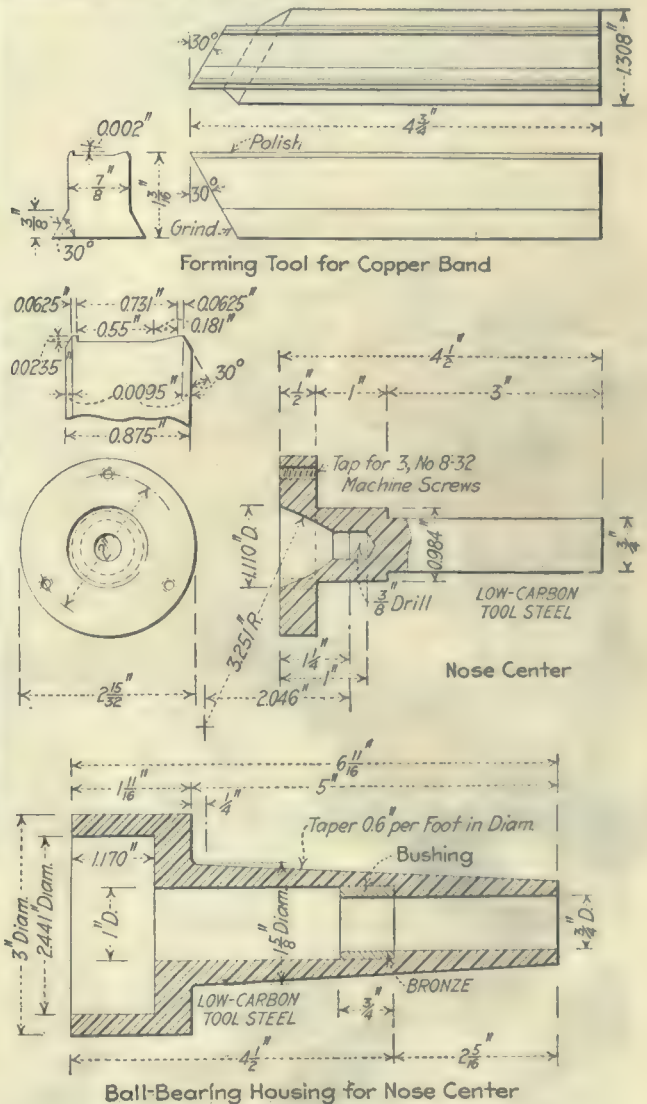


FIG. 19. OPERATION 9: COMPRESSING ON COPPER BAND
Machine Used—Zeh & Hahnemann Co. press.
Production—180 per hr.
References—Figs. 2, 17 and 18.



FIGS. 21 AND 22. FORMING TOOL AND DETAILS OF NOSE CENTER

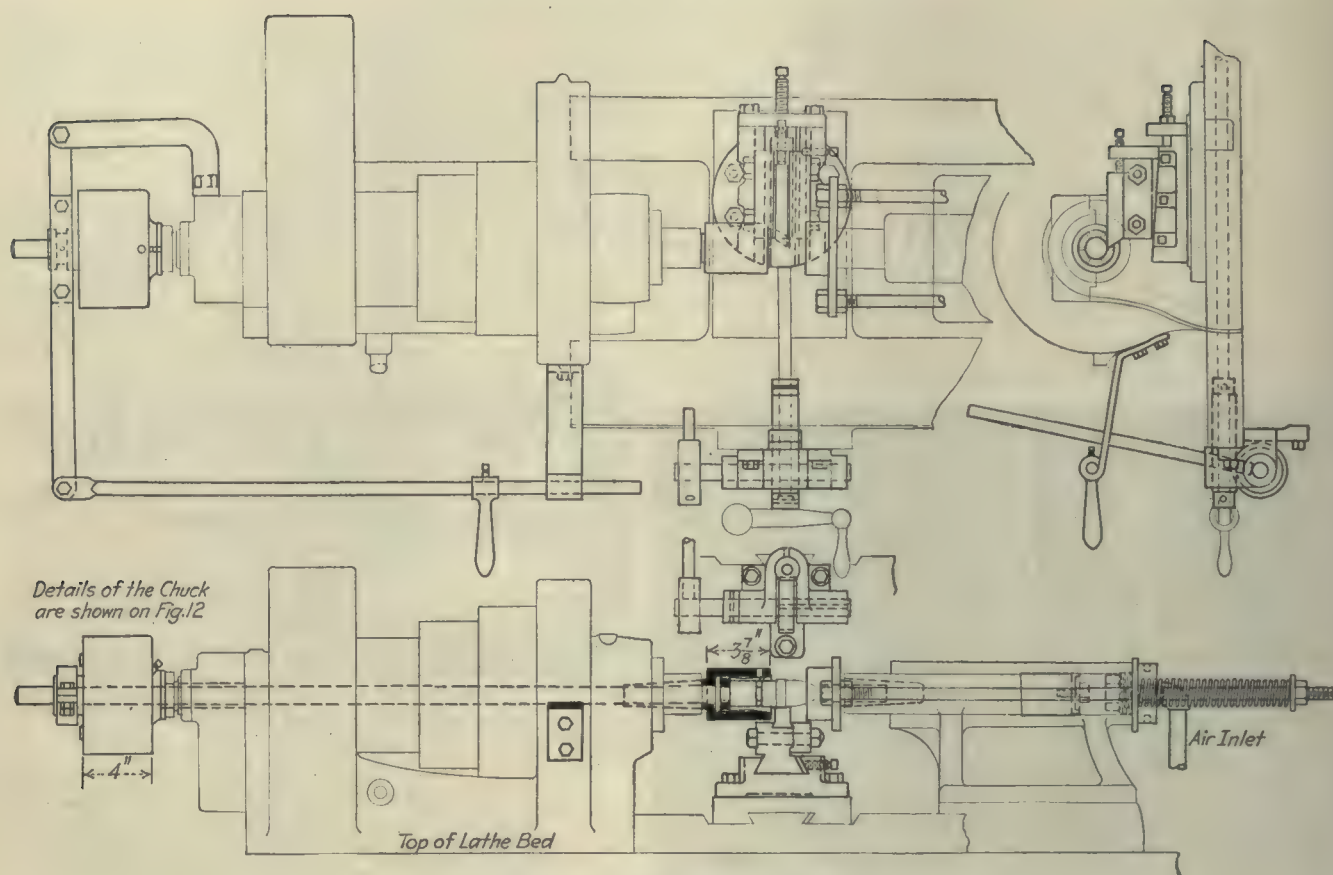


FIG. 23. MACHINING THE SHELL IN THE LATHE

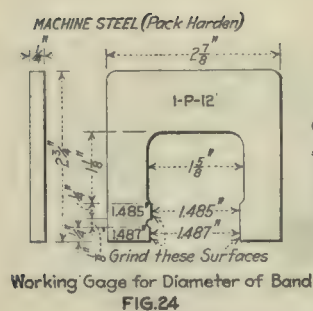


FIG. 24

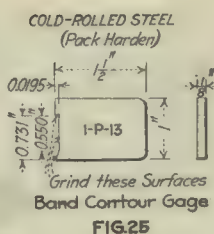


FIG. 25

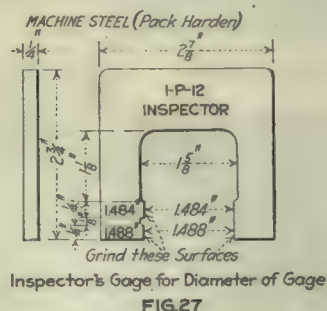


FIG. 27

FIGS. 24, 25 AND 27. DETAILS OF BAND GAGES

The copper bands are purchased in the dimensions given on the detail, Fig. 2. They are annealed in a crude-oil furnace at a temperature of 1,375 deg. F. The bands are passed in on one side of the furnace and out on the opposite side, sliding down a chute into a tank of water to complete the annealing operation.

An improved form of banding die is fitted to the press and is shown in detail in Fig. 18. The features of this tool are the inclined steel die blocks. These

are fitted with tension springs so that as the upper element of the die is raised the springs draw back the side blocks, allowing the shell to be quickly removed and preventing the shell seizing the dies after the copper band has been compressed. The banding operation is also shown in diagrammatic form in Fig. 19.

The copper band is next machined in the lathe, Fig. 20. For this operation the shell is held in a drawback collet operated in a similar manner to the lathe when machining the nose and shown in detail in Fig. 13. Details of the forming tool for the copper band are shown in Fig. 21. The nose end of the shell is supported in a center operated by air. Details of the nose center, the housing and the device for operating it by air are shown in Fig. 22. An assembled view of the shell in position to be machined is shown in Fig. 23.

The gages for use on the lathe are shown in Figs. 24 and 25. The turning operation is shown in diagrammatic form in Fig. 26. The next operation is inspecting the band; the gages used are shown in Figs. 25 and 27.

(To be continued)

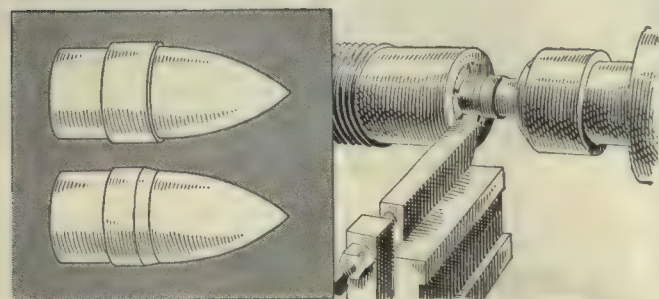


FIG. 26. OPERATION 10: MACHINING COPPER BAND
Machine Used—16-in. Reed-Prentice lathe.
Production—60 per hr.
References—Figs. 13, 20, 21, 22, 23, 24 and 25.
Note—Speed of lathe, 450 r.p.m.

The gage used on the lathe by the operator, for testing the length of the machined shell, is shown in Fig. 15. The shell is then inspected for length and contour of nose. The gages used for this operation are shown in Fig. 16. The shell is then taken to the press shown in Fig. 17 and the copper band compressed into place.

Letters from Practical Men

Cam-Cutting Fixture

The accompanying illustrations show a fixture for recutting cams. The outside diameter of the cam is $15\frac{1}{2}$ in. The circumference of the large part of the ball race

enough to allow the collar *J* and the top of the blades *G* to come within this part of the mill.

By adjusting the collar *J* the inside blades can be moved either up or down to regulate the length of cut and compensate for the loss in grinding. The blades *G* being

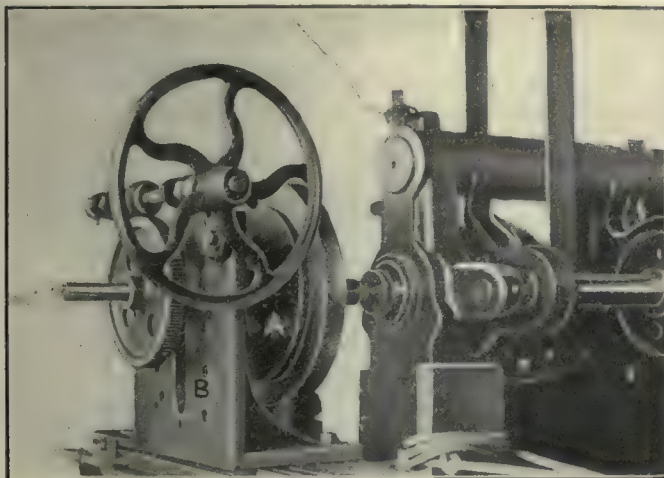


FIG. 1. REAR VIEW OF ATTACHMENT

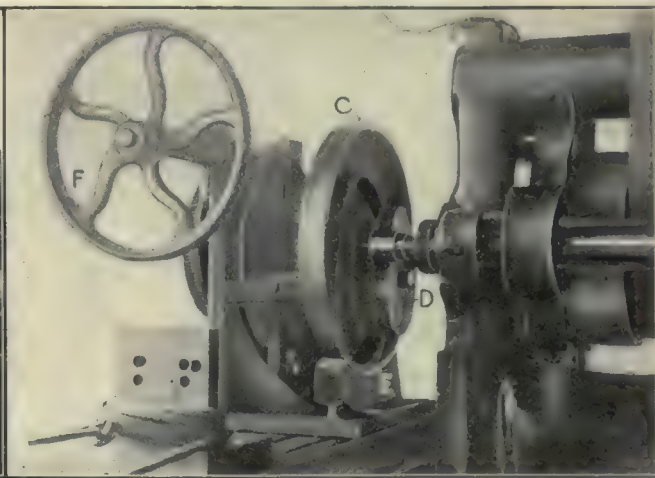


FIG. 2. FRONT VIEW OF FIXTURE

is about $31\frac{1}{4}$ in., and the size of the cam race before recutting is $15\frac{1}{8}$ in. in diameter by $1\frac{3}{8}$ in. deep.

The faceplate *A* is bolted to the angle iron *B* and acts as a bearing for the arbor. An arbor carries the cam *C*. At *D* is shown the master cam. It is fastened to the arbor by a key and bolted to the cam and faceplate.

A block of wood *E*, lined with fiber board, acts as a steadyrest or support for the cam and is adjustable. The faceplate has adjusting screws to take up any lost motion between the bore of the faceplate and the arbor.

The roll is held against the master cam by a weight, the screw being disconnected from the table. Rotary motion is given to the cam by turning the handwheel *F*. We have reset six cams with this fixture and have found the race to be within 0.001 in. at any part.

Central Falls, R. I.

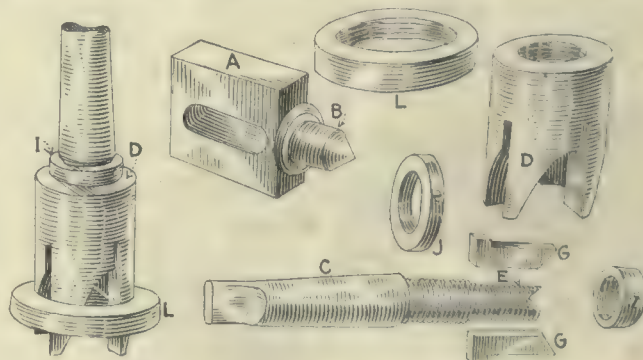
ROBERT A. SPENCER.

Combination Hollow Mill and Pointer

A combination hollow mill to mill and point the ends *B* on the casting *A* was made in the following manner: A taper shank *C* was turned to $\frac{7}{8}$ in. and threaded for the hollow mill at *D*. The lower part *E* was turned to $\frac{5}{8}$ in. and also threaded for the adjusting collar *J* for the inside blades *G*. Two slots were then cut in *E* to take the blades *G*, the slots being of sufficient depth to allow the blades to come flush with the surface of *E*.

A collar with a $\frac{7}{8}$ -in. thread, as shown at *I*, was made and put on *D* to act as a check nut for the mill. The other collar *J* was put on *E*. The blades were then inserted in the slots. A mill was made and put on the shank *C*. The $\frac{7}{8}$ -in. hole in this mill was drilled deep,

wider at the top, the collar *J* bears directly on them. The mill *D* can also be adjusted and the check collar *I* tight-



COMBINATION HOLLOW MILL AND POINTER

ened. These collars have setscrews to hold them. The collar *L* prevents the mill from springing.

Hyde Park, Mass.

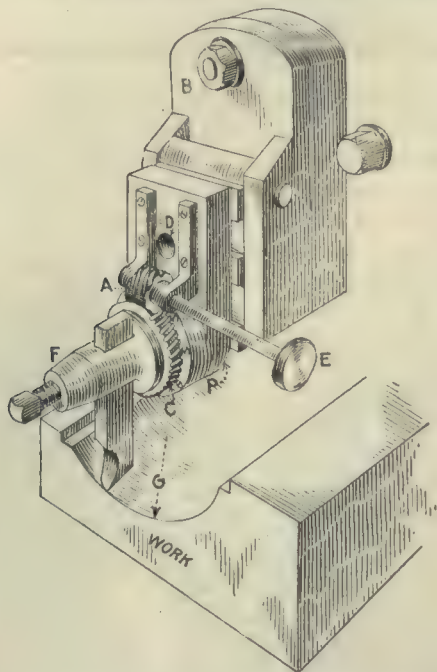
PAUL CYR.

Circular Shaping Attachment

The accompanying illustration is of an attachment for machining concave surfaces that cannot be done practically and cheaply in a lathe. It can be easily attached and taken off, as it is only necessary to remove the tool holder from the clapper block of the shaper and bolt this attachment to the clapper block in place of the regular tool post.

The several parts are lettered as shown in the diagram, *A* being the worm, which is fastened on a shaft having a knurled handwheel *E* for the purpose of feeding the tool into the work. The worm *A* meshes into the wheel *C*,

which has a tool post *F* fastened to it, in which the cutting tool is attached. The tool post and wormwheel move in the block *P*, clamping the attachment to the clapper block *B* by means of a special nut. The thickness of the block



CIRCULAR SHAPING ATTACHMENT

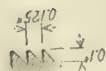
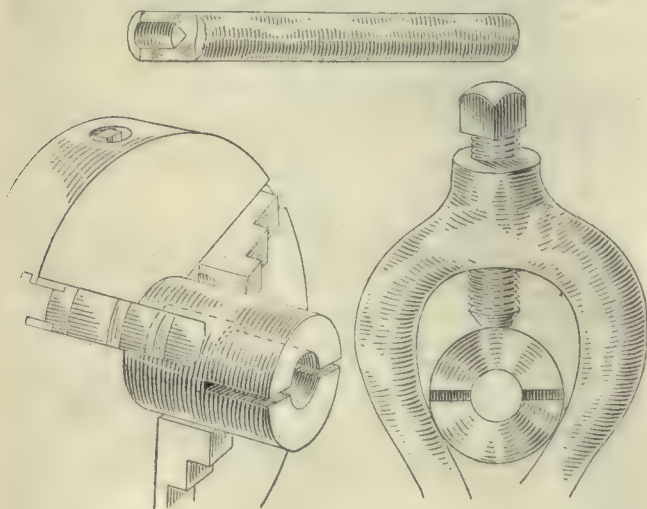
P should not be such as to bind the wormwheel to the block *P*.

By moving the cutting tool in or out rather a large number of radii can be machined. When the tool overhang is too great, the attachment can be fastened by an ordinary bolt, using the hole *D* and also the special nut as shown in the illustration. NELSON GEERSTEN.

Amsterdam, N. Y.

Improved Spring Chuck

Herewith is illustrated a quickly made chuck that I have found very convenient in emergencies. Suppose a dozen small spindles are to have a hole bored true in one end, as shown. A piece of 1-in. round mild steel, 2 in.



AN IMPROVED SPRING CHUCK

long, is held true in the chuck, and a hole is rough-drilled 1 in. deep, as shown in the sketch. The piece of steel is reversed in the chuck and a hole is drilled $\frac{1}{32}$ in. to meet the other hole.

Now bore out to within a few thousandths of size of the spindles to be held and slot across the end with a hacksaw, as shown. Bore to a good fit for the spindles. Insert a spindle, and clamp with a lathe dog.

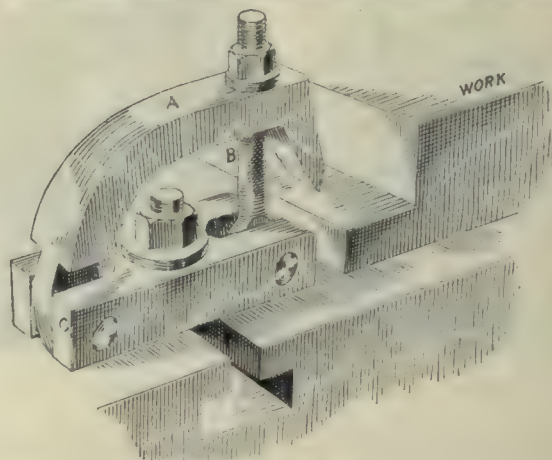
If the spindle is a good fit, it will run dead true. When the standard three-jaw chuck does not run true enough, this is a good way to handle such work.

Wembley, England.

J. H. DAVIS.

A Planer Clamp

The drawing shows a self-contained clamp to do away with the nuisance of blocking and to save time in setting



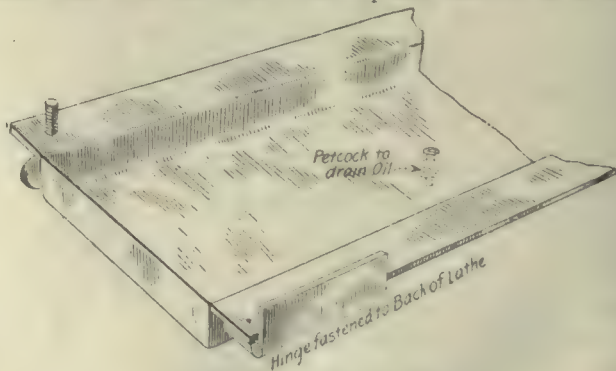
A PLANER CLAMP

up. The parts are of heavy enough section to avoid weakness due to the slots. GEORGE C. LAWRENCE.

Brooklyn, N. Y.

Chip Pan for Lathe

The illustration shows a chip pan for the lathe. It is about 1 in. in depth, and the length is the same as that of the opening under the lathe. It is made from $\frac{1}{16}$ sheet steel with the ends formed up and soldered to be oil-



CHIP PAN FOR LATHE

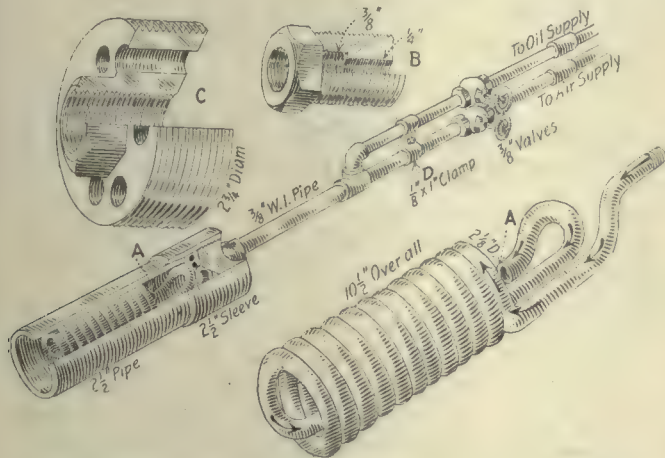
tight. Two thumb-screws, as shown, fasten the pan to the lathe. To release the chips, remove the thumb-screws. The pan swings on the hinges secured to the lathe bed. The pet-cock soldered in the center permits the oil to be drained off. This device does away with the unsightly pan generally placed on the floor.

Chicago, Ill.

WILLIAM CUNNINGHAM.

An Oil Burner with Heating Coil

The illustration shows a new kind of oil burner, which may be used in the boiler shop, on steel car and tender or tank work. Oil and air are admitted, as shown, through two $\frac{3}{8}$ -in. globe valves, which regulate the supply. The



OIL BURNER FOR TANK AND BOILER-SHOP WORK

$\frac{3}{8}$ -in. pipe screws into brass fittings and the long end of the coiled pipe into the inside end of the same fitting. The oil in passing through the hot coil is heated to the proper temperature for ignition when it reaches the open end A.

The small brass fitting B screws into the larger one C, and this in turn screws into the sleeve, which is 3 in. long. Into this sleeve is screwed a piece of $2\frac{1}{2}$ -in. wrought-iron pipe 9 in. long. The large brass fitting C has six $\frac{3}{8}$ -in. air holes drilled in it as shown. The pipes through which oil and air enter are held together by small clamping plates D. These pipes make a good handle to direct the flame toward any spot desired. The device is light and easily handled.

The $2\frac{1}{2}$ -in. pipe on the end keeps the flame confined to the desired area. The device was designed here and a dozen or so have been made. They are in constant use and give satisfactory service.

JOSEPH K. LONG.

Renovo, Penn.

The Art of Grinding

When we stop to consider that nearly every branch of metal manufacturing uses grinding wheels, it appears strange that the art of grinding has never been reduced to an exact science. To be sure we know that certain grits, grades and bonds are suitable for particular classes of work, but vary the working conditions ever so slightly and we are all at sea, as it were, only to regain a correct course through long experimentation.

It is true that grinding-wheel manufacturers are quite willing to experiment at the customer's expense. Indeed, they are not at all bashful about sending several trial wheels on the slightest suggestion. Why should this state of affairs exist? Why is it necessary to be eternally experimenting to suit an every-day product to an every-day need? Why should not the grinding-wheel manufacturer be able to state instantly the proper wheel for a certain class of work? As a matter of fact, he can only

in one case out of ten and, when he falls down, he excuses himself under the plea that conditions were not right and blandly asks for another trial.

Again, suppose that a manufacturer of automobiles, for example, is getting good results with a certain make of wheel for grinding crankshafts. Along comes a salesman from a competitive concern and asks for an opportunity to submit trial wheels. He often succeeds in getting the desired chance, and sometimes his wheels show efficiency over those of his competitor, in which case he is generally given a small stock order. When salesman number one calls on his next trip he has visions of a nice order (if he doesn't he is a poor salesman), and when he sees his competitor's wheels where his used to be he realizes that it is up to him to get busy or lose a customer. He enters into several arguments, more or less of a technical nature, and generally succeeds in obtaining permission to submit wheels for a further trial. Of course, this is perfectly legitimate, but why didn't he send the best he had in the first place, thus entrenching himself as firmly as possible before his competitor made a favorable showing?

The bulk of the experimenting is done at the customer's expense; at least I have found this to be a fact during several years' experience as a grinding-wheel salesman. I recall one grinding-wheel manufacturer who spent thousands of dollars in experimenting at the plant of one of the largest automobile manufacturers of the Middle West in an attempt to find suitable wheels to show efficiency over those of his nearest competitor. Of course, it was necessary for the concern that originally had the business also to conduct extensive experiments through repeated trials in an attempt to hold its customer. Who pays for this costly experimenting in the long run? The consumer, of course, otherwise the grinding-wheel manufacturer would speedily go out of business.

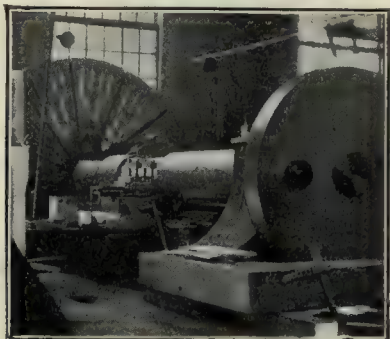
All this costly experimenting, which is done absolutely at random, has but one object in view: To obtain the most efficient wheel for a given purpose. Theoretical knowledge of the art of grinding is almost impossible to procure, because the bulk of what has been published was written with the idea of exalting the merits of particular brands of wheels. In other words, one manufacturer will state that his wheels are excellent for a certain work, but he of course, will not state that his competitor makes a better article for the same purpose. Authentic data concerning the merits of different abrasives are not to be had, and every one who writes upon the subject takes a different point of view. I have sold thousands of grinding wheels, besides writing extensively on the subject for the technical press, and I am frank to admit that I know very little about them. Well, neither does any other grinding-wheel salesman. But that is not the point. It appears to the writer that it is up to some of our scientifically trained engineers to reduce the art of grinding to an exact science. "It can't be done!" exclaims the grinding-wheel manufacturer, "what do college men know about grinding?" Nevertheless the fact remains that scientifically trained minds have accomplished wonders in other branches of engineering in spite of the jeers of those who prefer to work by rule-of-thumb methods, and the time will come when the art of grinding will be given attention. Thus much of the air of mystery that surrounds the subject will be dispelled and the shop superintendent will have at his command actual data.

Indianapolis, Ind.,

F. B. JACOBS.

Turning a Large Crankshaft

The illustration shows the machining of a large crankshaft 23 in. in diameter, weighing 17,000 lb. where the machines were too small for the job. As indicated, the main framebox was used to revolve the shaft in, and the



MACHINING A LARGE CRANKSHAFT

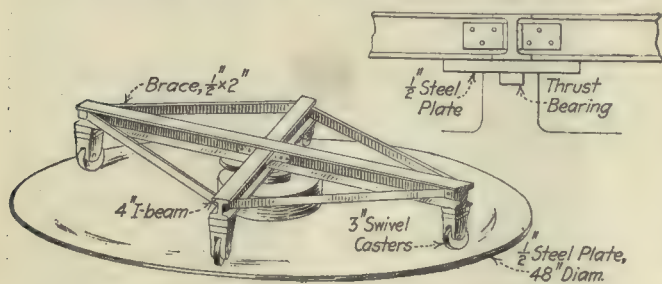
other end was put on the center of a large pit lathe and clamped to faceplate, as will be seen in the picture. The shaft was first turned and then cut off to the required length.

JAMES H. FAIRBORN.

Spokane, Wash.

A Cable Rack

While employed by a large electrical manufacturing concern, I gave some time to putting one of the stockrooms on a more efficient basis. One of the worst problems I found was in storing various kinds of cable, which was received on large wooden reels. The practice had been to roll these reels into as small a space as possible, with the result that it was always necessary to move from two to a dozen reels in order to reach the one desired. It was also neces-



A CABLE RACK

sary to roll out the required reel so that it could be picked up by a crane and set on a stand to remove the cable.

I designed and had built a revolving rack that solved the problem satisfactorily, not only saving a great deal of expense, but also reducing the necessary floor space at least 50 per cent. Some good features of this rack are that reels of any diameter or width may be stored equally well, also that cable may be removed from any reel without taking the reel from the rack or handling any other reels that may be stored on the same rack. The sketch shows that the reels are simply stacked one on top of another, and usually from five to eight reels can be stored on each rack, depending on the width of the reels.

One other good feature is that this rack can nearly all be built from scrap material, as will be seen from the following description: The crosspieces are made of 4-in. I-beam braced with a 1/2x2-in. strap to hold it in position.

On the bottom a 1/2x12-in. diameter plate is riveted, which makes a bearing surface for the base. At the ends of each of the arms is mounted a swivel caster that runs on the bedplate, which is made of 1/2-in. boiler plate 48 in. in diameter. Almost any piece of cast iron may be used for the base casting, which has a thrust bearing in the top for the rack to turn on, so that a man can with one hand revolve the rack with six to eight thousand pounds of cable on it. The dimensions may be changed.

Pittsfield, Mass.

L. M. HALEY.

Machining Large Cast Iron Rings on the Lathe

The problem was to make 58 cast-iron rings, each 7 ft. 4 in. in outside diameter, with inside bore of 6 ft. and the thickness of the ring 5 in. They were to be cast with a web on one side.

The first thing was to cast a square box in two sections, with suitable holes. When machined, this box was of a size sufficient to go under the headstock of the largest lathe to enable the turning flange to be raised high enough so that when the ring was bolted to the flange the latter would clear the bed-frame. In that way the headstock was secured solid with long bolts. This arrangement is shown in Fig. 2.

The back gear *B* was set in the belt cone-pulley pinion and the pinion of the back gear *C* was slid ahead so far that the latter was out of mesh of the belt cone-pulley gear. An extra gear *D* was secured to the headstock frame with special bearings *E* which are in mesh with the back gear pinion *C*. Then a large integral gear *F* was made and bolted to the back of the turning flange,

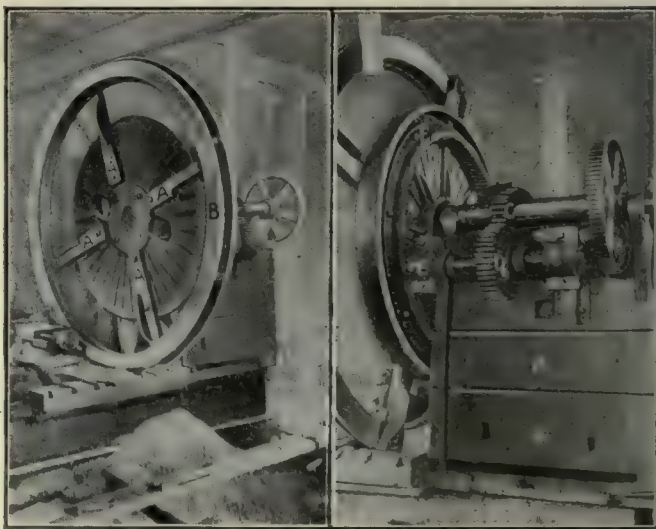


Fig. 1

Fig. 2

RINGS SET UP ON LATHE

which in turn is in mesh with an extra pinion mounted on the end of the extra gear shafting.

By this arrangement the speed problem was solved on the ordinary medium-sized lathe, and at the same time gave a large turning power to take full cuts of the tool.

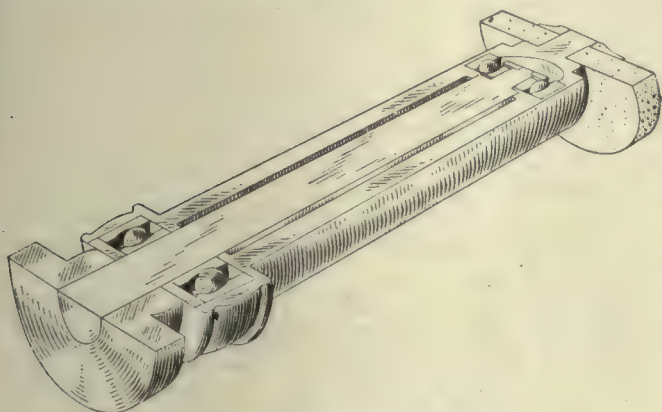
Fig. 1 shows the front view of the lathe. It may be seen from this view that the ring is much larger than the flange, but with four special supports *A* the ring *B* is secured for the machining operation.

Sault Ste. Marie, Mich. J. G. KOPPEL.

Discussion of Previous Question

Data on Cylinder and Piston Grinding

In reply to the inquiry on page 860, Vol. 44, for information on cylinder and piston grinding, perhaps my experience in this line will be helpful. I have bored many cylinders with varying success not only in the finish,



GRINDING MACHINE FOR CYLINDERS

but in the shape of the bored cylinder. I have made a grinder, shown in the illustration, that could be adapted to almost any lathe. Clamped to the faceplate slightly off center and using a wheel nearly the size of the cylinder, this grinder is turning out jobs successfully.

Eustis, Fla.

N. R. HERRICK.

Screw Threads in Small Shops

As John H. Van Deventer states on page 1017, Vol. 44, trouble begins when the V-thread and the U. S. Standard get together in a shop.

Some little time ago, we were much mystified by the complaints received concerning the fit of two small threaded pieces. One of these was originally a casting, but was afterward changed to a bushing peened over a stamped shell. This was then made by an outside concern, but the manufacture of the other piece was cared for in our own factory.

The parts were not only used in our assembling department, but also sent out as repairs. Owing to the fact that the complaints arose coincidentally with the change in design and also that our assembling room had reported no trouble, we immediately put it up to the manufacturer of the shell. He reported that their tap had been made in strict conformity to the gage furnished. In fact, he had just tried a few leftovers and found them correct. Upon request the gage was mailed to us, but was lost in transit.

The matter was forgotten for the time being, but finally a double-barreled protest was received together with the rejected pieces themselves. Just about the same time the writer, in a trip through the factory, observed an assembler busy running a tap through the bushing. Upon being questioned, he stated that this had been necessary

ever since the new type had been supplied to him. As he expressed it, "The tap used is evidently small, as the shell will not run freely on the male thread." A V-thread plug gage was obtained from the toolroom, but not a piece was found to be right, either of those returned or those in stock. A close inspection of the thread showed it to be of U. S. form. No ring gage could be located other than for a V-thread so that the piece had always been made the same, but evidently some one unfamiliar with the shop practice had made a plug gage for U. S. thread, especially as the blueprint failed to specify which form was required.

Inasmuch as our only evidence against the outside manufacturer had been lost, we were forced to the expense of retapping several thousand shell bushings. There was also a lesson read to the foreman whose supervision of his department was so lax that a man could day after day spend time fitting together pieces which were practically guaranteed to be interchangeable.

H. D. MURPHY.

Jersey City, N. J.

Forming Tool for Adjusting Shells for Weight

The article on page 1131, Vol. 44, by John S. Watts, interested me enough to ask for a fuller explanation as to its operation.

The writer says, "The tool is revolved 180 deg. in the eccentric bushing." This would not change the axis of the tool. I should think it would be necessary to revolve the eccentric bushing that fits in the turret hole in order to advance or to recede the tool. Or, perhaps, a better way would be to turn the shank of the tool eccentric to the body carrying the cutter and bore the bushing central. The reason for the L-shape of C (stops) is also not plain.

Philadelphia, Penn.

HENRY E. BILGER.

Taper Shank Drills

To supplement the discussion on taper shank sizes, page 870, Vol. 44, it might be well to refer to a standard adopted in 1908 or 1909 by Adrians Platt & Co., now a branch of the Moline Plow Co. Trouble was being experienced with twisted tangs on three- and four-lip drills used for boring out cored holes. Feeds from 0.040 to 0.060 in. per revolution were quite commonly used and tang breakage was frequent. F. B. Case, then master mechanic, hit on the scheme of cutting off the whole tang and milling below it a new tang the size of the next larger Morse taper. This put a No. 5 tang on a No. 4 taper, a No. 4 tang on a No. 3 taper and so on. In order to do this, the drill spindles were bored out slightly and the tang slots widened to fit the new shanks.

At first, we had to mill new tangs on commercial drills as received; this was not a very serious matter, however, as most of the boring equipment had inserted cutters, using the old shanks over again. Later, however, we were able to get drills which would fit our collets at no extra

cost. I used this taper nearly three years before I saw the first double tang collet such as made by the Cleveland Twist Drill Co. The drill company may have antedated us, although we did not know it.

With eight years of use behind it, the system just described is still unchanged in any detail.

Poughkeepsie, N. Y.

HARRY W. JOHNSON.

Locking Cam for Jigs

Burr Bennett on page 868, Vol. 44, claims that his cam arrangement is successful on rough castings. It seems to me that too much time would be lost adjusting the nut shown underneath to suit the carrying thickness of the castings being machined. My experience with such fittings has taught me to leave such clamping devices alone unless finished surfaces are being held. Their failure is that either the work is too thick and the cam slips, or it is too thin and the clamp does not grip at all. It is better to stick to the crude but effective bolt and piece of stock more often met with. It is quite common to see a bolt and clamp with the bolt too close to the fulcrum when it should be as near to the work as possible. This can be prevented to a great extent when designing the jigs, and by the shop superintendent paying closer attention to the rig-up of his workmen.

Surrey, England.

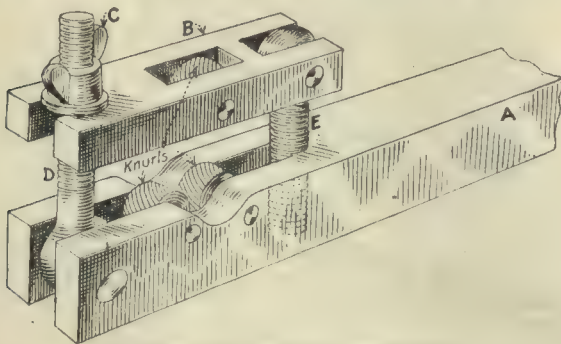
P. JAMES.

Knurling in the Small Shop

It seems as if Mr. Van Deventer has shown about every kind of knurl holder on page 845, Vol. 44. However, some of your readers may be interested in the one shown in the accompanying sketch.

It is excellent for use in the toolpost of an engine lathe or as a hand tool in knurling work held in a vise or in the chuck of a speed lathe. Occasionally, when the lathes are all in use, I make use of the drill press, by inserting work to be knurled in the chuck and clamping this knurl holder flat on the table of the press.

The shank *A* is slotted out to take two knurls, and the third is in the hinged piece *B*. Pressure on the work is



ADJUSTABLE KNURL HOLDER

exerted by the wing nut *C*. To make adjustment for work of a different diameter, the screw *D* is swung down out of the way. This allows *B* to be brought around and run the screw *E* in or out of the shank *A*. The working range is considerable, as I have knurled pieces from $\frac{3}{16}$ up to 1 in.

This contrivance is not only one of the most efficient, but also about the simplest and cheapest, triple knurl

holder to make. The parts *A* and *B* are of cold-rolled steel. The screws *D* and *E* and the wing nut *C* can be found in almost any shop, and the knurls are of standard size. It is not only useful in the small shop, but will be found mighty handy in the big shop, especially on pieces of such small diameter that they cannot be knurled between centers.

H. M. DARLING.

Greenfield, Mass.

[A similar knurl holder, shown in the *American Machinist*, Vol. 28, Part 2, page 63, was used in a lathe. The upper knurl was weighted to knurl tapered work and automatically compensate for the change in diameter.—Editor.]

Reducing Keyway-Cutter Cost

On page 1062, Vol. 44, J. E. Bracket illustrates and describes a keyway cutter having teeth at an angle with its axis, the direction of the angle alternating with each successive tooth.

His experience with the cutter has no doubt proved what he claims as advantages over a cutter having straight teeth, but I cannot understand how they can be made in one long bar as he suggests.

The illustration shows a cutter in which the grooves are much deeper on one side than on the other, and this would be the result if milled alternately with parallel lands. If Mr. Bracket has a way of milling teeth of this kind in a long bar and then cutting them apart, he will confer a favor upon the younger readers of the *American Machinist* by describing his method.

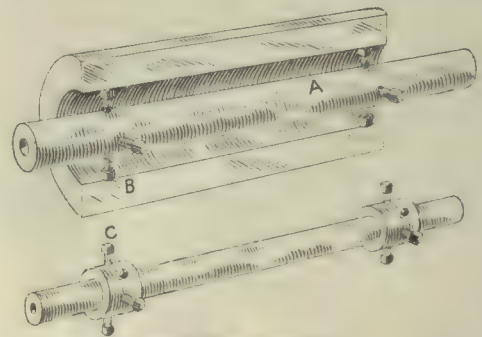
Cleveland, Ohio.

WILLIAM R. GRISWOLD.

From a Small Shop Notebook

On page 588, Vol. 44, are shown small-shop devices. They are also of value in toolrooms. To the uninitiated some of them look doubtful, but to one who has been up against hard propositions in breakdowns of machinery and emergency work they are almost indispensable.

There is one thing that could be added to this list—a spider arbor for heavy work that requires both facing and



SPIDER ARBOR

turning at one setting, such as pipe flanges, columns and cylinders. This arbor has been used on pieces with 10-in. holes and of variable lengths. The stock for *A* may be from 2 to 4 in. in diameter with $\frac{5}{8}$ -, $\frac{3}{4}$ - or 1-in. tapped holes for ordinary setscrews *B*. Collars like *C* are for small arbors. The illustration is otherwise self-explanatory.

G. STROM.

Brooklyn, N. Y.

Editorials

Working Stresses in High-Speed Gears

A valuable paper was presented to the British Institution of Mechanical Engineers in May, by Daniel Adamson, in which is given a digest of notes and information in regard to spur gears, touching upon wear, materials, allowable working stresses, maximum speeds and durability. He shows—what is well known to the student of gearing, but is perhaps not appreciated by others—that the present state of our knowledge is far from complete in regard to many important factors involved in gear design. An important part of this paper is the large number of records of both successful and unsuccessful gear installations. More data of this kind are needed to aid in clearing up a most important bit of machine-design knowledge.

The discussion in the latter part of Mr. Adamson's paper dealing with the variations in stress induced by variations in the angular velocity of gears due to errors in manufacture is of particular importance. He quotes examples of wheels that failed by breakage after only a few months of work, where failure could not be accounted for by the peripheral load due to the power transmitted. From Lasche he takes the suggestion that "The stresses induced by variations in the angular velocity of wheels, due to unavoidable errors in pitch, may be many times the transmitted load alone, and also that these excesses will vary as the square of the velocity." He then goes on to say that if Lasche is correct, the varying angular velocity resulting from inaccuracies in cutting causes extra loads which are large compared to the normal loading, and the resulting stresses must be taken as practically equal in magnitude and of opposite sign. He also quotes Dr. Unwin to the effect that this breaking stress is only about one-half the primitive yield stress of the material because of the Wöhler effect of the repeated stresses.

A number of deductions are then given from previously cited examples, which lead to the assumption that the additional stresses induced in a wheel running at a high velocity are very large, and that accordingly it is not sufficient to consider the stress due to the transmitted load alone and reduce this as speeds are increased merely for the resulting higher velocities.

From one of Lasche's examples the author draws the conclusion that if we wish to secure a factor of safety of 3 at a pitch-line velocity of 2,460 ft. per min., the inaccuracy in pitch must be reduced to less than 0.5 per cent.¹ It is assumed that the excess load increases directly as the amount of inaccuracy and as the square of the velocity.

All of this discussion shows quite plainly that one of the essential things is a standard of accuracy of cutting for different velocities. The higher the velocity

the greater the needful accuracy. Mr. Adamson appreciated this most fully and knits together the conclusions of his paper in the form of the following table:

Velocity of Pitch Circle in Feet per Minute	Inaccuracy of Pitch in Per Cent.	Velocity of Pitch Circle in Feet per Minute	Inaccuracy of Pitch in Per Cent.
100 or less	5	1,200	0.12
200	1.76	1,500	0.09
300	0.96	1,800	0.065
600	0.34	2,100	0.052
900	0.185	2,400	0.042

These figures emphasize in an unmistakable fashion the need of greater accuracy in cutting gears when we propose to run them at higher pitch-line speeds; for not only does inaccuracy produce noise, but it also tends to induce destructive stresses.

Durability of Spur Gears

Reference has been made in the immediately preceding comments to a paper presented by Daniel Adamson to the British Institution of Mechanical Engineers. In his discussion of the important property of durability in spur gears, he quotes from the work of Dr. Schaefer, giving a formula for tooth strength and a table for values of one of the factors, K . This numerical factor is a variable dependent upon the material used and the circumstances of the drive.

The formula is as follows:

$$W = PFK$$

where W = Safe working load in pounds;

P = Circular pitch in inches;

F = Width of face in inches;

K = Factor from accompanying table.

The table expressed in British units follows:

Total Life of Gear in Millions of Revolutions	VALUES OF FACTOR K					
	Maximum Allowable Stresses					
	17,000 Lb. per Sq.in.	14,000 Lb. per Sq.in.	11,400 Sq.in.	8,500 Sq.in.	5,700 Sq.in.	2,850 Lb. per Sq.in.
0	1,350	1,120	898	685	455	228
1	1,292	1,080	870	655	442	228
2	1,238	1,040	840	640	442	214
3	1,180	1,010	812	626	428	214
4	1,138	968	798	612	428	214
5	1,094	940	785	598	413	214
6	1,051	910	770	598	413	214
7	1,023	883	742	584	413	214
8	997	868	726	570	399	214
9	968	840	713	555	399	214
10	940	826	698	555	384	214
12	883	782	670	526	384	200
14	840	710	640	512	370	200
16	797	712	612	498	356	200
18	769	685	598	484	356	200
20	740	655	570	470	342	200
30	612	555	485	442	314	185
40	526	484	428	370	285	172
50	413	384	356	290	242	157
60	342	327	299	270	214	142
100	297	234	256	226	200	134
120	257	242	226	212	171	123
150	228	212	200	185	157	111
200	185	171	157	142	128	97
250	142	142	137	127	111	86
300	128	123	120	109	100	77
400	101	98	94	88	80	64
500	84	81	81	74	69	56

Dr. Schaefer suggests maximum stresses of about 17,000 lb. per sq.in. for forged steel, 14,000 lb. for steel castings and 5,700 lb. for cast iron. The table is arranged, however, for six different maximum stresses, ranging from 2,850 to 17,000 lb. per sq.in. This is done in order to adapt it to various materials.

¹From an example by Christie, he deduces that the same error for a velocity of 3,900 ft. per min. must be less than 0.2 per cent.

How Shall We Get Our Armor Plate?

One does not need to be a Methuselah to remember when practically every machine shop in this country made all the various parts for its products. This included bolts, setscrews, oil cups and all accessories of this kind. Then began the period of specialization following the introduction of automatic machinery, and, to some extent, making its introduction possible. Comparatively few manufacturers at that time required sufficient setscrews, for example, to keep even one machine continuously busy.

This specialization enabled small parts to be manufactured in large quantities at a much lower price than the individual shop could possibly make them, and the buying of various parts that are common to machines used by various manufacturers has become almost universal.

Suppose, now, that a large user of special setscrews, should decide that the few shops that were able to supply them were combining to charge an exorbitant price for the material, and that the directors after more or less careful consideration, decided to appropriate a large sum for the building of a plant for this purpose.

Suppose, further, that on learning of this decision the owners of the plants that have been accused of overcharging for these special setscrews offer to open their books to any committee appointed by the purchasers, and to supply the setscrews at any price that, in their opinion, would give a fair remuneration to the plants.

Assuming still further that it was decided by the consumers that for special reasons it was advisable to have the production of these special setscrews entirely under their control, both with the object of controlling the price and of preventing them from being made for other customers. Would it not, under such conditions, be the better judgment to buy at a fair valuation the plant already established than to build a rival plant, particularly in view of the fact that these special setscrews were badly needed, and that the deliveries might be delayed unless this was done?

Does not this supposititious case compare in most details with the existing complications in regard to the manufacture of armor plate for our new battleships? Should not the same sort of business reasoning be applied in expending \$11,000,000 of the taxes paid by the people of this country as the directors of a manufacturing concern would use in expending 1 per cent. of this under very similar conditions?

It is quite probable that the passage of this appropriation has had a chastening effect upon the manufacturers of armor plate for, instead of maintaining the former "Public be damned" attitude, they are endeavoring by a very sensibly planned publicity campaign to show the advantages of dealing with them instead of erecting a Government plant. But, as previously suggested in the imaginary case of the setscrews, price is not the only consideration and there are extremely good arguments for having plants of this kind under Government control in order to prevent similar equipment being supplied to possible enemies, even though the cost per ton be higher on this account.

It would seem, however, to be much more sensible to take advantage of the experience already gained by

private manufacturers to secure coöperation instead of antagonism. Then, too, the question of prompt deliveries to meet immediate needs must also be considered. And even if the plant under consideration is so badly located geographically as to make it advisable to move it inland at a later date, this is not an insurmountable objection.

The main consideration in any case of this kind is to have every phase of the question carefully gone over by competent engineers and managers without political bias and who have in mind only the best interests of the country at large. It is a plain business proposition, in spite of the limitations that it may be desirable to put on both output and locality, and it should be decided solely on this basis. If it is desirable to have a Government-owned plant let the best private plant be bought at a fair figure and thereby secure the trained men and the experience that has been accumulated.

✱

Aluminum as a Bearing Metal

The aëroplane and the racing automobile have taught us several things that have a bearing on machine construction of various kinds. They have made the use of aluminum about as common as cast iron and have developed new uses for it in fields to which it seemed unsuited. Engine-base castings can be made very light and yet very stiff by suitable ribbing, and this ribbing has been used for some years. But the successful use of aluminum alloys, either die or sand cast, for bearing surfaces is not only unusual but contrary to not a few predictions.

Yet the aluminum piston is finding favor in many quarters. And not only does the aluminum stand up in contact with the cylinder walls, but it is being used as a bearing for the piston pins as well, and giving good service in some instances. Its increased expansion over cast iron or steel makes different allowances necessary, but when these have been worked out, the results are said to be very satisfactory.

Water jackets of monel metal, connecting-rods in high-tensile alloys of extremely light section, and careful attention to heat treatment, are all comparatively recent developments due to these sources. The field of engineering offers few more promising developments during the coming years.

✱

Nine years ago, when many thought the automobile business had reached its climax, the Ford plant reached the unheard of and unbelievable record of building 10,000 cars in less than eight months. Machine-tool builders began to look for other fields to conquer and the dropping off of the fad was freely predicted. But instead of the expected decline the production figures have continued to mount to an unheard of rate, until the first six months of 1916 show a production of over 750,000 passenger automobiles and Ford has grown from 10,000 in eight months to 298,000 in six months. At this rate the yearly production will go over one and a half million pleasure vehicles made this year—or, roughly speaking, one and one half cars for every hundred people in the country, counting men, women and children. Add those built previous to this year and still in use, and the total must run close to one to every 40 to 50 people. Predictions as to the future output are indeed dangerous.

Shop Equipment News

High-Speed Press Clutch

The average speed of a flywheel on a power punch press is from 80 to 200 r.p.m. The clutch described makes it possible to run from 80 to 1,000 r.p.m., and where it is required on other machinery it will operate satisfactorily and positively at a speed of from 500 to 5,000 r.p.m. The clutch is an improvement of the rolling-pin type. It has a rolling pin with a flattened engaging surface that acts horizontally. It has two locking shoulders that lock the

flywheel itself pulls it into position before power is delivered to the ram, and therefore prevents any shearing or binding of the pin. The flywheel runs on smooth bronze bushings that have no holes for the pin to operate through. The engagement is in the center of the flywheel at the axis of the shaft, preventing any blow and allowing smooth operation.

The clutch latch is a tool-steel dog with a wedge-shaped end and contains a notch that makes it a positive stop.

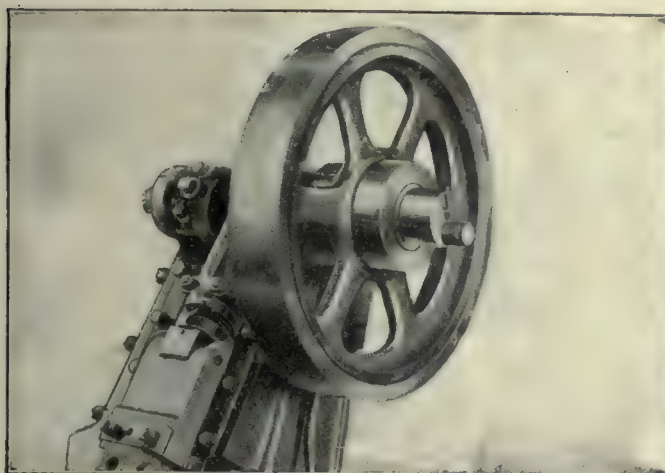


FIG. 1. PUNCH PRESS EQUIPPED WITH HIGH-SPEED CLUTCH

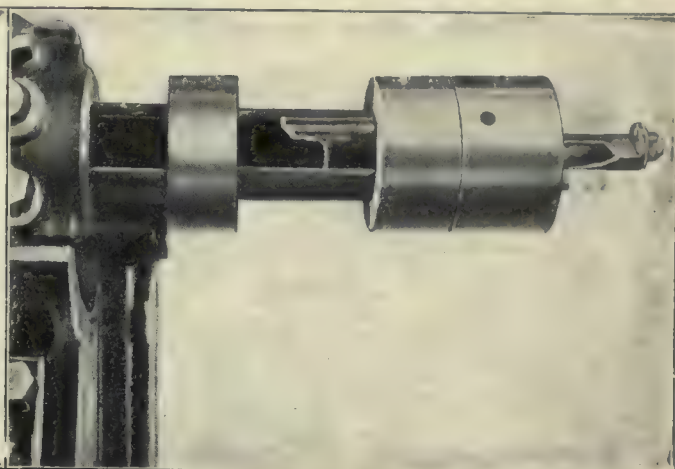


FIG. 2. FLYWHEEL OFF AND KEY SHOVED OUT TO SHOW SHAPE

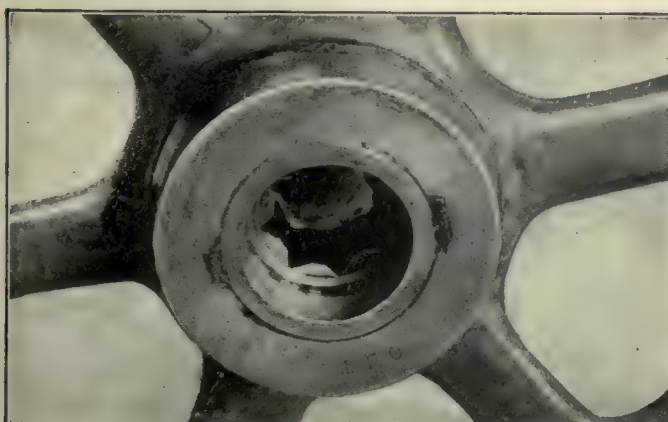


FIG. 3. NOTCHES IN FLYWHEEL BUSHING

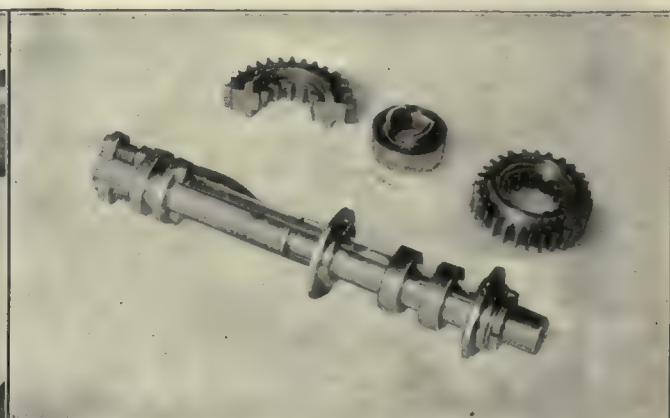


FIG. 4. CLUTCH USED FOR AUTOMOBILE TRANSMISSION

pin in position by a cam action that fastens the flywheel to the shaft in a manner similar to that of a solid key. These shoulders also lock the flattened part down in the shaft when not in operation. The ordinary flywheel on a punch press has three recesses for engaging the pin and allows time for the pin to engage. This type has eight recesses, made in a steel bushing, case-hardened and keyed and pressed into the flywheel hub. These recesses are the same size as the pin and no time is allowed for it to enter. Since the pin is locked in position, it prevents any backlash or rebound when combination dies are used. The flattened part of the pin is so made that the motion of the

The face of the wedge-shaped end is set at an angle that interlocks the rolling key at the time of release and prevents its bounding away from the pin when engaged.

A positive stop device is attached to the clutch that causes the slide to stop at the highest point after one depression of the treadle. It will lift the operator's foot and will not repeat unless there is another depression of the treadle. This device can be detached and the press run in the usual way if desired. The engaging and releasing mechanism is so positive and accurate that it is not necessary to use a brake or friction on the press. The clutching device normally cuts out at the highest point of

the slide, but it may be released at any point in the revolution of the wheel, and is especially useful in celluloid work where the impression must be held for a period as it will cut out at the lowest point also.

The clutch principle can be used in any place where a positive clutch is desired such as automobile transmissions, change gears in machine tools, countershafts and the like. When designed to operate in transmissions it is impossible to shear the gears, since they are always in mesh, and speeds can be shifted to higher or lower when in operation without damage. In an automobile, the speeds can be

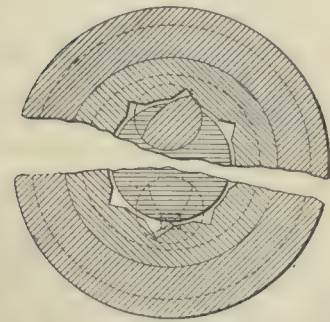


FIG. 5. ACTION OF KEY IN FLANGE

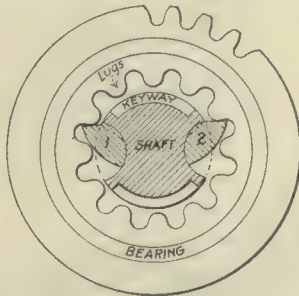


FIG. 6. ACTION OF TRANSMISSION KEYS

changed without releasing the clutch, and in cases of emergency, it can be used as a brake without trouble of any kind.

A punch press fitted with one of these clutches is shown in Fig. 1. A larger view of the shaft with the flywheel removed is shown in Fig. 2. This gives a good idea of the pin that takes a spiral motion as it is shoved over, which brings the lock up into the wheel. The hub of the flywheel with the steel, eight-notched bushing in place is shown in Fig. 3. Fig. 5 shows the action of the pin and the manner in which it rolls up into the notches of the bushing.

A shaft fitted for an automobile transmission is shown in Fig. 4. The gears have all been removed to show the position of the keys, of which there are two, set into grooves on opposite sides of the shaft. The manner in which these keys roll up into the notches in a gear is shown in Fig. 6. This takes care of both the front and the back lash. These clutches are made by the Campbell Manufacturing Co., 3715 Wentworth Ave., Chicago, Ill.

Motor-Driven Polishing Lathe

The illustration shows a motor-driven polishing and buffing lathe recently added to its line by the Gardner Machine Co., Beloit, Wis. The motors used are of heavy design and are fitted with frames carrying ball bearings.

The motors are fully inclosed; for ventilation a fan, attached to the motor shaft within the cover, draws air up from the base on the right, forcing it through the motor and down into the pedestal on the left.

A push-button control station is furnished. The button on the right is used for starting and is below the surface of the plate so as to remove any likelihood of accidental starting. The left hand or stopping button is provided with a simple locking device which is a further precaution against closing the circuit unintentionally.

Either adjustable or constant-speed direct-current motors can be supplied. When adjustable speed is used, the lever within the base is moved to the desired point and by

pressing the starter button the motor comes up to the speed at which it is set. In alternating current only certain speeds are obtainable.

The spindle is provided with a locking device. A button-head pin, acting over a coil spring, is pushed



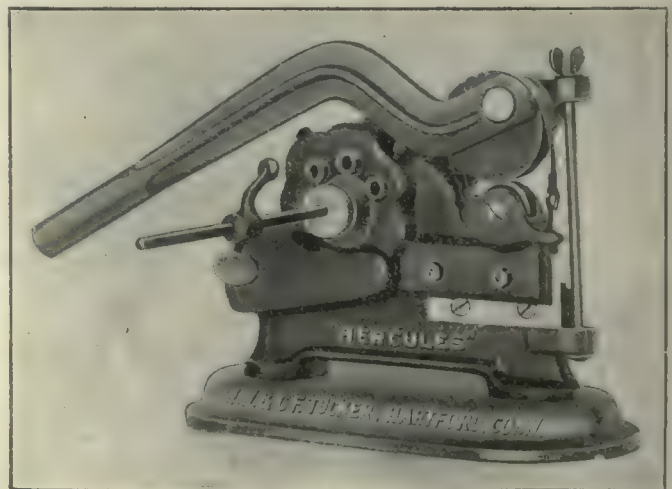
MOTOR-DRIVEN POLISHING LATHE

down into one of the four holes in the spindle collar. This locks the spindle when it is desired to change wheels.

The machine is made in several different sizes.

Shear and Rod Cutter

The form of shear and rod cutter shown was developed especially for toolroom and light bench work by W. W.



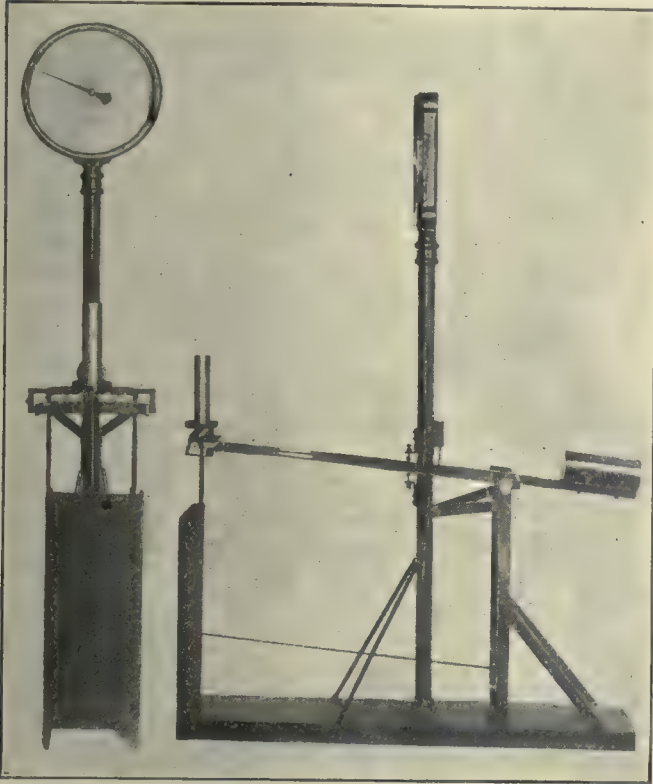
LIGHT SHEAR AND ROD CUTTER

Capacity, $\frac{1}{8}$ -in. flat sheets and bars; $\frac{1}{4}$ -in. rods; base, 10x4 in.; weight, 15 lb.

& C. F. Tucker, Hartford, Conn. In design and construction it follows closely the heavier type of machine illustrated on page 1141, Vol. 44.

Shell-Test Scale

The purpose of the scale shown is to immediately indicate whether a shell is under or over the prescribed weight. It will be noted that the weight of the shell has been counterbalanced entirely, thereby confining the functions of the pointer to an indication of variation

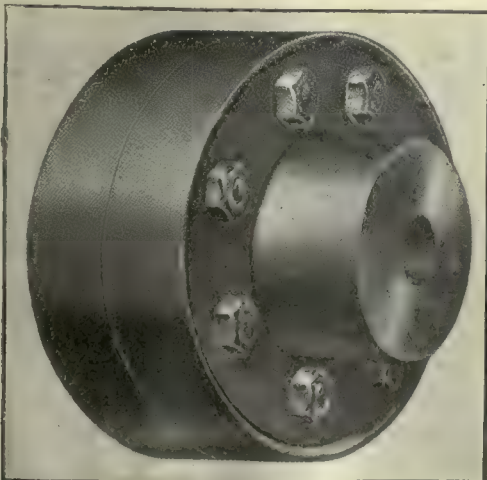


AUTOMATIC SHELL-TEST SCALE

only. To clearly show such variations there is provided a reading index 13 in. long, reading from 8 to 14 oz. by drams. The scale is a recent product of John Chatillon & Sons, 85 Cliff St., New York City, and is made for various sizes of shells.

Flexible Coupling

The main features of the coupling shown are that its only moving part is a slotted driven hub and that aside from the bolts it has only three separate sections.



FLEXIBLE COUPLING

The casing remains rigid at all times and can be used as a pulley for belt connection to other machines. The closed construction, preventing the entrance of dirt or grit, is apparent.

The hubs are bored and keyseated. The bolts are machined to exact size and are held rigidly at the ends, an arrangement designed to give to the flexible coupling the strength found in the solid flanged type. The bolt holes in the flanged side and the slots in the flexible side are accurately spaced to insure a uniform torque with a minimum of lost motion.

The coupling is made in a variety of sizes by J. R. Shays, Jr., 47 West 34th St., New York City.

Design and Construction of Textile-Machinery Cams

BY SUMNER B. SARGENT

Spinning frames are designed to spin warp yarn on warp bobbins, or filling yarn on filling bobbins, or are sometimes so arranged that with slight change the same frame will spin either warp or filling yarn. The warp yarn is wound on bobbins in successive layers, the first traversing practically the full length of the bobbin and each succeeding layer being somewhat shorter at both ends. This gives a tapered effect at both ends of the bobbin. In succeeding operations the yarn is removed by revolving the bobbin on its own axis. Filling yarn is wound on the bobbin in successive layers, the first traversing only a short length on the bobbin, say 2 in. on a bobbin 61½ in. long. Each succeeding layer, through the instrumentality of the builder, is lifted slightly toward the top of the bobbin. Thus the full diameter of yarn on the bobbin is obtained long before the layers of yarn reach the top of the bobbin. The wooden filling bobbin generally has a tapered base (see Figs. 1 and 2). The first layer of yarn is wound on this taper, and each succeeding layer being the same in length, but lifted slightly toward the top of the bobbin,

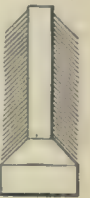


Fig. 1



Fig. 2

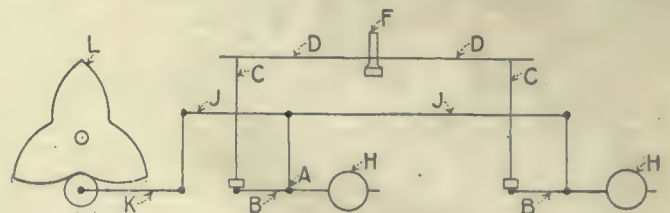


Fig. 3

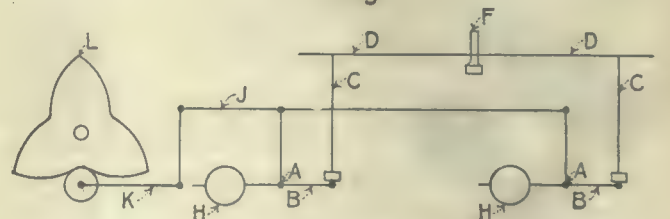


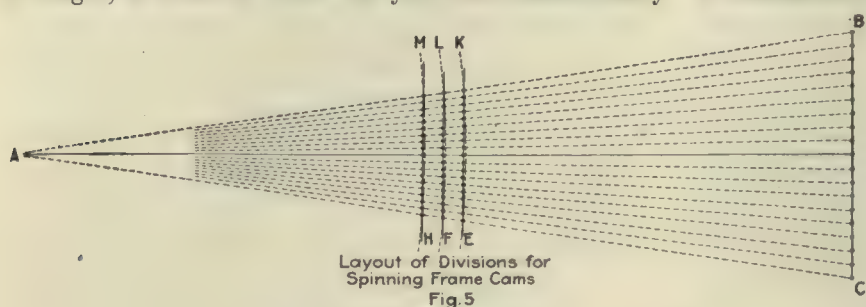
Fig. 4

FIGS. 1 AND 2. YARN BOBBINS. FIGS. 3 AND 4. DIAGRAMS OF "BUILDER" MECHANISM

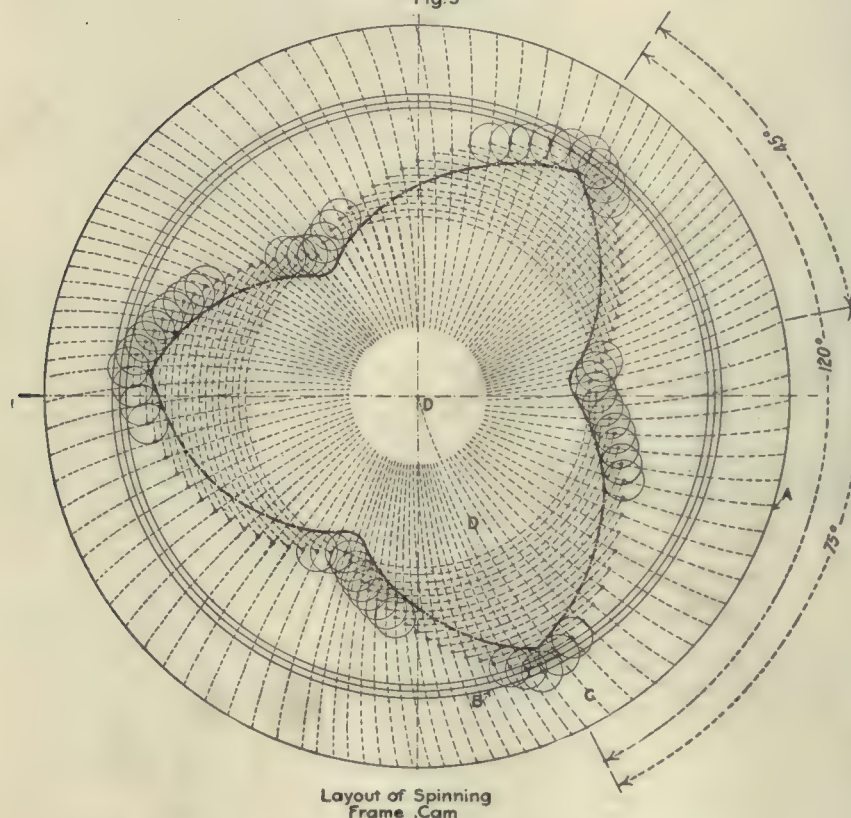
the tapered effect shows only at the top of the full bobbin. The filling yarn, when placed in the loom shuttle, is removed from the tapered end, the taper allowing the yarn to slip off easily as the shuttle traverses back and forth.

Filling cams are generally three-pointed, making three complete strokes in one revolution of their periphery. These strokes are usually identical. I depart from this general practice and make each stroke a little different in length, in order to "bind" the yarn more satisfactorily

Now, in this case the weight of the builder and traverse motion act on the same side of the fulcrum with a tendency to pull the cam ball *away* from the cam and are counterbalanced by weights *H*, which must be sufficiently heavy to overbalance positively the mechanism and its friction



Layout of Divisions for Spinning Frame Cams
Fig. 5



Layout of Spinning Frame Cam
Fig. 6

FIGS. 5 AND 6. SPRING FRAME CAM LAYOUTS

on the bobbin. Each of the three strokes delivers two layers of yarn on the bobbins, one layer corresponding to the down stroke of the cams, the other to the upstroke.

I have frequently noticed in spinning frames a faulty method of design that I consider serious; namely, the traverse motion, actuated by cams, moves up and down the length of the bobbin, delivering the yarn in successive layers on the bobbin. The cam operates directly on a lever called the builder. The builder operates a series of rocker shafts, raising and lowering the traverse motion. The cams pull this entire mechanism in one direction, and on the return stroke the mechanism is kept against the cam periphery by a number of heavy balance weights hung to a lever arm on the rocker shafts (see Fig. 3). Here *A* represents the fulcrum of the rocker shaft. *B* is a lever arm of the rocker shaft alternately raising and lowering the guide rods *C*. *D* is the ring rail guiding the yarn up and down on the bobbin *F*. The counterbalance weights are seen at *H*, at *J* is the connection between the rocker shafts and the builder *K*, and *L* represents the filling cam.

in the guide-rod bearings. Otherwise, the ring rail might hang stationary and spoil the bobbins. I much prefer this mechanism designed as in Fig. 4. Here, the weight of the traverse motion itself causes the mechanism to move in one direction, and keep the cam ball *against* the face of the cam, and the stroke of the cam causes the mechanism to move in the other direction. In this case the balance weights are only sufficiently heavy to remove unnecessary strain from the builder and cams, and the lighter balance weights are more easily adjusted as occasion requires. On "filling" bobbins, or shuttle bobbins, the yarn is put on with numerous short strokes of the traverse motion; the builder motion raises the traverse motion on the bobbin a slight amount on each successive stroke. Thus each succeeding layer of yarn is lifted slightly toward the top of the bobbin, gradually filling the bobbin from bottom to top. In the present case I will arbitrarily decide that the three strokes of the cam shall be respectively $2\frac{1}{8}$ in., $2\frac{1}{4}$ in. and $2\frac{3}{8}$ in. In the cam layout the proportional method is used, as in all such cams (see Fig. 5). Now, as the traverse motion automatically lifts each succeeding stroke toward the top of the bobbin, Fig. 4, I decided that the lengthening of the cam strokes shall be toward the top of the bobbin and therefore do not use in the present cam layout a common center line to locate the center of the three strokes the same distance from the cam center, as in the previous cam

design. If the spinning frame is designed as in Fig. 3, the cam ball is in the heel of the cam (or nearest the center of the cam) when the traverse motion is at the top of its stroke. If we decide that the three cams should each lift the traverse motion to a different height, it must be done by changing the amount of stroke of each cam at the point nearest the center of the cam, and we cannot change the stroke height of any one of the three leaves of the cam at this point without affecting the stroke of the adjoining leaf, whereas if the difference in length of the three strokes occurs at the toe or outer point of the cam, the lengthening or shortening of the stroke of one leaf does not affect the stroke of an adjoining leaf. Fig. 1 represents a full filling bobbin and Fig. 2 one partly filled.

We will now proceed to develop a cam employing a cam lever 15 in. from the fulcrum to the cam-ball center and a cam ball $\frac{3}{4}$ in. in diameter, using 120 deg. for each complete cam stroke. One side of each stroke having a longer duration of time than the other side (in order to bind the yarn on the bobbin), we determine which side

of the cam points shall have the longer period of time. Referring to Fig. 4, we see that the cam pulls up the traverse motion. During the movement in this direction the mechanism is using power, while the movement in the opposite direction is due to gravity or the weight of the traverse motion. Therefore, to conserve power and lighten the strain on the mechanism, we determine that the stroke side of the cam shall have the longer period of time and decide that the stroke shall be completed in 75 deg. and the follow in 45 deg. This division of time will wind a proportional number of spirals of yarn on the bobbin during the up and down movement of the traverse motion. This difference in the number of spirals wound on the bobbin binds the yarn more firmly than would be the case if the same number of spirals were wound on in each direction of traverse.

Proceeding with the development from each division point on the line *BC*, Fig. 5, extend radial lines to *A* parallel to the line *BC*; erect lines *EF* and *H*, representing the strokes $2\frac{3}{8}$, $2\frac{1}{4}$ and $2\frac{1}{8}$ in. With a 15-in. radius strike the arcs *KLM*. The intersections of these arcs by the radial lines indicate the division points for the three strokes.

Strike the circle *A*, Fig. 6, with a 15-in. radius equivalent to the cam-lever length and divide it into three segments of 120 deg. each. Divide the segments into sections of 75 and 45 deg. Divide the 75-deg. segment into 18 equal divisions. From each of these 18 division points, with a 15-in. radius strike radial arcs to the center of the circle, the centers of the arcs lying on the circumference. Deciding that the cam point shall be 5 in. from the center, add half the diameter of the cam ball and with a $5\frac{3}{8}$ -in. radius strike the circle *B*. Transfer the divisions of the arc *K*, Fig. 5, to the radial arc *CD*, Fig. 6. From the center *D* swing these division points to their proper radial arc, and with a $\frac{3}{8}$ -in. radius swing the points of contact for the stroke side of the $2\frac{3}{8}$ -in. cam.

For the follow side of the cam divide the adjoining 45 deg. of the circle *A*, Fig. 6, into 18 equal divisions. Strike the radial arcs as for the stroke side. From the center *D* swing the division points of the arc *CD* to these radial arcs, and with a $\frac{3}{8}$ -in. radius swing the points of contact as on the stroke side.

Proceed in the same manner in transferring and developing the $2\frac{1}{4}$ -in. and $2\frac{1}{8}$ -in. strokes.

NECESSITY OF BINDING ON THE YARN

To obtain more satisfactory bind of the yarn on the bobbin, I also design each of the three strokes with a different duration of time for the up and down strokes. This binding of the yarn on the filling bobbins is very important. It is desirable to put as much yarn as possible on the bobbin, in order to secure maximum production both of the spinning frames and the loom. The "doffing" of the yarn on the spinning frame lessens its production, and the stopping of the loom to replenish its supply of filling yarn lessens the loom production. The filling supply is carried in a shuttle on the loom. This shuttle is banged from side to side of the loom by a "picker stick." The continuous shock to the shuttle and bobbin is liable to cause the yarn to "slough off" the bobbin, making waste and lessening the loom production, if the yarn is not properly and tightly bound on.

The proper binding of the yarn also allows the spinning frame to wind the yarn more tightly on the bobbin, thus

securing more production on both frame and loom, whereas if the yarn is not properly bound, any attempt to wind it tightly by the spinning frame causes the layers of yarn to slip or "slough," making waste both on frame and loom.

NEW PUBLICATIONS

PRACTICAL FORGING AND ART SMITHING—By Thomas F. Googerty. One hundred and forty-four $5\frac{1}{2} \times 7\frac{1}{4}$ -in. pages; 89 illustrations; indexed; cloth bound. The Bruce Publishing Co., Milwaukee, Wis. Price, \$1.

This work is an elementary instruction book on the forging experience. The first part contains seven chapters devoted to forging and smithing of wrought iron. The author has taught this subject for many years and has written from his personal to the elements and principles of wrought-iron hand forging. The first chapter takes up the forge and its tools. The second and third chapters cover the preparation of work for welding, such as scarfing and upsetting, and jump, butt, split, corner and T welding, with instructions on making welded eye-pins and S-links.

Chapter IV is devoted to staples, links, chains and grab hooks. Chapter V takes up a few other simple pieces, including a hay hook and a welded ring. Chapter VI is devoted to the making of tongs and information on iron and steel. The last chapter of this section is devoted to some of the simpler forged tools, including chisels and punches, with information in regard to the working of high-speed steel.

The second part, devoted to art smithing, includes Chapters VIII to XV. A number of art objects, such as door latches, hinges, candlesticks, lamps and lanterns, are shown in detail, with instruction in the methods by which the various ornamental features are planned, made and finally assembled. Much of the work shown is of a high order of artistic merit.

EMPIRICAL DESIGN—By Leslie D. Hayes. Ninety-nine 6×9 -in. pages; 66 illustrations; numerous tables; indexed; cloth bound. Carpenter & Co., Ithaca, N. Y. Price, \$1.

Every draftsman, designer and engineer has in some well-thumbed notebook a number of empirical formulas gathered during his own experience. Every engineering handbook contains many of these equations. They come from the great storehouse of practical experience and have the authority of frequent and widespread use.

Professor Hayes has done a real service in showing how to obtain and use such formulas. His book is planned as a textbook for second-year students in machine design. However, the matter has a wider use, and the work should be in the possession of every draftsman, designer and engineer. The method of application of empirical design is stated in this illuminating paragraph:

"The machine parts to which empirical methods will be applied belong to a large class of parts in such general use and under such similar conditions that they are now made in a number of standard sizes, having the same general form and proportions, and purchasable in the open market at a cost much less than that at which they could be designed and built especially for each case. Empirical methods are also often applied by manufacturers in the design of parts which they have occasion to make in a number of sizes, even though those parts are never placed upon the market, except in conjunction with some complete machine."

The work is divided into seven chapters with these headings: Empirical Design, Screw Fastenings, Keys and Taper Pins, Shafting and Shaft Fittings, Shaft Fixtures, Transmission Members, Pipe and Pipe Fittings. In addition, there are a few tables, including decimal equivalents and trigonometric functions.

ADVANCED ELECTRICITY AND MAGNETISM—By William S. Franklin and Harry MacNutt. Three hundred $5\frac{1}{2} \times 8\frac{1}{2}$ -in. pages; 217 illustrations; indexed; cloth bound. The Macmillan Co., New York City. Price, \$2.

Reviewed by ALEXANDER GRAY*

A new book by these authors is always of interest because of the individuality of their methods of treatment and because of their ability to keep the attention of the reader always on the physical problem.

The first part of the book is devoted to a discussion of magnetism, electromagnetism and electromagnetic induction. So many authors have written on these subjects that the method of treatment has become more or less standardized. Nonessential details have been eliminated from this new text, and the fundamentals are emphasized by the use of striking

*Director, department of electrical engineering, Sibley College, Cornell University.

mechanical analogies. The concluding chapter is devoted to a study of ship's magnetism and the adjustment of the ship compass.

In the second part of the book, subjects such as electric fields, potential, electric waves and oscillations are treated in an original and stimulating manner, and problems such as the design of insulating structures, the propagation of waves and transmission-line surges are so handled that the reader gets a real grip on the principles involved. The short chapter on the electron theory, with which the book closes, leaves one with the desire for further information on this subject.

The book should find a place on the shelves of those engineers who are interested in the design of high-voltage structures and in transmission-line phenomena. It should also find considerable use as a reference book for students of physics and electrical engineering.

The chapter headings of the book are as follows:

Part 1. Elementary Theory of Ferro-Magnetism; Elementary Theory of Electromagnetism; Induced Electromotive Force and Inductance; Magnetic Properties of Iron; Ship's Magnetism and the Compensation of the Compass.

Part 2. Electric Charge and the Condenser; Theory of the Electric Field; Theory of Potential; Electric Oscillations and Electric Waves.

Part 3. The Electron Theory.

ENGLISH AND AMERICAN TOOL BUILDERS—By Joseph Wickham Roe. Three hundred and fifteen 6x9½-in. pages; 57 illustrations; indexed; cloth bound. Yale University Press, New Haven, Conn. Price, \$3.

Reviewed by DEXTER S. KIMBALL*

The purpose of this book is to show the importance of the work and influence of the great builders of machine tools. Most men realize that civilization itself is dependent on the use of tools and, furthermore, that civilization, with all its enlightenment, comfort and culture, is measured by the character and efficiency of the tools of production. Few men, however, realize how fundamental the machine-tool industry is to machine production in general. Without modern machine tools, so called, our vast and complex equipment of industrial and war-making machinery would not be possible. It should be of interest, therefore, to read who the master minds were that laid the foundation of this fundamental art.

History always takes good care of kings, queens, soldiers and statesmen. It also makes note of a few of the master minds of engineering, such as Watt and Fulton. But there are other men whose names are little known, even in the engineering fraternity, whose labors made possible the successes of these giants of engineering. If there is inspiration in reading of Watt and Fulton, there is equal inspiration in reading of the struggles and successes of Maudslay, Nasmyth, Whitney, Brunel, Bramah and Whitworth.

The development of the machine-tool industry, it should be mentioned, is essentially English and American. Professor Roe's book, therefore, begins with the story of early English tool makers, not omitting, however, to give due credit to the French and other early European inventors and builders who had wrestled with these problems. The author then traces the progress of the machine-tool industry in England up to the middle of the nineteenth century, when the supremacy in the art began to pass to the United States. The author's reasons for this change are interesting and instructive and offer food for reflection.

The last half of the book is devoted to the stories of American inventors and builders, principally in the machine-tool industry, but necessarily overlapping other kinds of machine production. Some of these inventors and builders are well known, while others are seldom heard of. An interesting chapter, with genealogical table, shows the profound influence that the old firm of Robbins & Lawrence, which was established in the backwoods of Vermont in 1838, has had upon this art. An equally interesting chapter tells the history of the present firm of Brown & Sharpe and of the radiating influence of its founders. Other chapters deal with the development of the machine-tool industry near Philadelphia and in the Middle West.

It is somewhat significant that many of the early improvements in machine tools in this country had to do with the development of firearms and that European nations obtained here their ideas of firearms manufacture, which they have developed so highly. The interchangeable system of manufacturing is also a direct outgrowth of the efforts of American manufacturers to produce high-grade rifles for the American Government.

The entire book is well written and gives a fairly full account of the history of the art of machine-tool making without being verbose. It would seem that the book would be more complete if some mention had been given of those

designers who have made contribution to the art, though they were not in the business of manufacturing machine tools. Thus the work of the late Professor Sweet, which has had a great influence on American machine design, is not mentioned, nor is the work of John Riddell at the General Electric Co. or that of George W. Dickie on the Pacific Coast, though both of these latter men have produced some remarkable and very large machine tools.

The book is handsomely bound, well printed and well illustrated, the illustrations including pictures of epoch-making machines and of many of the pioneers in this important industry. It is interesting and instructive indeed to see what manner of men these pioneers were and to read the story of their successes and failures.

BUSINESS ITEMS

The New York Office of Jno. Hy. Andrew & Co., Ltd., Sheffield, has been moved from 107 West St. to 26 Cortlandt St.

The International Oxygen Co., with offices at 115 Broadway, New York, is installing a new plant at College Point, L. I., for the manufacture of oxygen and hydrogen gas.

The Sullivan Machinery Co., Chicago, Ill., has established an agency in Holland with Messrs. Petrie & Co., Heeren-gracht, 141-145, Amsterdam, as its special representatives.

TRADE CATALOGS

Machinists' Measuring Tools. J. T. Slocumb Co., Providence, R. I. Catalog. Pp. 127; 5x7½ in.; illustrated.

Oxycetylene Welding and Cutting of Metals. Vulcan Process Co., Minneapolis, Minn. Catalog No. 4. Pp. 29; 6x9 in.; illustrated.

Quick Change Lathes. Walcott Lathe Co., Jackson, Mich. Bulletin. Pp. 12; 9x11½ in.; illustrated.

Geared Head Engine Lathes. Phoenix Manufacturing Co., Eau Claire, Wis. Bulletin. Pp. 15; 14x10 in.; illustrated.

Special Machinery, Fine Tools, Saws, Burrs and Cutters. Thurston Manufacturing Co., 419 Eddy St., Providence, R. I. Catalog. Pp. 15; 6x9 in.; illustrated.

Hack Saws and Frames, Small Tools and Hardware Specialties. Crescent Co., Meriden, Conn. Catalog. Pp. 16; 5x8 in.; illustrated.

Tumblers and Dust Arresters. Whiting Foundry Equipment Co., Harvey, Ill. Catalog No. 120. Pp. 20; 6x9 in.; illustrated. This catalog supersedes No. 113.

Core Oven Equipment. Whiting Foundry Equipment Co., Harvey, Ill. Catalog No. 121. Pp. 24; 6x9 in.; illustrated. This catalog supersedes No. 112.

FORTHCOMING MEETINGS

American Foundrymen's Association and American Institute of Metals. Annual meeting, September 11-16, Cleveland, Ohio. A. O. Backert, secretary, American Foundrymen's Association, Cleveland, Ohio.

American Society of Mechanical Engineers. Monthly meeting first Tuesday. Calvin W. Rice, secretary, 29 West 39th St., New York City.

Boston Branch National Metal Trades Association. Monthly meeting on first Wednesday of each month, Young's Hotel. W. W. Poole, secretary, 40 Central St., Boston, Mass.

Providence Association of Mechanical Engineers. Monthly meeting fourth Wednesday each month. J. A. Brooks, secretary, Brown University, Providence, R. I.

New England Foundrymen's Association. Regular meeting second Wednesday of each month. Exchange Club, Boston, Mass. Fred F. Stockwell, 205 Broadway, Cambridgeport, Mass.

Engineers' Society of Western Pennsylvania. Monthly meeting third Tuesday; section meeting, first Tuesday. Elmer K. Hiles, secretary, Oliver Building, Pittsburgh, Penn.

Rochester Society of Technical Draftsmen. Monthly meeting, last Thursday. O. L. Angevine, Jr., secretary, 857 Genesee St., Rochester, N. Y.

Superintendents' and Foremen's Club of Cleveland. Monthly meeting third Saturday. Philip Frankel, secretary, 310 New England Building, Cleveland, Ohio.

Western Society of Engineers, Chicago, Ill. Regular meeting first Wednesday evening of each month, excepting July and August. J. H. Warder, secretary, 1785 Monadnock Block, Chicago, Ill.

Philadelphia Foundrymen's Association. Meetings first Wednesday of each month. Manufacturers' Club, Philadelphia, Penn. Howard Evans, secretary, Pier 45 North, Philadelphia, Penn.

Technical League of America. Regular meeting second Friday of each month. Oscar S. Teale, secretary, 35 Broadway, New York, N. Y.

*Professor of Machine Design and Construction, Sibley College, Cornell University.

Using Steam Heat for Melting the Softer Metals

By ROBERT CRAMER*

SYNOPSIS—The waste of tin, babbitt or other soft metals by overheating, when melted in the ordinary way, amounts to a large sum annually, which the method here outlined gives promise of considerably reducing. While the particular apparatus described was designed especially for melting type metal, the wide range of application to other purposes will be at once apparent. The uniformity of temperature obtained and the elimination of fire risk make the device and method attractive for use with inflammable mixtures.

In industrial heating processes the use of steam as the heat-carrying medium is always preferred to other methods, such as heating by hot water, hot air or the

process can be carried out at constant temperature, as the latter does not change without a change in pressure.

This latter feature sets definite limits to the temperature up to which the use of steam for heating purposes is practicable. In many industrial processes, as for instance in metal melting, the temperatures are so high that the corresponding pressures are beyond the limit for which steam boilers are commercially available.

The designers of the Winslow high-pressure boiler had for some time been considering the use of their apparatus for heating purposes at temperatures outside the range of ordinary boilers and had even experimentally melted tin in a crucible in which a high-pressure steam coil had been placed, when they were approached by Lucien I. Yeomans, of the Amalgamated Machinery Corporation, of Chicago, with the following problem:



FIG. 1. THE APPARATUS AS MADE AND TESTED

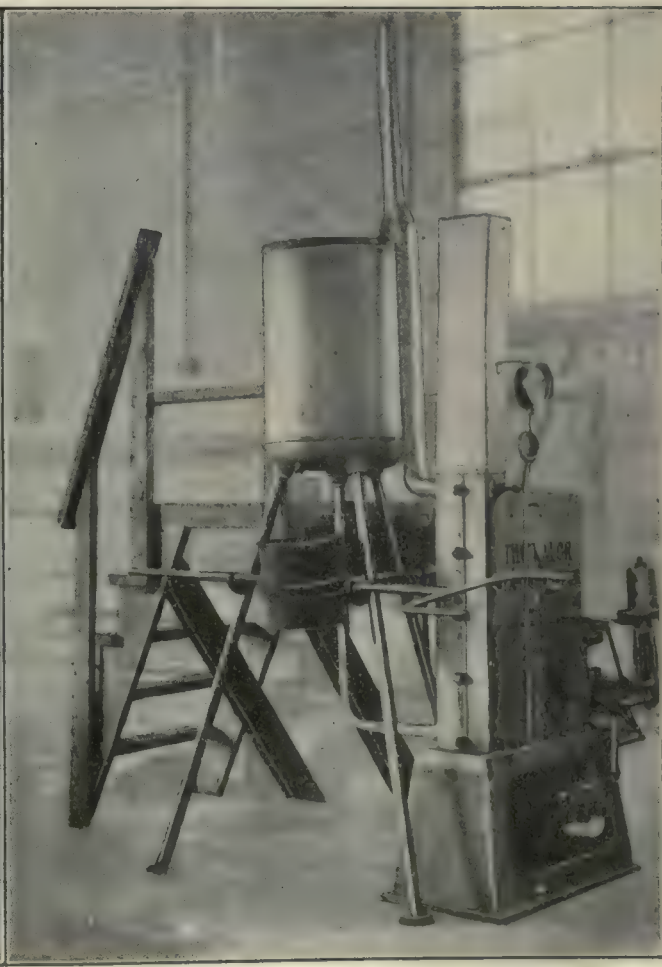


FIG. 2. AS INSTALLED IN THE SHOP WHERE IT IS USED

direct application of a flame. The reason for this is twofold: First, the large amount of latent heat of the steam, which is given up in condensation, makes possible the accomplishment of the given task with a small quantity of steam; and secondly, by the use of steam the

In its manufacturing process Mr. Yeoman's firm uses large quantities of type metal, which is an alloy of lead and antimony, for setting bearings and the like in cored castings. The alloy has a melting point of 475 deg. F., and it is essential that it be poured at a temperature not exceeding 550 deg. F. Ordinary gas-heating melt-

*Chief engineer, Winslow Brothers, Chicago.

ing furnaces such as are in common use for this kind of work necessitate the constant vigilance of an attendant using a thermometer, in order to prevent overheating of the metal bath.

It was thought that by means of a coil containing steam of sufficiently high pressure, the latter being kept constant automatically, the metal bath could be kept in proper condition, ready to be drawn from at any moment, without an attendant.

The pressure at which saturated steam has a temperature of 550 deg. F. is 1,050 lb. per sq.in. In order to insure transfer of heat from the condensing steam to the metal, it is necessary to employ an even higher temperature and corresponding pressure. In the case under discussion a maximum temperature of 600 deg. F. was considered desirable. The corresponding pressure of saturated steam is 1,575 lb. per sq.in.

It might be suggested that, in order to avoid these extremely high pressures, the steam could be superheated. This, however, would entirely do away with the advantages of the use of steam coils. The temperature could not be kept constant by the simple device of keeping the pressure constant, and the coil surface would have to be enormously large, because superheated steam gives up heat at a very much lower rate than saturated steam. In the design of the apparatus the following conditions had to be met:

1. A boiler had to be made which would be perfectly safe and reliable under pressures exceeding 1,500 lb. per sq.in.

2. In order to avoid a feed pump, the arrangement of boiler and coil had to be such that the natural circulation of the steam and the return of the condensate to the boiler by gravity would be reliable under all conditions of operation.

3. An automatic pressure regulator had to be provided; but in this, as in all other parts of the apparatus, it was necessary to avoid all possibility of leakage, as a feed pump would otherwise be required to replace the lost water. The apparatus as designed, built and tested is illustrated in Fig. 1. In Fig. 2 it is shown as actually installed at the present time in the shop of the Amalgamated Machinery Corporation. There is little difference in the two set-ups except that the latter has hooks placed for the pouring ladle and stairs leading to a small platform for the convenience of the workmen in placing metal in the pot and manipulating the outlet-valve handle. The general arrangement of the apparatus is seen in Fig. 3. Here *A* is the high-pressure boiler and *B* the melting pot containing the heating coil *C*. Steam and condensate circulate in both and in the connecting pipes in the direction indicated by arrows. At the highest point of the steam pipe there is a "trap pipe" *D*, in which all the air in the boiler accumulates. On account of the very high pressure this accumulation occupies a small space, and the trap pipe removes it from circulation. At *E* in the boiler shell are two gas burners, with a

pilot burner between them. These burners are served by the main gas pipe *F*, in which is located the diaphragm-regulating valve *G*. The arrangement of this valve is such that it is normally closed by spring pressure and opened by water pressure applied to a diaphragm. The amount of this water pressure is regulated by the steam pressure in the boiler through the relay valve *H*.

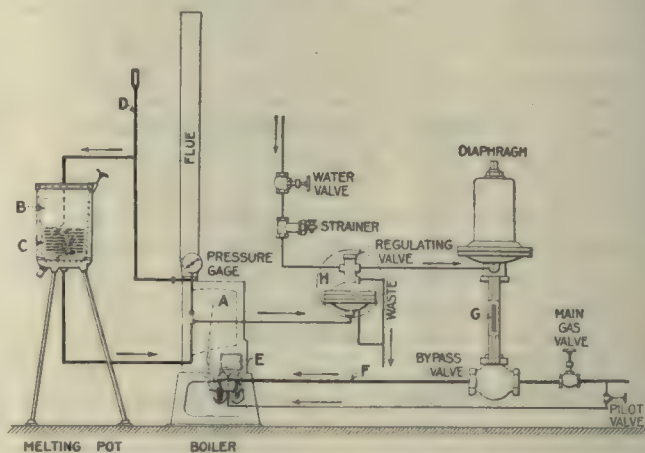


FIG. 3. GENERAL ARRANGEMENT OF APPARATUS

The heating surface of the boiler, removed from its casing, is shown in Fig. 4. This consists of sets of seamless-steel tubes like Fig. 5, the ends of the tubes in each set being welded into headers of the same material. Six of these sets, or sections, are used in this boiler, the rear headers being welded into a steam cross-header at the top and into a water crossheader at the bottom. These crossheaders project through the cast-iron boiler casing when in place.

To the tubes of each section there is fastened a baffle strip, each one touching that of the adjoining section.



FIG. 4. HEATING SURFACE OF THE BOILER REMOVED FROM CASING

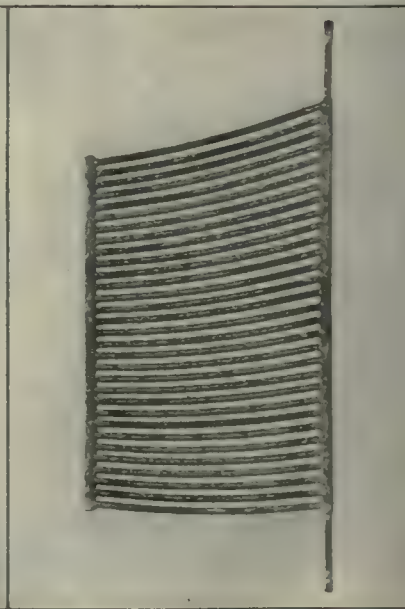


FIG. 5. ONE OF THE BOILER-TUBE SETS

These strips form a complete baffle wall that directs the flow of the gases of combustion. The flow is upward in front of the baffle, then downward and finally upward again between the rear section headers and the casing wall, toward the flue.

The boiler casing is made of cast iron, lined with asbestos and, in the furnace, with "transite," which is a mixture of asbestos and portland cement.

There are none but welded joints within the casing. The only unions are at the ends of the crossheaders, where on one side they form the connections to the steam coil and on the other side to the steel water column, which carries on top the pressure gage and about halfway between the crossheaders a filling plug and a connection to the regulating device. The safety valve is also placed at this point.

Before assembling the boiler, each section is tested separately under 3,000 lb. per sq.in. water pressure; after

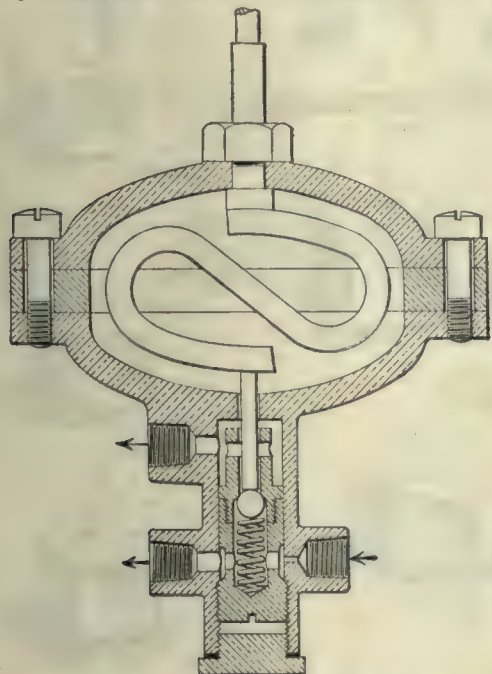


FIG. 6. PRESSURE RELAY VALVE

assembling, the same test is performed upon the completed boiler.

The pressure relay valve is shown in section in Fig. 6. It consists of a heavy housing containing a Bourdon spring acting through a stem upon the water-distributing ball valve. The Bourdon spring, made of steel, is welded to a small steel pipe, which is connected to the boiler. Thus there is no outlet for the steam and no possibility of leakage. A ball valve is contained in a plug that is adjustable in the casing, permitting the changing of the pressure at which the deformation of the Bourdon spring lifts the ball from its seat. Connection is made to a source of water under pressure. Through a very fine hole the water pressure is carried into the chamber that contains the ball valve, and from there through a larger hole to the diaphragm valve previously mentioned. As long as the ball valve is seated, the full water pressure acts on the diaphragm. When the Bourdon spring raises the ball, the leak thus opened permits enough water to escape through the waste connection to reduce the water pressure under the diaphragm sufficiently to permit the spring above the diaphragm to close the gas valve. If water pressure is not available, the relay valve may be operated by compressed air or even by steam under pressure.

The melting pot consists of a cast-iron crucible surrounded by a steel lagging, the space between them being

filled with insulating material. The whole rests on three legs. The outlet for the melted metal is a steel nipple in which a steel plug is seated, the latter being attached to a rod that passes between the layers of the steam coil through the molten metal and through the wall of the crucible. At its upper end this rod carries a non-heating handwheel, by means of which the plug is operated. The crucible is closed by a cover made of asbestos millboard. The apparatus, as installed, is capable of melting about one ton of metal per hour.

All the details of the apparatus have worked reliably in practical operation. It is possible to keep the metal in a melted condition, at the desired temperature, ready for instant use, without more attention to the apparatus than a casual glance at the pressure gage. In addition to this important feature there is the advantage of fuel economy. The efficiency of the boiler, considered apart from the rest of the apparatus, is high, the rate of evaporation being rather low. Whatever heat is contained in the steam finds its way either into the metal or back to the boiler, except for the small amount lost in radiation.

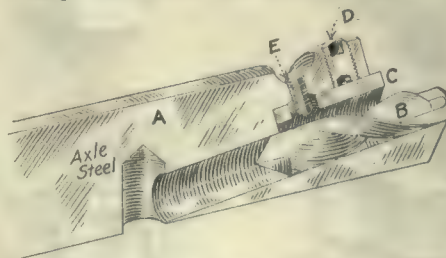
One advantage in practical operation is found in the accumulation of all impurities at the top of the metal bath. As the metal is drawn from the bottom, these impurities never cause any trouble and are left to accumulate, forming a protective covering that prevents rapid oxidation.

The safety of the apparatus deserves consideration. While the steam pressure is high, the factor of safety is much greater than that usually found in boilers, because the tubes are small in diameter and the tube walls are relatively heavy. The arrangement of the regulating device is such that any irregularity, such as failure of the water-supply, would cause the diaphragm valve to shut off the gas. Even should rupture of a boiler tube occur, the heavy cast-iron casing would render the accident harmless.

Using Broken Drills for Turning Tools

BY JOSEPH K. LONG

Here is an economical little device that cuts down tool-steel expense. It is a tool holder made of a size best suited to the use to which it is to be put. The drill holder, or rather tool holder, is illustrated at *A*. *B* is a drill, which is properly ground for turning; *C*, a clamp that holds the drill in place; *D*, a setscrew for



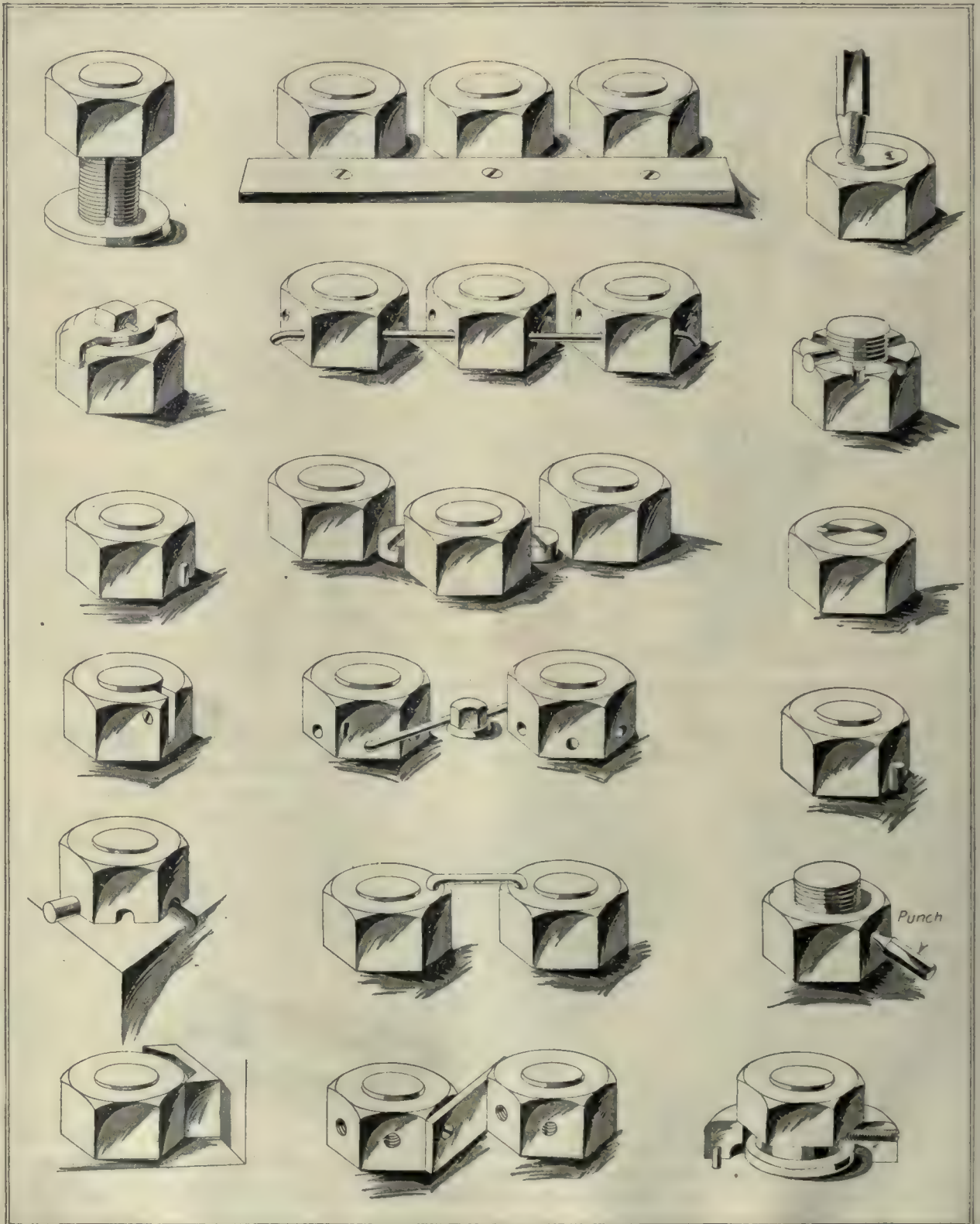
HOLDER FOR USING BROKEN DRILLS

tightening the clamp. The drill *E* is a small screw that prevents the clamp from getting lost when the device is not in use.

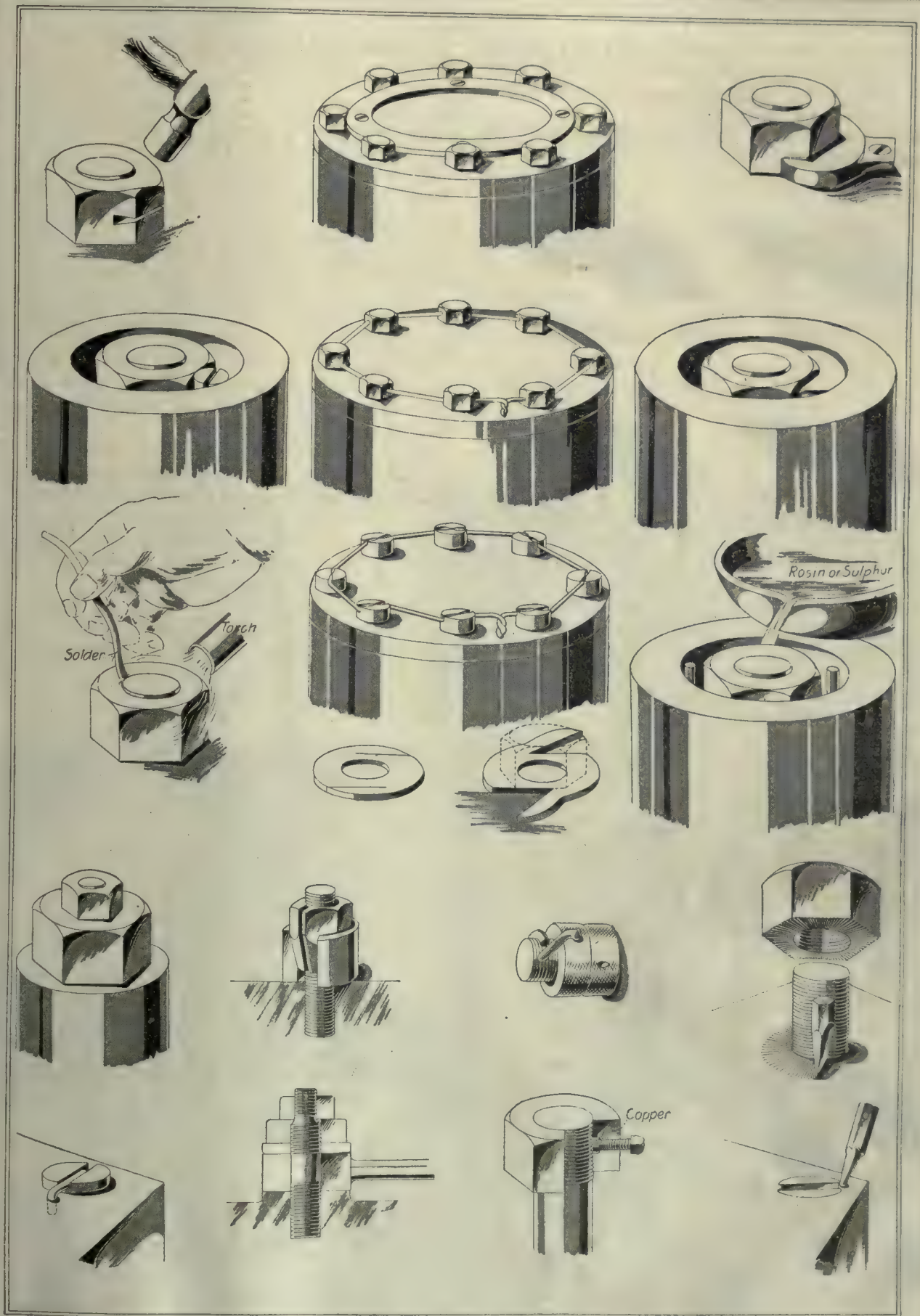
This contrivance works well, as drills are usually made of a good grade of steel, and it reduces tool-steel expense by making use of the broken drills for cutting tools.

From a Small-Shop Notebook

BY JOHN H. VAN DEVENTER



A NUT THAT WORKS LOOSE HAS LITTLE VALUE



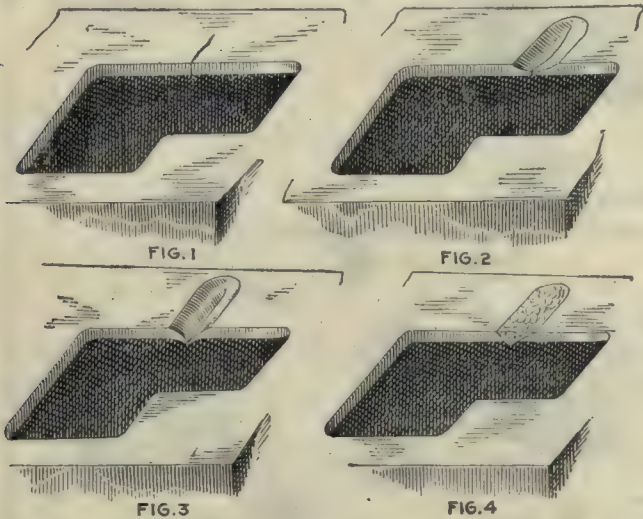
THESE PAGES SHOW A NUMBER OF WAYS OF LOCKING NUTS

Oxyacetylene Welding

By H. HOWARD

When a steel casting is cracked, as in Fig. 1, and the under side of the weld is inaccessible owing to the shape of the casting or difficulty in turning it over, the following method will be found useful:

Chip as shown in Fig. 2, leaving the bottom of the groove rounding and about $\frac{1}{8}$ in. thick. Apply the



FIGS. 1 TO 4. METHOD OF WELDING A CRACKED CASTING

torch and heat the edges to a red heat. With a calking tool or the peen of a hammer drive the edges down, Fig. 3, forming a bulge on the under surface. Then proceed with welding in the usual way. Starting below the under surface insures a solid weld, as seen in Fig. 4—the full thickness of the section, in fact. The section can be “built up” considerably by this means.

Broaching Connecting-Rod Ends

The increase of broaching in automobile shops is nowhere more noticeable than with round holes such as the bearings in the ends of connecting-rods of gasoline motors, and similar parts. An interesting example of this, secured from the Detroit shop of the Continental Motor Co., is shown in Figs. 1 and 2.

The first shows the broaching of the large ends of the connecting-rods on a Lucas power press. The finished size is 1.995 in., the last thousandth of an inch being secured by a burnisher, which follows the broaching. The broach is $13\frac{1}{2}$ in. long but carries only seven cutting edges, or lands, as can be seen. Each land removes 0.001 in., and, with the remaining thousandth to be taken care of by the burnisher, this makes 0.008 in. total allowance for finishing.

The pressure varies from 2,000 to 2,500 lb., while the burnishing requires from 3,500 to 4,000 lb. total pressure. These rods can be handled very rapidly, 1,200 being broached in a day.

The final diameter of the small end is 0.877 in., the last tooth of the broach leaving it 0.876 in., an allowance of a thousandth for final burnishing. These broaches also have seven lands, although the total length is but 9 in. These lands vary by steps of 0.0005 in. This is shown in Fig. 2, which illustrates a hydro-pneumatic press built by the Chambersburg Engineering Co.

The main air plunger of this press is $13\frac{1}{2}$ in. in diameter with 80 lb. air pressure. The intensifier piston is $2\frac{9}{16}$ in. and the main ram of the press is $4\frac{1}{4}$ in. in diameter. The intensifier gives a pressure of 2,115 lb. per sq. in. or a total of 15-ton pressure on the ram. For this work, however, the pressure rams from 500 to 600 lb.

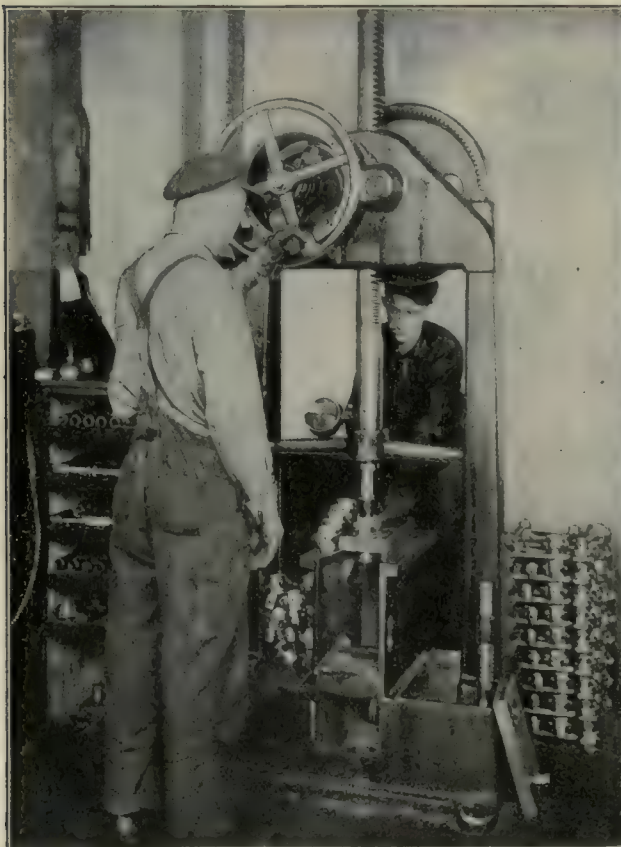


FIG. 1. BROACHING THE LARGE END OF ROD



FIG. 2. HOW THE SMALL ENDS ARE BROACHED

Interesting Methods in an Old New England Pump Shop

By FRANK A. STANLEY

SYNOPSIS—The oldest pump shop in the world, so considered, is located in the center of the manufacturing district of Connecticut. Its first hand pump was made over 80 years ago and is still in existence at the home shop. So well known has this particular type of pump become that it is ordered by its original number even today in considerable quantities. The methods herewith relate to the manufacture of parts of hand pumps and other equipment of this nature.

The firm of W. & B. Douglas, Middletown, Conn., is one of the oldest of the old New England machine-building concerns. Established in 1832, its history now runs back for the greater portion of a century. It has been

constructed at this plant, and what is commonly believed to be one of the first power crossfeed lathes, if not the first, was also built here.

These tools, dating back, some of them, to 1833-34, are still in existence at the Douglas plant and in actual daily use, and there are a few of these machines which have been in service for over 80 years. Naturally they are not put on the heaviest work that comes along, nor on operations where the requirements are especially exacting; nevertheless, they do constitute an important and most interesting element in the organization of the plant, which with its generally uptodate equipment still retains, largely from motives of sentiment, some of the designs of bygone days.

To those acquainted with manufacturing plants in New England, many of which have histories dating back several



FIG. 1. THE FIRST HOUSEHOLD PUMP MADE IN 1832 BY THE W. & B. DOUGLAS CO.

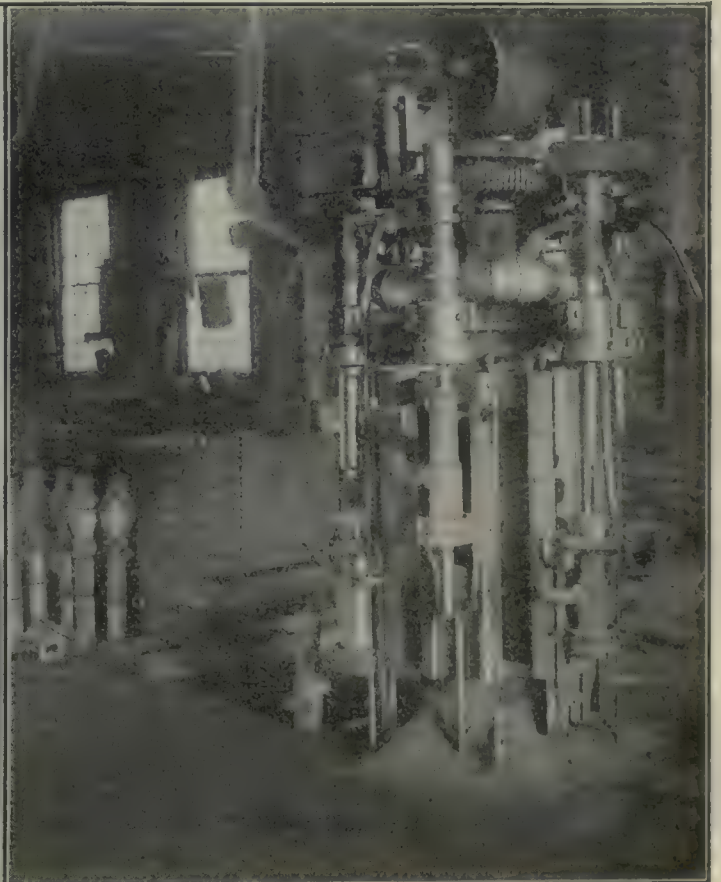


FIG. 2. MULTIPLE-SPINDLE VERTICAL DRILLING AND BORING MACHINE

continuously engaged in the manufacture of hand pumps for over 80 years, power pumps for over 50 years and triplex pumps for a full generation. During this long period it has not only kept pace with the progress of the times in its specific line of manufacture, but has also played an important part in the building of machine tools and special equipment of one kind or another. In this connection it may be stated that some of the earliest American-built engine lathes were designed and con-

generations, there is nothing especially surprising about the retention of certain old-time apparatus alongside of the most uptodate tool equipment. Along with these old-time machines there are quite apt to be a number of old-time mechanics who prefer to operate the older tools to recent innovations. These men handle a surprising amount of work, usually fairly simple in character, requiring perhaps simple cuts only, and work that may be said generally to be handled under conditions where

high rates of speed and feed and removal of large amounts of stock in a hurry are of relatively little importance. Such work still exists to an appreciable extent in a good many shops, and often some of the hang-over in the way of equipment is fully adequate to care for it, where occasionally, due to limited requirements, an investment in fully

for this particular appliance, except that the cylinder and base were originally secured together by hexagon-head screws. After the pump parts had rusted sufficiently long, these screws would sometimes stick and refuse to be removed from place, thus causing more or less trouble when the pumps were to be taken apart. In the modern-



FIG. 4. CUTTING BRASS TUBING



FIG. 5. FINISHING COPPER PUMP BODIES

uptodate tools would scarcely justify itself except in the general way of fitting in harmoniously with the run of equipment about the shop.

So at the Douglas shops with the few old-time interesting engine lathes and other tools there is today a group of machinists and other shopmen each of whom has had in the neighborhood of 50 or more years of continuous experience in the plant, most of their time having been spent in the direct operation of tools even older than the men themselves. These conditions form such an interesting feature to the visitor accustomed to machine shops in general that they seem worthy of a special article dealing with tools designed nearly 100 years ago and with machinists who operate them after a record of over half a century of continuous service. So far as is known, the Douglas company has the oldest hand pump, a reproduction of which is given in Fig. 1 herewith. This type of pump was patented in 1835, and the patent granted was signed by Andrew Jackson, then President of the United States.

This pump is kept at the Douglas works and represents practically the same type of construction followed today

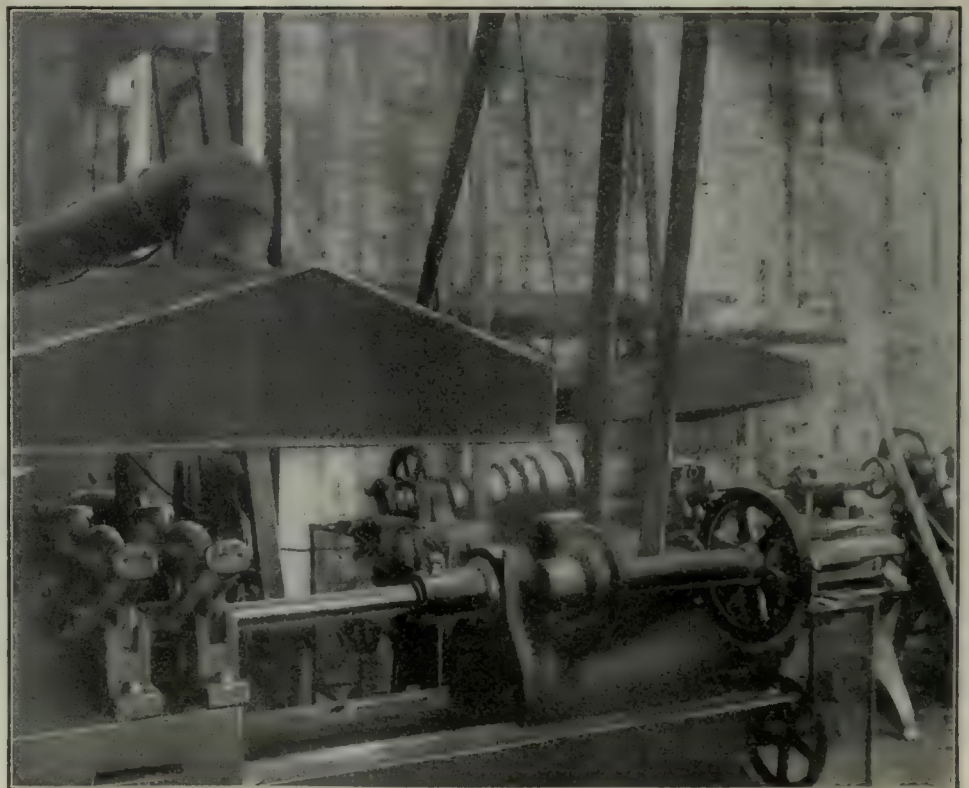


FIG. 3. DUST COLLECTOR AND ENGINE LATHES

ized construction this type of appliance in the two members referred to is secured by bolts and nuts that permit easy detachment whenever it may be desirable to disconnect the parts.

This pump still carries a list number in the catalog of the concern and is actually ordered regularly by customers

in various parts of the world. In fact, on the day when this pump was photographed, just 80 years after its patent was issued, orders for five of the pumps were received at Middletown.

It is not the intention in this article to refer at any length to the various products of the company. It is the

One of the most useful machines in the plant is the multiple-spindle vertical boring machine illustrated in Fig. 2. This machine was designed and built in the shop a good many years ago, and as will be seen, it is adapted to bore six castings at one time. Each of the six cylinders or other parts that are secured in the machine may be

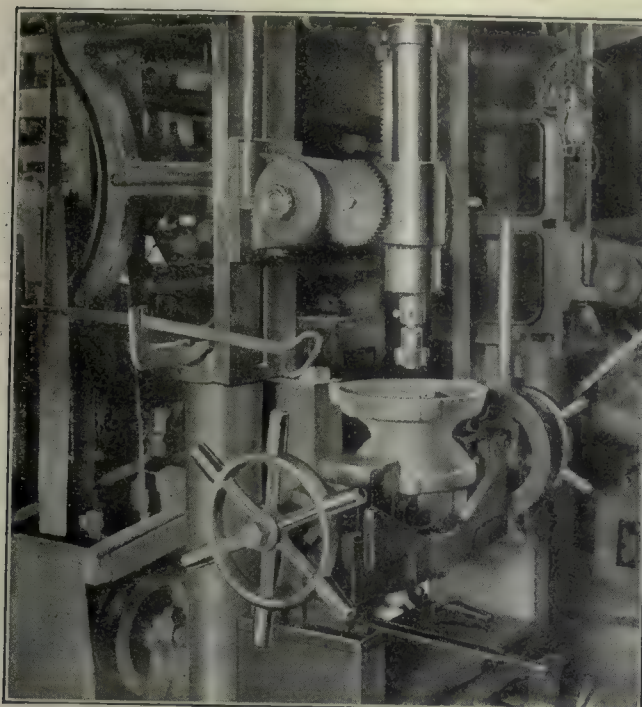


FIG. 6. SWIVELING AND INDEXING FIXTURE

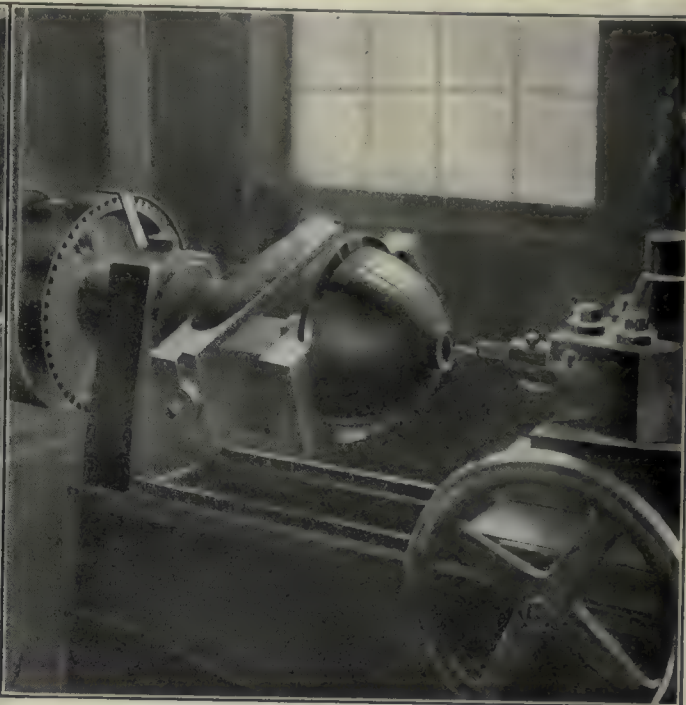


FIG. 7. CHUCKING JOB IN THE LATHE

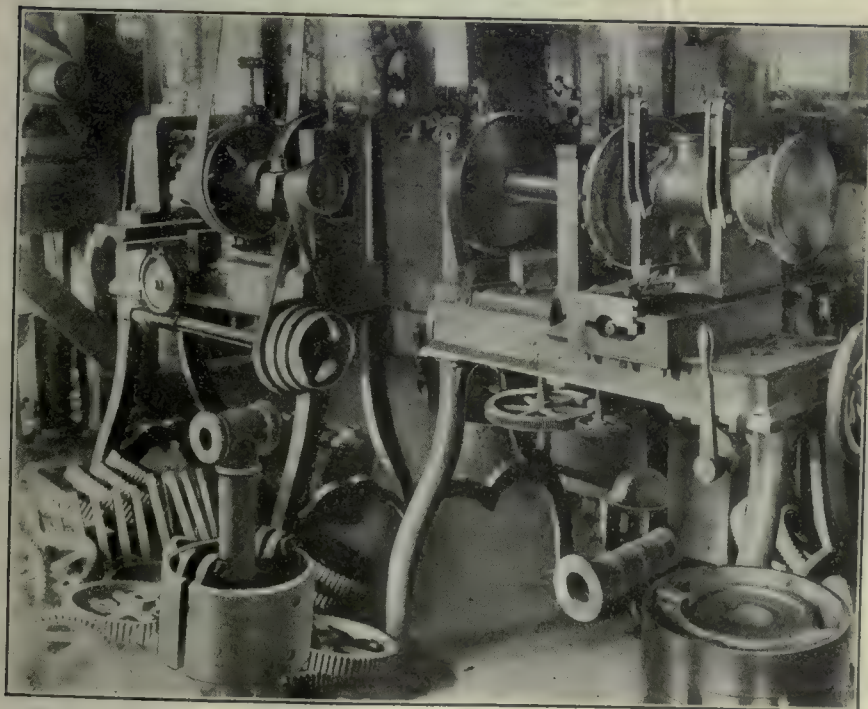


FIG. 9. FACE MILLING ENDS OF PUMP CASTINGS

purpose here to illustrate some of the machines and methods commonly used throughout the shop. Some of these methods are especially important in the production of the parts required for the equipment turned out; others have a certain degree of interest, not so much from the nature of the operation itself as from the character of the tool upon which it is performed.

operated upon independently or the whole machine may be driven in unison, as desired, as each spindle has independent drive and each of the work slides carrying the pump cylinders has an independent feed for lifting it to the cut. The method of securing the work in place on the vertical slides or tables will be obvious upon inspection of the illustration. The lower end of the cylinder casting rests against a seat or shoulder on the traveling slide, and the upper end is adapted to fit into a form of steadyrest placed horizontally, as shown, with a swinging cap which is opened to admit the work or to release it upon completion of the machining process. The boring bar with its cutter is rotated by spur gearing at the top of the spindle, driven from a large central gear, which is itself rotated by a spur pinion and a pair of bevel gears at the top, operated by the two-step cone pulley. The series of levers for controlling the independent operation of the spindles may be seen in the top of the column. This view also shows clearly the dust-collecting system, which forms an important feature in the operation of the tool. The machine has a capacity to admit work up to about 36 in. in length and has ample feeding movement to take care of any cylinders coming within the holding capacity of the chucking fixtures of the operating table.

Another dust-collecting arrangement that is found of advantage to workmen employed over machines where cast-iron dust is likely to fill the atmosphere is illustrated in Fig. 3. Here will be noticed a pair of engine lathes fitted up with special holding blocks for securing pump cylinders and similar parts longitudinally for the boring of the chambers. In this case the longitudinal carriage feed is employed to pass the work over the cutter. The cutter bar is secured and driven by a special chucking device on the nose of the lathe spindle.

The dust hoods are rectangular in form, extending nearly the whole length of the lathe body. They are sufficiently low so that, while they escape striking the top of the operator's head, they still bring within their scope practically all the dust produced in the boring operation.

SOME OPERATIONS ON BRASS AND COPPER MATERIALS

Figs. 4 and 5 illustrate some interesting operations in handling brass and copper pump parts. Fig. 4 shows a home-made rig for sawing up brass tubing to length for various purposes, such as liners, connections, tube barrels and the like. A home-made saw bench is here illustrated equipped with a 12-in. saw, and with this the workman is enabled to cut tubing up to 12 in. in diameter.

At the right-hand end of the saw bench will be noticed an end stop against which the end of the tubing is placed for the cutting operation. The front side of the tube rests against the longitudinal gage on the bench. During the process the tube is rotated to bring continuously a fresh cutting surface against the saw teeth. This operation is very rapid and works out to entire satisfaction.

Fig. 5 shows a lot of high-grade household pumps with copper bodies undergoing finishing operations after the soldering on of the nozzles. These pump bodies are slipped for fabrication upon a double-ended arbor mounted on the bench block, as shown. While thus held, they are freely handled by an expert finisher, who attends to soldering, cleans up the surfaces, polishes up the joints and prepares the body for final buffing and for assembly and shipment.

The operator is skilled in all branches of sheet-metal work and has at his elbow bending and forming rolls, soldering and burnishing tools and everything else that can be of service to him in preparing these high-grade copper pumps for service.

A HANDY DRILL-PRESS FIXTURE

Fig. 6 illustrates a holding fixture for work of various shapes and sizes which has to be handled under the drill press. The piece here shown is a spherical form of base casting. It is gripped at one end by special jaws held in the swiveling fixture, which is mounted on good-sized trunnions in bearing blocks at each end. The vise that holds the work can thus be rotated to any angle in the vertical plane to suit the sides where the holes are to be drilled. It is locked at certain definite angles and is quickly operated so as to swing to any desired position or for the opening and closing of the jaws when work is to be admitted or removed.

Like the casting shown in place for boring, in Fig. 6, many other parts at this plant are simple in nature, requiring little more than the boring of a central hole and the drilling and facing of certain seats for bolt heads and stud nuts on bosses formed around the surface. A lot of this work is readily machined and inexpensively

handled by simple special jaws attached to a regular vise or chuck already in existence for some standard machine tool.

An illustration of this kind is presented in Fig. 7, where a semispherical casting to be bored through the top and tapped and faced is shown in the pair of special gripping jaws carried in the rectangular chuck on the nose of the lathe spindle. This lathe has been fitted with a special turret carriage and slide built on the premises, and a set of simple flat boring and counterboring tools has been added to the equipment to facilitate the chucking out of the hole and the finishing of the exposed upper surface. In the photograph the tap will be seen in position for operation.

The nature of the chuck body is apparent and needs no description whatsoever. The two chuck jaws, it may be pointed out briefly, are cut out to conform to the curvature of the periphery of the castings. The annular chan-

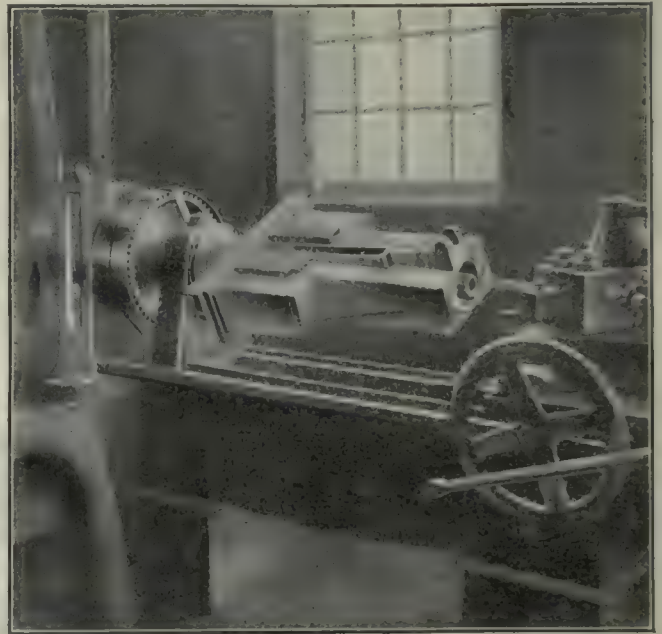


FIG. 8. A LONG PUNCH PART HELD IN SPECIAL CHUCK JAWS

nels thus formed in the inner surfaces of the jaws are produced to a depth sufficient to provide for an engaging lip coming up over the head on the casting, so that the possibility of the latter being accidentally withdrawn from the chuck jaws is entirely obviated.

Another chucking job in this same lathe which should be of interest is seen in Fig. 8. The casting in this view is about 20 in. long and has to have a hole machined at the bottom of the base and a facing operation performed thereon. The casting is supported near the outer end by the ends of the long holding jaws, which are cleared for the greater portion of the length to allow the ends only to grip. The hole in the base and the surrounding surfaces are machined with tools quite similar to those shown in connection with Fig. 7, no special explanation here being required.

Fig. 9 illustrates some early types of Lincoln millers equipped with special fixtures for surfacing the ends of pump castings. These fixtures consist, like numerous other holding appliances for similar work on these machines, of a built-up pair of V-blocks, constituting a locating and holding base upon which are secured swinging

hinge straps adapted to come down over the top of the work and clamp it securely at each end. In this respect the fixture much resembles a double steadyrest on an engine lathe.

In the machine seen in the foreground, provision has been made to keep backlash out of the table by the heavily weighted cord attached to the left-hand end. This cord passes over a pulley in the top of the standard shown in the immediate foreground and carrying at its end a heavy weight, cylindrical in form and bored out to slide freely up and down over the upright post carrying the cord sheave wheel. The cutters on these machines, like the fixtures, are home-made and are of the inserted type, carrying teeth widely spaced and easily removed and renewed when necessary.

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Sir Joseph Whitworth on Scraping Practice

BY A. L. HAAS

A paper on plane metallic surfaces was delivered by Sir Joseph Whitworth in 1840 before the members of the British Association at Glasgow. The original paper is now scarce and it is for the benefit of those who are familiar with the process but have never seen the original text that the following extracts are published.

The discovery of the process was at once the most revolutionary and simple of the inventions of this pioneer of mechanical art. It will be admitted from the following extracts that few technical papers have been clearer or have a greater claim to style than this on "Plane Metallic Surfaces."

There are two cases for consideration in reference to the preparation of surfaces—the one, where a true surface plate is already provided as a model for the work in hand, and the other where an original surface is to be prepared.

The former case is that which will generally occur in practice. The method to be pursued is simple and requires care rather than skill. Coloring matter, such as red ochre and oil, is spread over the surface plate as equally as possible; the work in hand, having been previously filed up to the straight edge, is then applied thereto and moved slightly to fix the color, which, adhering to the parts in contact, afterwards shows the prominences to be removed by the scraping instrument, and the operation is frequently repeated. As the work advances, a smaller quantity of coloring matter is used, till at last a few particles spread out by the finger suffice for the purpose, forming a thin film over the brightness of the plate. A true surface is thus rendered a test of the greatest nicety, whereby the smallest error is detected. At this stage of the process, the two surfaces must be well rubbed together that a full impression be made by the color. The higher points on the rising surface become clouded over, while the other parts are left more or less in shade. The dappled appearance thus produced shows to the eye of the mechanic the precise condition of the new surface in every part, and enables him to proceed with confidence in bringing it to correspondence with the original.

It will be a matter of discretion, as before remarked, how far to proceed in working up the minute detail, but it is essential that the bearing points, whether more or less numerous, should be equally distributed and a uniform character preserved throughout. This rule should be carefully observed during the progress of the work as well as at its conclusion.

In order to secure the equal advance of all the parts together, particular attention must be paid to the coloring matter, both with reference to the quantity employed and its equal distribution. If too small a quantity be used in the first instance, it will afford no evidence of the general condition of the surface. It will merely indicate the particular points which happen to be most prominent, and to reduce these in detail would be only a waste of time, so long as they are considerably above the general level.

When the surface is finished, if it be rubbed on the plate without color, the bearing points will become bright and the observer will be able to judge of the degree of accuracy to

which it has been brought. If it be as nearly true as it can be made by the hand, bright points will be seen diffused throughout its whole extent, interspersed with others less luminous, indicating thereby the degree of force with which they respectively bear.

As the surfaces approach perfection the utmost caution and vigilance will be necessary to prevent them from degenerating.

A mistaken idea prevails that scraping is a dilatory process. . . . It will be found, however, to involve the sacrifice of less time than is wasted on grinding. Were the fact otherwise, it would be no argument against the preference due to the former. But it is worthy of observation that in this instance, as in many others, improvement is combined with economy. There is not only an incalculable saving effected by the improved surface in its various applications, but there is also a positive gain of time in the preparatory process.

The series of operations in generating a new surface is purposely omitted as it is so well known. Attention is however directed to the following points made by Whitworth in the foregoing extracts:

Little importance is attached to the coloring media, but it is to be applied to the surface plate. Stress is laid upon the intelligent use of the coloring media rather than upon its precise method of application.

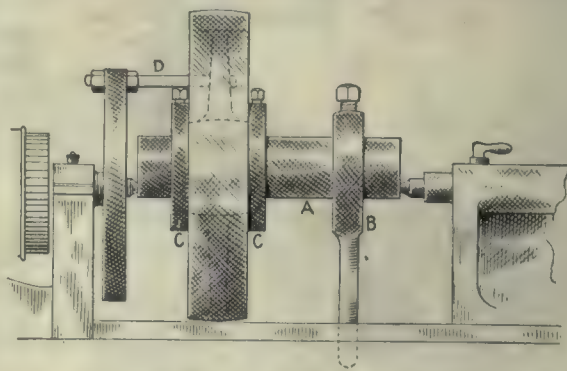
Scraping is an essentially cheap operation if fine results are not necessary and although a hand operation, it is even today worth extended application. Sharp tools wielded by skillful hands shift a surprising amount of metal in a short space of time. It leaves the surface clean of particles left by the shear cut-and-break of machine operations and is worth while if only for a smooth finish. When, however, the improvement to truth of surface is considered its importance cannot be overrated. If surface plate conditions are not sought, and widely spaced bearing points are allowed, its cost is not prohibitive for quite cheap jobs.

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Turning a Large Pulley

BY W. D. DAWSON

The illustration shows a way to turn a pulley larger than the capacity of a lathe. The pulley is first bored and reamed. Then a piece of shafting *A* is made a nice running fit, the pulley turning on the shaft, which is



TURNING A LARGE PULLEY

held stationary by the cam *B*. The collars *C* hold it in place.

A stud *D*, fastened to the faceplate, drives the pulley. It is obvious that the pulley will run faster as the stud is coming up and slower as it is going down. The stud should be so placed that the tool is taking the high spots when the stud is nearing the bottom center.

Drop-Forging Dies for a Link, Wrench and Turnbuckle

BY ROBERT MAWSON

SYNOPSIS—In this article are shown the dies used in drop forging three pieces of hardware. The tools are designed to form many thousands of parts from each. The article not only shows the tools in detail, but also gives the average production of each.

The Marine Hardware Equipment Co., South Portland, Me., manufactures a large variety of drop forgings for marine and other purposes. The dies for making the double-lock connecting link form the two halves with the intersecting lugs and recesses, as shown. These are made so that no further manufacturing operations are required.

The making of a patented wrench is the next subject described. The dies form this part with the imprint on one end, as shown. It will be seen that three impressions are used in these dies, so that the amount of metal necessary to be upset is divided into three suboperations.

A turnbuckle is the last example. The tools illustrated first form the part in two suboperations. The fin on the inside and the flash on the outside are later trimmed off with trimming dies. All the tools are shown in detail.

It will be seen that these dies are heavy and rigid in construction. On the first three, the two elements are manufactured out of a single piece of tool steel, the part to be made being formed with an impression in the upper and lower dies.

This procedure is necessary, for many thousands of parts are produced with one set of tools. As these tools

are designed to work on steel, a tremendous pressure is required in their manufacture.

It will also be observed that the part is made in several impressions in one die, this tending to produce a better finished piece and lengthening the life of the dies.

The tools used for the trimming operation are made with a steel plate having an opening of the same contour as the fin to be punched out. The punch is then caused to descend onto the element, which is placed over the lower die and the fin punched out to the shape of the contour desired.

These tools, as shown in detail, will suggest other applications of drop-forging work, as they have been found by the test of practical experience to give satisfaction both as to lasting qualities and economic production.

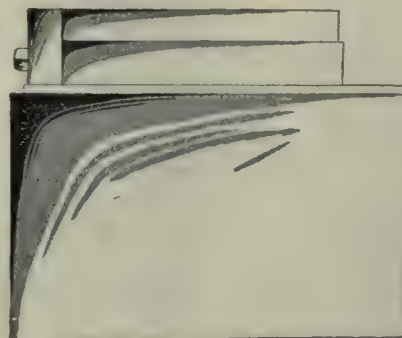


Fig. 8

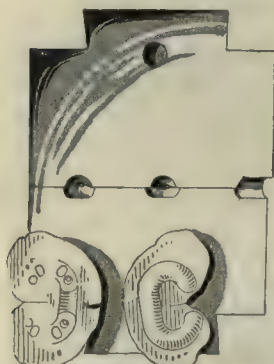


Fig. 2



Fig. 4

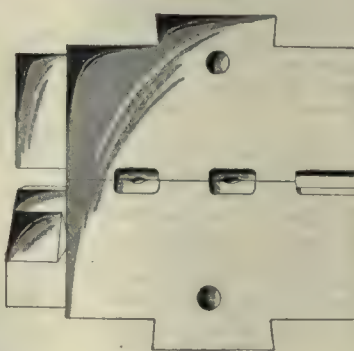


Fig. 6

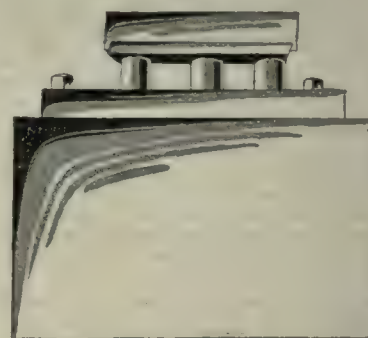


Fig. 7

VIEWS OF DROP FORGE AND TRIMMING DIES SET UP IN THE POSITIONS THEY OCCUPY ON MACHINES

FIGS. 2 AND 2-A

Operation—Drop forging the connecting link, Fig. 1. The heated steel is placed on the first lower die, and the upper die is caused to descend. The formed part is then transferred to the second set of die openings and the operation repeated. The link comes from the dies in the form seen in Fig. 2. The fins are then removed from the drop-forged part with another set of dies.

FIGS. 4 AND 4-A

Operation—Drop forging the patented wrench, Fig. 3. The heated bar is placed over the first opening of the lower die; the upper die being fed down, the first impression is made. The part is then transferred to the center form and the operation repeated. The partly formed wrench is afterward placed over the third form, and by repeating the operation a finished wrench is produced. Between successive drop-forging suboperations the stock is heated.

FIGS. 6 AND 6-A

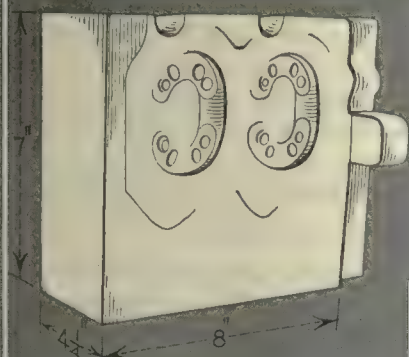
Operation—Drop forging the turnbuckle, Fig. 5. The heated bar is fed between the dies, and the stock is upset in the first opening. The part is then transferred to the second and third position in sequence until the turnbuckle is formed. Between each suboperation the stock is heated.

FIGS. 7 AND 7-A

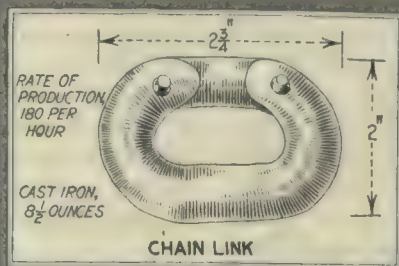
Operation—Trimming out center fin of turnbuckle, Fig. 5. The heated turnbuckle is placed over the lower die; the upper die being forced down, the fin is removed.

FIGS. 8 AND 8-A

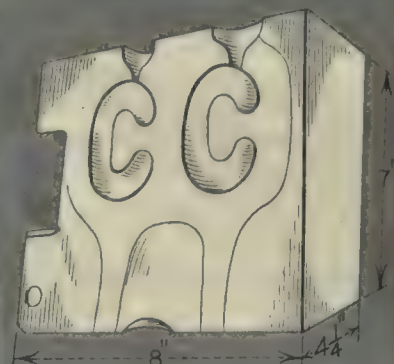
Operation—Trimming fin from outside of turnbuckle, Fig. 5. The heated part is placed over the lower die. The upper die, locating by a center plug, as shown, when fed down trims away the outer fins from the turnbuckle. This finishes the part ready for the subsequent drilling and tapping operations.



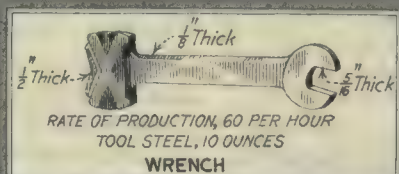
PUNCH
FIG 2-A



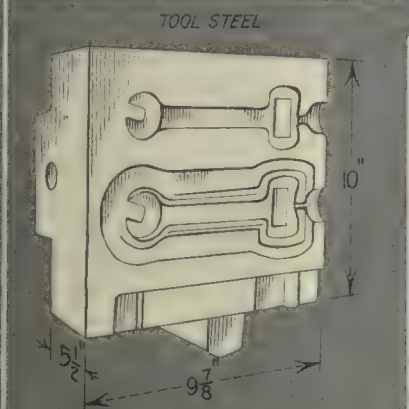
CHAIN LINK
FIG 1



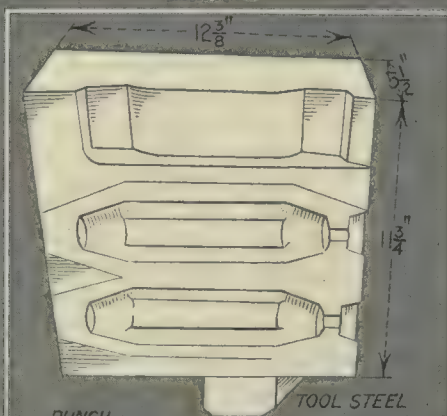
DIE
FIG 2-A



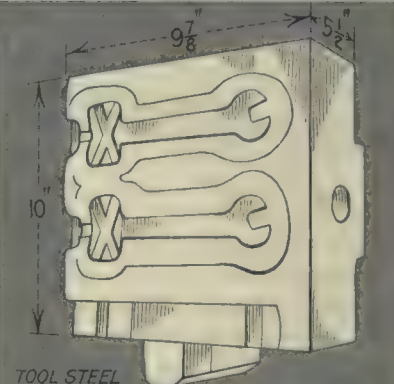
WRENCH
FIG 3



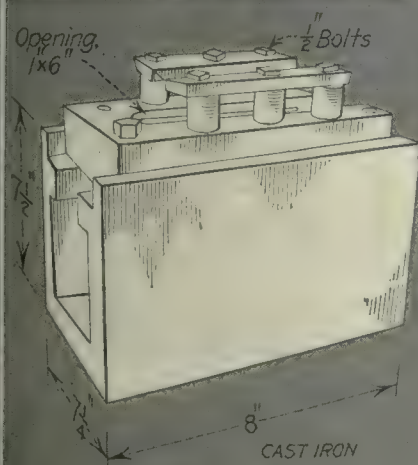
PUNCH
FIG 4-A



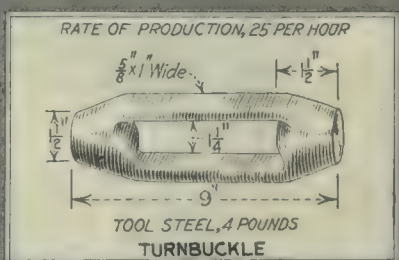
PUNCH
FIG 6-A



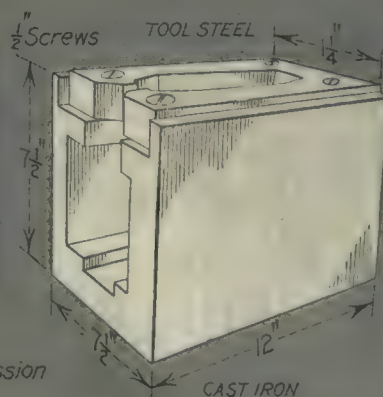
DIE
FIG 4-A



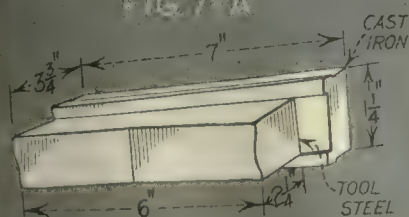
DIE
FIG 7-A



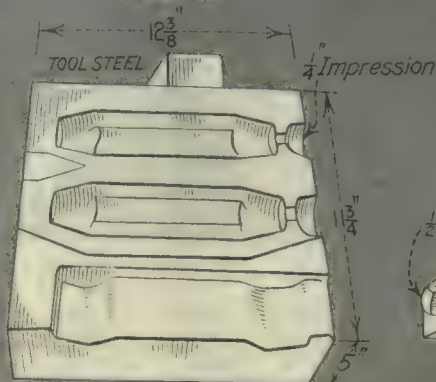
TURNBUCKLE
FIG 5



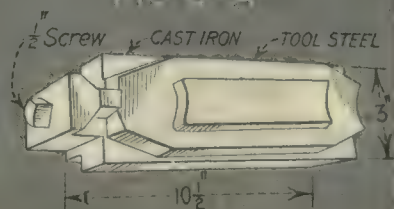
DIE
FIG 8-A



PUNCH
FIG 7-A



DIE
FIG 6-A



PUNCH
FIG 8-A

A Babbitting Problem

By R. WILLIAMSON

In babbitting the engine base on a gasoline traction engine we use a mandrel similar to that shown in Fig. 1. When a new rig was sent into the shop, the workman complained that the center bearing *A* was large in diameter or that the mandrel was sprung, as the center bearing would not clean up. The mandrel was checked over

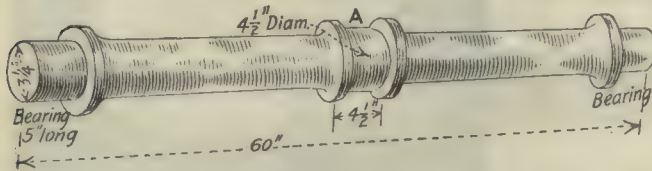


FIG. 1

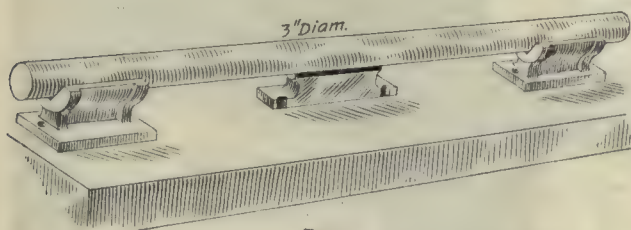


FIG. 2

FIGS. 1 AND 2. A BABBITTING PROBLEM

and found to be correct for diameter and straight within a few thousandths.

We made several attempts to find the cause of the trouble, without any success. Finally, we reduced the diameter of the mandrel at the center bearing by 0.020 in., giving an allowance of 0.010 in. for the babbitt. In this way we got out of our trouble. Since this discovery

Some time later I had an opportunity to try out the same thing, shown under different conditions in Fig. 2. We had three pillar blocks to babbitt. They were planed on the base and placed on a surface plate. The shaft which was to be used as the mandrel was about .7 ft. long and was supported in V-blocks known to be correct. In this case also the center bearing was low. Some of your readers may know where our practice is wrong.

Oil-Burner Drilling Machine

By E. V. ALLEN

The machine shown in Fig. 1 is a special 63-spindle drilling machine, made by the J. L. Kunz Machinery Co., Milwaukee, Wis., for drilling holes in kerosene-burner caps. The drills used are No. 56 size, and eight rows of holes are drilled in each cap. These holes are drilled staggering—that is, alternate rows are shifted over half the distance between two holes. The cap to be drilled is placed at *A*, over a center pin, and locked down with a nut. The center pin is so made that it may be raised or lowered a certain amount by means of lever *B*, which is set along the segment *C* at regular intervals by means of a latch. This gives the spacing for the different rows of holes that are drilled around the burner cap.

The staggering effect is produced by means of a lever *D*, which is fastened to the center pin, so that by shifting the lever to the right or left, against stops, the burner cap will be shifted accordingly. The plan of procedure is to drill a row of holes, then shift this lever over against one stop before the next row is drilled. When this row is finished, the lever is shifted back against the opposite stop, and so on. The drill spindles are fed into the work by means of lever *E*. Handle *F* works the belt shifter.

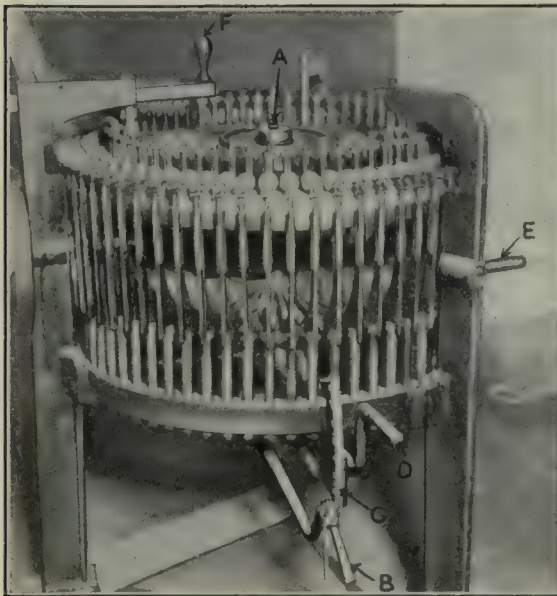


FIG. 1. A 63-SPINDLE DRILLING MACHINE

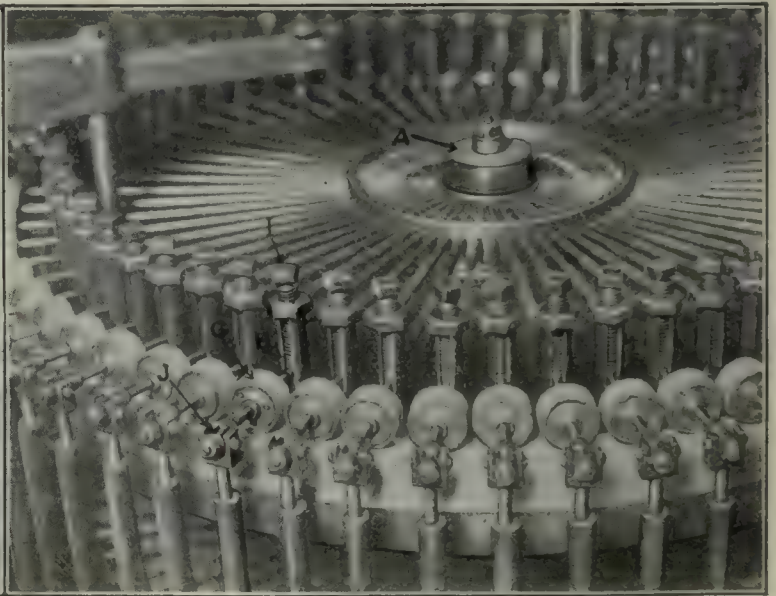


FIG. 2. CLOSE-UP VIEW OF SOME OF THE MECHANISM

we have made several of these mandrels for different sizes of engines, and we always reduce the diameter of this bearing.

Whether the mandrel is solid or hollow seems to have little to do with the question. We made one mandrel of very heavy tubing in order to reduce the weight. The shrinkage of the babbitt from the center bearing was not affected.

A larger view of part of the mechanism is shown in Fig. 2. This gives an idea of the way the spindles are run. Each spindle has a small friction wheel like *G* on it. This friction wheel is 1 1/4 in. in diameter, and is leather covered. It is held to the large driving rim, which is 28 in. in diameter, by means of a spring *H*, tensioned by screw *I*. A fork *J* is set between collars on the spindle so that it may be fed out or in. The entire machine weighs about 400 lb.

Indirect or Expense Labor*

BY ROCKWOOD CONOVER†

SYNOPSIS—A detailed analysis of the duties of the various groups of indirect shop labor. In many cases helpful unit factors are given for the number of production employees per supervisor or laborer for various shop and department conditions.

One of the subjects requiring the attention of the factory manager is that of indirect labor. The successful business manager in every field is a close student of expense. The profitable conduct of business depends upon this factor fully as much as upon any other one feature connected with the operation of the shop. Failure to provide for systematic scrutiny and control of overhead charges is often the underlying cause of unsuccessful competition and loss of trade. The relation of indirect labor to productive output and manufacturing costs renders constant investigation and study of all items of expense imperative. The subject merits careful and somewhat extended consideration.

It is evident that no definite ratio of indirect labor to direct or productive labor in the individual shop can be set down as the universal or correct one, for the reason that such ratios are governed entirely by local conditions. The overhead-expense labor in departments manufacturing a variety of large or heavy special machinery will necessarily be very much greater than in shops manufacturing large quantities of small standard fittings, articles of utility, novelties, appliances, etc. In the former case the productive force will consist chiefly of tradesmen machinists, will be relatively fewer in number, while the supervising force, clerical and labor force will be relatively large. In this class of manufacture under normal conditions the ratio will average 25 or 30 per cent., although a ratio as high as 40 or 50 per cent. may in some cases appear justified and reasonable.

Where the product consists of small standard articles or appliances, the productive help is usually composed largely of young men, boys and female operatives, and the number of supervisors required is comparatively limited, each supervisor being able to oversee the work of a large number of hands. The amount of clerical help and the number of floor laborers for moving material will also be proportionately less. Under these conditions the ratio of indirect labor to direct labor will be as low as 10 per cent. and may reach the high point of 20 per cent.

The class of product manufactured and the prevailing local rate of wage must be the governing factors in determining what is a proper ratio for the individual shop. The foregoing ratios are departmental ratios, based on the overhead expense incurred within the individual shop, for such classes of labor as foremen, clerks, cranemen, laborers, etc. They do not include official and office help outside the department or such extraneous expenses as are commonly prorated, such as

light, heat, and power, insurance, taxes, receiving, shipping, etc.

Any ratios based on the total indirect labor and total direct labor of an industrial establishment are naturally affected by and subject to local conditions in the same manner in which departmental ratios are affected. A ratio of 40 or 45 per cent. may appear justified to the manufacturer of a miscellaneous class of product in a given locality, and there are facts to establish this as a fair average figure for certain industries operating under average conditions and producing a variety of mechanical or electrical apparatus. In other localities under other conditions, however, the manufacturer is warranted in increasing his ratio to 60 per cent. or even higher and in so doing may be multiplying his profits proportionately.

It is obvious that the indirect-labor ratio may, within certain limits, be considered a relatively unimportant factor for specific reasons. The addition of more supervision and other classes of expense help to the manufacturing department may enable the foreman to devise ways and means of increasing his product and materially reducing the number of productive employees. By the addition of efficiency men many tools and appliances that, with a limited supervising force, would not be put into operation, can be devised and thereby increase the workman's daily output.

In the same manner an increase in labor force will obviate the necessity for productive hands gathering materials or moving materials between benches and machines. The clerical labor, if any, performed by the operator should be limited to filling out such record as may be necessary for him to make on his job card, as filling in his name, date, check number, etc., and even this work may be done by the shop clerk. All helps of this kind have a direct effect on the producing capacity of the shop and likewise exert a definite influence on manufacturing costs and selling prices.

RATIO OF EXPENSE EMPLOYEES TO PRODUCTIVE EMPLOYEES

The ratio of expense employees to productive employees will necessarily vary greatly with manufacturing conditions. In certain classes of manufacture the number of overseers required is relatively small in proportion to the number of productive hands, as also is the number of hands doing general floor labor, trucking, sweeping, packing, stock keeping, etc. This is largely true in factories where the product consists of small standard articles that continue to be made throughout the year or for long periods without change. Productive help in such instances soon become proficient in performing the individual operations and normally require a small proportion of the foreman's time, and consequently the number of hands to each overseer will be large. In these cases the ratio of expense employees may be as low as 3 to 5 per cent. of the productive employees.

On the other hand, where the product consists of larger apparatus requiring considerable labor for the handling of individual parts, increased amount of labor in receiving, shipping, stock keeping, supervision, etc.,

*Prepared for the author's forthcoming book on "Industrial Economics." Copyright, 1916, Hill Publishing Co.

†Factory economist, General Electric Co.

as well as machining and assembling, and also in lines where the product is subject to frequent engineering changes involving the production either in part or whole of new designs, the number of expense employees will be relatively large, and the ratio may reach as high as 12 to 15 per cent. A higher ratio than this should not exist except under special conditions and should receive the manufacturer's attention.

DEPARTMENTAL SUPERVISION

The function of supervision of the productive forces being so intimately related to various phases of manufacturing renders it desirable to review these duties with more detailed analysis and with repeated emphasis. In general, in addition to seeing that production schedules are maintained and that all the various individual processes proceed with uniformity the head foreman and his assistants should see that proper discipline is maintained throughout the working hours of the shop; that each employee reports promptly for duty at the beginning of the day and at the close of the noon hour; that he is diligent in his work and cleanly in person, keeping his tools also in a cleanly and orderly condition. He should be provided with proper air and light and other elements of comfort and healthfulness that aid him in his labor.

Proper watch should be exerted to determine the skill and fitness of each employee and the neatness and accuracy with which he performs his tasks, in order that he may be advanced to higher-grade occupation, or to a different class of work in cases where he may have been assigned to duties for which he is found to be unfitted by previous experience or training. The foremen should see that the workmen are supplied with proper drawings and instructions and with necessary tools and materials to facilitate their work. Constant investigation should be made and the necessary time devoted to devising new tools and methods for increasing production and reducing labor costs. Suggestions made by the workmen should always receive prompt and careful attention, and should be properly rewarded whenever they are found to be of value in improving in any manner the efficiency of the department or when they result in gain to the employer.

The relation of the foreman between employer and employee is peculiar in its character. Upon his judgment, tact and competency depends the maintenance of proper relations between the managing executives and the shop. He should be filled with a sense of justice and right and possessed of an intelligence that enables him to interpret correctly and clearly the attitude of the management toward the workmen. He should give his personal attention to all requests or complaints made by the men and should thoroughly investigate and understand each case from the workmen's standpoint, in order properly to place the matter before the superintendent or manager where necessary. It is essential that the foreman be a man of broad training and experience in shop practices and conditions, competent in discerning human nature and appreciating the merits of others' opinions when such opinions differ from his own.

The position of foreman at the present day is one of greater responsibility and intensity of application than in former years, when a large percentage of the shop

employees were tradesmen machinists or experienced hands. Modern labor-saving tools and special appliances, both for machining and assembling, have enabled the manufacturer to employ a large percentage of unskilled help in his shop. This grade of help requires constant attention and instruction on the part of the foreman and his assistants, in order to keep up the productive output and insure a fair quality of workmanship. It is also usually a floating class, which involves the constant breaking in and training of new employees to fill the vacant places as time goes on.

In manufacturing plants producing a miscellaneous line of mechanical product consisting of machinery and other apparatus that may be termed medium in bulk and weight, together with a variety of small machines, devices and fittings, the average number of productive employees under one supervisor will normally range between 25 and 35. This number will be greatly increased in all lines of small manufacture that have been fully standardized.

The supervision of small gangs of a limited number of workmen may properly be charged directly to the manufacturing shop orders, where the boss or leader of such gangs is simply held responsible to see that the work proceeds correctly and without delay and the greater portion of his own time is spent in labor of a productive nature. In such cases he should be classed as a productive gang boss and not as an expense foreman.

The cost of directive force per 100 productive employees will obviously vary in different localities and under different conditions. In the manufacture of apparatus that is subject to frequent engineering change and consequently requires close supervision it will be much greater than in shops producing a standard line of product subject to comparatively few changes.

In shops where the nature of the product admits of each supervisor or assistant overseeing approximately 100 hands the cost of directive force per 100 employees will be between \$30 and \$45 per week. It is doubtful if a lower cost than this will be reached under normal conditions in any prosperous locality.

Large work and special apparatus requiring the subdivision of the productive force into limited numbers assigned to each overseer will increase the cost of directive force to a point between \$90 and \$125 per week. Between the former figures and the latter there is necessarily a wide range in cost of supervision to be considered, which can only be determined by the nature of the product and the conditions under which it is manufactured. It is safe to say that a supervising expense exceeding \$125 per 100 productive employees per week will bear investigation from the standpoint of economical administration.

INSPECTORS AND INSPECTING EXPENSE

The amount of inspection help required in the shop must necessarily depend upon the class of product manufactured. Instrument work and other apparatus involving close mathematical precision make careful detail inspection necessary. There are, however, many kinds of apparatus where the workmen become trained to do their operations in a sufficiently accurate manner to make the employment of a regular inspector unnecessary, except for the purpose of inspecting the finished product after assembly.

It is always desirable to have the assistant foreman understand that he is held responsible for the quality of work performed under his immediate charge and that it is one of his chief duties to keep a close observation on the various jobs in order to see that each employee is working accurately to drawings and turning out a high grade of work so far as finish and correctness of workmanship are concerned. If the assistant foreman is alive and properly equipped with the right kind of knowledge and training in his work and gives sufficient attention to mechanical details, the expense of maintaining a regular inspector on the shop floor can, in many cases, be avoided. He should understand it to be a part of his duties of supervision to make regular inspections daily and teach and show his men how to perform each operation with neatness and precision.

The influence upon the workman himself is also beneficial. It teaches him the exercise of care and diligence in the performance of each individual task. It tends to increase his skill and usefulness and to raise the grade of his work generally and fits him for transfer to tasks requiring a higher skill or larger experience.

In shops where it is necessary to maintain a regular force of inspectors those men should be selected for the position who have had a broad training in mechanical work. In the performance of his routine duties the inspector will find many opportunities to suggest changes in the construction of apparatus. These alterations will obviate some of the difficulties or defects that develop during the process of manufacture and will thereby eliminate certain labor operations which are unnecessary and which tend to increase the manufacturing cost. The inspector will discover frequent cases where the weight of castings can be reduced and the amount of material lessened without seriously affecting the quality of the finished product. He should work in harmony with the engineers, foremen and assistant foremen in pointing out defects and raising the standard of workmanship in general.

When it is necessary to condemn a piece of work because of mistakes made by the operator in performing the various labor operations, the inspector should take special care to explain the defects to the workman fully and clearly, so that he may understand why his labor is rejected and avoid mistakes of the same nature in future. This should be done in a painstaking and courteous way, in order to gain the workman's interest and coöperation in striving to raise the quality of his labor to as high a standard of excellence as possible. The inspector's attitude toward the workman should always be one of friendly helpfulness, and all his decisions should be made with absolute impartiality and justice.

The inspector should not be too ready to condemn product for defects which may be insignificant and relatively unimportant and which may be easily remedied without an undue expenditure of time and material. Good inspection does not involve the wholesale condemning of detail parts that do not measure up to the drawings. Small variations frequently do not affect the mechanical efficiency or sale of apparatus, and here is where the shop inspector must employ a large degree of wisdom and judgment mixed with a good measure of commonsense. He should, however, strive to hold the productive labor in close accordance with drawings

and engineering instructions and in this respect maintain the high-water mark of accuracy and finish.

Castings that are purchased from several outside foundries should be stamped at the time of receipt and inspection for purposes of identification, so that charges can be made back to the proper foundry if defects develop during the process of machining.

The gaging and looking over of detail pieces between operations in some lines of small product, previous to the final assembly, are considered by some manufacturers to be a legitimate charge against the manufacturing orders as a part of the process of manufacture, the final inspection after assembly being charged to expense.

Regular reports of all apparatus condemned should be made out daily by each inspector and copies sent to the superintendent and all heads of departments interested. These reports should give proper designation of apparatus or detail and full particulars relating to the nature and cause of the defect, labor operations that have been performed, the person responsible for errors, etc.

CLERKS IN SHOP DEPARTMENTS

The amount of clerical labor required in factory departments is an item of expense that deserves constant attention. There is always a tendency to build up routine practices involving additional clerical labor, either for the purpose of obtaining information to facilitate the handling of production on the shop floor or to furnish data for the preparation of costs and other accounting records and frequently for the purpose of compiling voluminous, detailed reports of manufacturing conditions. Many of these reports are filed away by the office boy and rarely or never looked at. Such reports often fail in accomplishing the purpose for which they were issued and simply represent an item of unnecessary expense. In most instances the clerical work of a department will admit of such modifications as will make possible the elimination of nearly all complicated methods or records of a special nature.

Ordering productive materials (where this is one of the functions of the foreman's office), keeping time, making out workmen's job cards, checking and recording filled orders, keeping stock card records, making out reports of finished and unfinished apparatus, necessary clerical labor connected with collecting and shipping supply and repair parts and following of orders placed on contributing departments constitute the chief items of clerical work common to the majority of shops.

The chief clerk in the foreman's office should be a person of more or less broad knowledge of general shop routine, in order that he may relieve the foreman as far as possible of many little details of a clerical nature connected with his position. He should also instruct the minor clerks of the departments how to do their work and see to it that they perform their duties systematically and with proper diligence and care. In this manner he relieves the foreman of many of the lesser responsibilities of his office and enables him to devote the major portion of his time to the more important phases of increasing the productive output of his department. The chief clerk should be responsible for all orders for stationery and office supplies for the department and see that the amount of these materials is kept within a proper limit. He should see that orders placed on stockrooms and contributing departments have the proper account num-

ber on them, in order that errors may be avoided in the accounting department. Any orders for expense materials that appear unnecessary or excessive should be called to the attention of the foreman. In every way possible the chief clerk should strive to make himself of practical use to the executive head of the department.

The employment of female help in shop department offices and in stockrooms on card record work has proved advantageous and economical. As female help has entered nearly all fields of industry and has come to stay, the adaptability and economy of this class of help must receive consideration. The average ambitious girl exhibits as much intelligence and care in her work as the average young man, when once she has been trained in the routine of duties she is required to perform; and little argument can be given in reason for preventing her from earning a livelihood through the various channels of industry.

In general, the average number of clerks required to perform all clerical labor (both in the foreman's office and on the shop floor) for a force of 30 to 40 productive hands should not exceed one, or a ratio of approximately one clerk to 35 employees engaged on machine, bench and assembly operations. A higher ratio than this should receive attention.

The crane operator in the large shop should be skilled in the handling of cranes. He should keep his crane in a clean condition and well oiled at all times. He should also exercise constant care to see that all parts of the crane are in good repair and should be quick to detect any break or the getting out of order of any parts of the operating mechanism.

CRANE OPERATORS AND CRANE FOLLOWERS

He should avoid accidents commonly caused by lifting too heavy loads, running the cable up too high on the drum and making side lifts at hazardous angles instead of lifting the load in a vertical direction. Great care should be exercised in starting and stopping the crane with heavy lifts. This should never be done suddenly. The brakes should be applied gradually, so as to lessen the stress upon the cables and slings as much as possible.

If the crane is stopped suddenly when raising or lowering heavy loads at the usual rate of operating speed, the stresses are increased beyond a point of safety and accidents are sure to result. Most of the accidents connected with crane work in large shops are due to lack of judgment or experience on the part of the crane operator or follower and not infrequently to taking too great hazards knowingly. With the exercise of proper care there should be few accidents in any shop.

Small hand cranes and hoists require the attention of the foreman or his assistant at frequent intervals to see that they are given proper care. These small cranes and hoists are usually operated either by the floor labor gang or by productive help as necessity arises. In consequence they are often neglected and do not receive sufficient cleaning and oiling. This neglect is the cause of frequent overhauling and repairs of greater or lesser extent.

It is often advisable in large plants to place the crane service of all shops under the charge of one person possessed of broad experience in crane operation. If the operating force is under his personal direction,

he is able to transfer the men as occasion requires and to have a small force of extra men to fill vacancies of absentees. In this manner all cranes can be kept manned by skilled men and in constant operation, which is not always possible where the service of each shop is under the charge of the foreman. Such a man in charge is also able to follow up accidents and repairs more efficiently and to improve the service generally.

A separate department devoted to crane repairs is a distinct advantage. It should be equipped with proper tools to do all necessary repair work promptly and thereby avoid many of the annoying delays to service caused by having these repairs made either in the regular productive departments or tool departments, which are often overcrowded with orders and unable to take up the work at a time when it is greatly needed.

Reports of all accidents or damage to cranes should be made out at once and sent to the superintendent's office for inspection. These reports should give the nature and cause of the accident, the repairs made and the name of the party responsible for the damage. By means of this publicity further carelessness and expense may be to a considerable degree prevented.

THE WORK OF THE CRANE-FOLLOWING FORCE

The work of crane following is important. The class of help employed on this labor should be of a higher grade than that required for the ordinary trucking, piling and handling of materials usually designated as miscellaneous floor labor. The leader of the crane-following force should be responsible for the care and use of slings and cables. Racks should be provided for holding the slings when not in use. Frequent inspections should be made, and all slings, chains or cables that have become worn or damaged should be sorted out and repaired or sent to scrap when unfit for further use.

It is essential that the head follower know something about loads and the stress to which the slings are subjected in lifting, as well as something about how strains are set up in materials. It is important that the points of attachment be chosen with a view to lessening these strains as far as possible. The factor of safety should always receive careful attention. In handling castings of heavy tonnage, such as castings weighing 50 tons or more, a reasonable amount of care is usually exercised to see that cables or ropes of proper strength are used and that the method of fastening is a correct and safe one. With castings and materials of comparatively light weight—200 lb. or less—the hazard is relatively small, as the foreman can usually determine within reasonably safe limits what size of slings should be selected. It is in the large range of loads running all the way from these lighter weights up to 50 tons where there is danger of misjudgment and accident. The foreman or head crane follower is sometimes inclined to take chances and estimate the load and size and number of slings required with too little care and investigation. The factor of safety to be employed under normal conditions should be approximately the multiple of five; that is, the various sizes of slings should possess a tensile strength approximately five times as great as that actually required to make the lift.

It is good practice to place in the hands of the head crane follower a table based on the vertical lift and on three angles of opening between the sling and work,

showing the number of pounds or tons that can be safely handled with each size of chain, rope or steel cable sling, when attached in these four ways. The angles at which the attachments are made should be between 30 and 60 deg. In general, the angle should not be below 45 deg. At this angle the stress of each sling is equal to about three-fourths of the total weight of the material, and the collapsing force between the two points of attachment is approximately one-half the weight. At an angle of 30 deg. the stress and collapsing force are equal to the total weight. With certain shapes of castings it is often desirable to place a spreader between the two points of attachment to resist the collapsing force.

Another table should be prepared giving the weights per cubical foot of all classes of materials used by the factory. This is valuable in estimating the weights of the various loads and in conjunction with the table of sizes of slings required provides the head crane follower with full information that enables him to keep within the limit of safety. It is desirable that castings of irregular shapes have the weight marked on them before leaving the foundry, as such pieces require too much time and labor figuring to compute correctly the cubical contents. It is a good practice to mark the gross weights on all castings weighing more than one ton for the guidance of all persons responsible for the safe handling of these heavier pieces. When other parts are assembled to the casting, the additional weight must be considered in making lifts.

METHODS OF ATTACHING SLINGS

The method of attaching slings to the material requires careful attention. Different forms of hitch are required for various shapes of castings and materials, and the crane follower must be governed by the kind of product to be handled. He should learn to employ the methods that secure the greatest safety and least strain upon both slings and materials. Ordinarily the hitch should be made so that the sling is not bent at a sharp angle either over itself or the edge of the casting. Pads of metal or canvas should always be used to protect the sling from sharp edges. When the hooking is done through a spliced eye, the slings should always be used double.

Lifting with eye-bolts is sometimes done. In such cases the eye-bolt should be screwed down until it is solidly seated and firm in the casting or material. The lift should be made vertically with the line of axis of the bolt wherever practicable. Lifting at an angle increases the lateral stress and is likely to cause breakage. Instructions should be placed in the hands of the head crane follower giving the number of pounds that may be lifted with safety with various sizes of slings and with the various diameters of eye-bolts when the lift is made vertically to the axis or at angles that increase the degree of hazard.

Handling material with chains demands that a large factor of safety be maintained on account of the tendency of the metal to crystallize. The process of disintegration is usually not discovered until after the chain has decreased in tensile strength to a point where even ordinary lifts are attended with undue hazard. It is good practice to use steel-cable slings in preference to chains wherever possible, not only because of lower initial cost, but because of the reduction in hazard.

The elevator man should have sufficient experience and judgment to operate his elevator with a proper degree of safety. He should see that the doors or gates are always closed when the elevator is in transit. He should give attention to the motor, drum and cables and see that they are always in good condition and that the motor is regularly cleaned and oiled.

A good degree of judgment is required in the handling of materials. The elevator should not be loaded beyond a point of safety, and care should be taken in distributing materials to the proper floors, so that delays and errors do not occur. The floor space about the elevator should be kept clean and free from congestion at all times.

FLOOR AND YARD LABOR

The floor and yard laborers require careful supervision on the part of the foreman. In nearly all sections of the country foreign help has largely superseded native-born workmen in all the lower grades of manual tasks, such as loading and unloading, trucking and handling materials and for other miscellaneous unskilled labor on the shop floors and in the open areas about the factory yard and buildings. Not a few of this class of employees prove industrious and valuable help to the manufacturer. A considerable percentage, however, is not only unable to speak or understand the English tongue, but is incapable from lack of proper training or other causes to perform efficient and satisfactory service or, in other words, to do what may be termed a fair day's work.

This latter class requires constant watching and teaching to do the simplest kinds of labor to advantage. It is the lack of proper attention and instruction that renders such help of only limited value in many factories. If small gangs of these men are put to work on a job, whether it be handling materials in the shop or doing yard labor, and are left to themselves, being visited by the boss only at intervals during the day, they will quite as often be found loafing as otherwise or simply keeping up the semblance of activity and as a result accomplishing little. As a rule, assistant foremen and bosses do not follow up these men closely enough after assigning them to a piece of work. They do not look upon floor labor in the same way that they view productive labor.

When a laborer is sent to another department or shop for material, the assistant foreman should follow the matter up at frequent periods to ascertain if valuable time is being wasted. Many of these men have never been taught in their own country to labor advantageously and perform their tasks with a saving of time and energy. They must be shown with exhaustless patience how to lift and move and pile materials before we can expect them to do these things intelligently and systematically. They should be taught to pile castings or other materials on the work benches, truck platforms or about machine tools in a neat and orderly manner and away from the main aisles and gangways where the articles would otherwise obstruct passage and give the shop a disorderly appearance in general.

This feature of departmental management is a more serious and important one than most foremen realize and is well worth any fractional increase in expense that may be entailed. There is no more potent advertisement of a successful industry than a normal condition of system and order throughout every department of the shop. It

is a certain indication of thrift, success and ability to produce and supply quickly whatever the customer may demand. Every laborer and sweeper should be educated to understand the importance of this phase of factory production and to perform his duties accordingly.

FACILITIES FOR OUT-OF-DOOR WORK

Yard labor in industrial plants commonly involves a large expenditure during the year. Excavating, filling, care of roadways and grounds, repairing tracks, etc., constitute some of the chief items that increase this portion of the factory budget. It is important that an efficient overseer be placed over the gangs performing this labor in order to see that they are kept busy and are supplied with proper facilities to work to the best advantage. All tools and materials should be on the job in readiness to proceed with the work in an economical manner without unnecessary delays.

A record should be made of all temporary help furnished to individual departments to perform additional labor during high peaks of production or to take the place of absentees from the regular labor force from sickness or other causes. This record should show the date the temporary help is furnished and the length of time it is required by the foreman, in order that each case may be investigated as to further requirements at the close of the period. There is often a tendency to retain such help within the department for a longer time than the period for which it was requested, unless some method of check and control is maintained. The time to prevent any unnecessary expenditures of this nature is before the expense has been incurred.

The ratio of floor labor to productive labor obviously depends entirely on the nature of the product manufactured. In plants building large machines, a ratio of one laborer to 20 or 25 productive hands may be fully warranted, whereas in smaller lines of manufacture an average of one laborer to 30 or 40 or even 50 hands appears sufficient. The individual manufacturer must necessarily be governed by his own judgment as to the amount of this class of labor required within his shops.

SWEEPERS, CLEANERS AND OILERS

The labor of cleaning departments and sweeping floors appears of so simple a nature as not to require discussion. An investigation will convince the manufacturer that the subject merits his careful attention. A comparison of areas covered by floor sweepers in the various shops of a manufacturing plant will often develop the fact that the men in one section are covering a far greater amount of territory than those in another where like conditions exist. Data showing the area swept in each department will be found of value in regulating the number of men employed.

New men engaged for the purpose of cleaning shop floors need instruction. The sweeper should be shown how to do his work systematically and efficiently. Wide push brooms should be used for the main gangways and broader aisles between benches and machines. They enable the sweeper to cover a much larger area daily than is possible with the ordinary corn broom. A good quality of broom should be obtained for this purpose. Coarse-fiber brooms are not adapted to cleaning light dust from dry floors. These brooms raise the dust, but do not clean well, except areas covered with coarser refuse or surfaces

that have been thoroughly sprinkled. A good quality of fine fiber or strong hair broom gives the best service for cleaning dry floors that are not covered with oily chips, turnings or heavy refuse.

The shop floors in the vicinity of elevators that are not in constant operation can often be kept clean by the elevator operator to good advantage, saving a portion of the regular sweepers' time for other sections or other work. In general, in machine shops each sweeper should clean on the average at least 28,000 to 32,000 sq.ft. of floor surface daily, including collecting of metal chips and turnings from machines and wheeling to cars standing on sidings within close proximity to the shops. This average will in some cases be increased to 35,000 or 40,000 sq.ft. per man where the accumulation of chips or turnings is relatively small. In other shops the area swept should cover a more or less wide range according to the nature of the product and the amount of refuse resulting from its manufacture. Where the amount of refuse is considerable, each sweeper should cover an average area of 28,000 to 35,000 sq.ft.; and in shops where the waste accumulation is relatively small, a sweeper will average 40,000 to 50,000 sq.ft.

Janitor service, cleaning and care of offices merit consideration. The nature of this kind of work is of such comparative uniformity as to render definite data quite possible. The average square-foot area covered daily by each employee should not be less than 5,000 sq.ft. and in most instances this can be increased to 6,000 sq.ft. This estimate is based on the work of sweeping, cleaning, scrubbing, etc., being performed between the hours of 5:30 and 7:30 a.m. and 6 and 9 p.m. It includes the sweeping and dusting of offices and the scrubbing of stairs and hallways daily; the scrubbing of all office floors and cleaning of windows every two weeks, together with such work as naturally comes within the duties of the head janitor or day porters who are on duty during the office hours of the day. The cost per thousand feet should not exceed \$1.25 to \$1.50 per week.

The care of shop washrooms and closets should receive the attention of the foremen, and frequent inspections should be made to see that the washroom attendants are doing their duty and keeping these places clean and sanitary at all times.

The necessity of keeping all shop motors and shafting properly oiled and cleaned cannot be too strongly emphasized. Each tool operator should be held responsible for having his motor clean and well oiled at all times. The motors should be blown out at least once a week and pulleys, line and countershafts thoroughly cleaned. In large plants a man is sometimes assigned to this work and is known as the department oiler and belt lacer. His duties include the keeping of all belts laced and in good repair. His field of duties can often extend to two or three departments, and he should be equipped with a good belt-lacing machine to facilitate his work.

The men employed as watchmen and gatemen should be possessed of a good degree of intelligence and be faithful and reliable in their duties. This is particularly true of watchmen during the night hours, when the safeguarding of all inside property is placed in their care.

The night watchman should register regularly on the clocks stationed at various points throughout the factory as evidence that he is making his rounds of inspection as directed by the superintendent.

Overtime labor is always expensive under any conditions. When productive help is retained on duty beyond the regular shop hours, an additional allowance per hour, if the work is performed on a day basis, is usually paid the workmen as compensation for remaining at their benches or machines the extra time. It is usually necessary in these cases for an assistant foreman and sometimes a clerk and laborers to remain also, to supervise and take care of the work of these men. There is also the cost of light, heat and power during the hours when the shop is not in full operation, which must be considered in connection with the other increases in the budget of the department. The foreman should carefully investigate all requests for overtime passes before placing his approval upon them. It will frequently be found that the schedules can be rearranged in such manner as to avoid this additional expense.

MAINTENANCE OF PROPERTY

There is always a tendency to increase expense charges under the classification of maintenance of property. Repairs to buildings, roadways, grounds, machinery, tools, electrical apparatus, molds, dies, patterns and many other items of maintenance involve a total yearly expenditure of a large amount. In order to keep the factory equipment in a proper state of repair, it is necessary that all these items receive proper attention. During high peaks of production, when the shops are rushed with a surplus of orders, the question of upkeep usually receives less consideration, except in the cases of repairs necessary to turn out product required for shipment. When a lull in business comes, the work of repairs is taken up and is apt to be carried beyond the point of wise judgment. Employees who have run out of work are sometimes assigned to repairing machine tools and to similar jobs for which they have had no previous special training. As a consequence a much longer time is taken to make these repairs than would be required by a skilled millwright or mechanic. An increase in the factory maintenance account is the usual result. Many of these repairs are unimportant and could well be laid over until more prosperous times.

All these items constituting the factory maintenance account should receive the superintendent's or manager's personal attention. They should be frequently analyzed by a competent executive in order to determine whether the expenditures from week to week are warranted and whether the foremen of the various shop departments are using good judgment in these matters of repair and upkeep.

DEPARTMENTAL EXPENSE BUDGETS

A budget of operating expenses should be issued to the head of each department at the beginning of the year or at the beginning of each six months' period. The budget should contain the amount allowed for expenditures on each expense shop order or account (both labor and material), classified under the head of manufacturing expenses. It is a good plan to issue this in the form of a combined budget and expense statement to be sent out weekly on completion of the factory payroll. This sheet should provide columns for the various expense classifications with their corresponding shop-order numbers, a column for the budget allowance on all expense labor items, one for the budget allowance on expense materials,

additional columns for entry weekly of the labor charges against each account on completion of the payroll, also for entry monthly of material charges on closing of the accounting-department records. Space should be provided for the total footings of budget allowances on the various accounts, both labor and material, and for total footing of the weekly and monthly charges.

Maintenance-of-property items may be shown on these same sheets, giving the designations and numbers of the various accounts under this classification, also giving the charges weekly for labor and monthly for material in the same manner as the several items classified as manufacturing expenses are shown.

In general, the classification of "Manufacturing Expenses" should include all items of expense shop labor, from supervising foremen down to floor laborers, sweepers, etc.; also lubricants, fuel gas, fuel oils, waste, non-durable small tools, miscellaneous shop supplies, office supplies and similar items of shop operating expense. The classification of "Maintenance of Property" should include such items as repairs to cranes, conveyors, machinery, tools, electrical apparatus, machinery foundations, ovens, furnaces, piping, wiring, molds, jigs, dies, flasks, patterns, shop fixtures, equipment, office furniture and like items that may be properly classified as property items.

By issuing statements of this character regularly each week to the head of each department the foreman is enabled to compare the current charges for labor and material, as turned in to the payroll and accounting offices, with his budget allowance on all items of expense within his department, as well as on items that have been initiated by him and are chargeable to his series of expense accounts. The weekly budget expense statement, it will be seen, brings to the attention of the foreman in a concise and concrete form all operating expenses of his shop. It leaves him without excuse for failing to investigate all charges or failing to keep within the total amount of expenditure that has been allotted to him.

It is advisable to issue these statements promptly each week on the closing of the payroll, as the work involving the various charges will then be fresh in the foreman's mind and wrong charges may be stopped before any appreciable harm has occurred. Some form of binder for retaining the sheets in a cleanly condition should be provided, so they can be accumulated from month to month as additional statements are issued and sent forth and back between the office and shop without damage.

A departmental monthly statement showing total productive labor, total indirect labor, also ratio, together with the percentage of increase or decrease in both classifications of the current month, in reference to the preceding month, is a valuable help to the foreman in watching any fluctuations due to changes in productive conditions. Such data afford a quick means of indicating to him whether he is justified in increasing or decreasing the overhead expense of his department.

Before making request for additional expense help, the foreman should avail himself of such reports and comparative statements as will enable him to determine whether or not he is getting adequate results from his present force and its relative efficiency as compared with that of other departments. The value of frequent comparisons of conditions, as well as of methods of doing work can hardly be too strongly emphasized.

fooling in the Shop

By F. J. DITTMAR

"Fooling," says Webster, "is foolish speech or conduct; buffoonery; banter; idle interference."

Apparently Mr. Webster had not much use for this pleasant pastime. Perhaps he happened to be the "other fellow" at some time or other and forthwith made up his mind to load the thing down with acrid adjectives if he ever got around to writing his dictionary.

There might be a load of fun in it for the fellow whose well-aimed snuffbox filled with cast-iron chips from the milling machine hits the other fellow in the face, causing it to resemble an ace of spades. But when the latter has to pay a doctor to dig the chips out of his eyes he is apt to be inclined to agree with the gentleman quoted above and curse the jolly marksman into the innermost recesses of Hades.

Of course it is human nature to be playful. I myself have spent a lot of energy devising schemes whereby life at the shop might be made more exciting—at the expense of some "fall-guy." However, I've reformed, once and for good. And this is how it came about:

Some years ago I worked in a little shop in central New York State. Where I had my bench were the milling machines and batteries of gear-cutters. The firm was a little behind in its orders and we put in a good deal of overtime. The milling-machine hands and the gear-cutter operators were youngsters from the surrounding country, easy-going, good-natured and full of the old Nick. Especially a long, apple-faced one, with a humorous twist of mind, made it a point to see to it that the wheel was kept moving. During the overtime the foreman used to be away visiting about the shop and his absence, coupled with the deep shadows between the machine tools, offered an opportunity too good to be neglected.

Now one evening, this apple-faced youngster I'm talking about went to work and rigged up some contraption that would dump a pail full of soapwater upon the head of a fellow when starting his machine. The stunt is too well known to need any describing, and in addition, the pail never came down, for the other fellow showed up unexpectedly and stopped proceedings by pulling the ladder from under Appleface. A wrestling match ensued forthwith.

They struggled about for a spell, with Appleface getting the better of the deal. However, in order to thoroughly subjugate his opponent he needed a certain hold, something his victim sought, by might and main to prevent. It got to be quite lively, arms and legs flying about, this way and that until suddenly the boys flew apart, one uttering an ear-piercing scream.

We all rushed up to see what had happened, and this is what did happen—as near as we could figure it out:

During the fracas Appleface had reached for the other fellow and missing him in the dark had seized hold of a train of change-gears of a gear-cutter just as the machine was about to change its cut. Of course the lightning-like rapidity of the revolving gears had given him no time to withdraw his hand and so all the fingers of his right hand were cut off sheer above the knuckle.

Yes, I've reformed. If that isn't enough to make one reform I'd like to know what would be. But many times fingers are the price of fooling in the shop.

Large Feed Tube for Small Screw Machine

By F. MASON

The illustration shows a feed tube that will allow $\frac{3}{8}$ -in. stock to be machined on Brown & Sharpe automatic No. 00 screw machines. It is a plain piece of steel tubing, slotted and closed at one end and hardened. It is closed so as to be a tight fit on the stock. A regular Brown & Sharpe latch collar is brazed on the other end so that it will function with the spindle latch. After



LARGE FEED TUBE FOR SMALL SCREW MACHINE

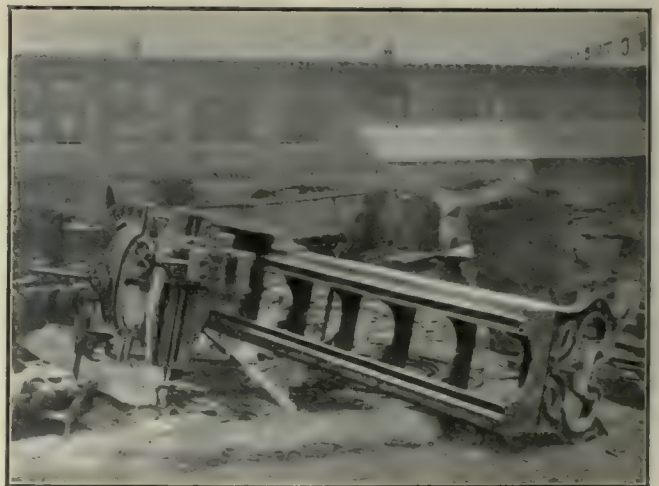
considerable wear the tube may become loose, which will affect the length of the feed. It can be annealed and by filing about 0.010 in. from each side of the slots it can be reclosed and hardened again.

I have used this tube to feed $\frac{3}{8}$ -in. drill rod $\frac{1}{2}$ in. and have machined 125,000 pieces before the tube showed signs of wear.

A Planer on the Scrap Heap

It is seldom that we find a machine tool actually on the scrap heap, although there are many in existence that should probably have been there years ago. As a rule, however, they are sold time after time, until all knowledge of their origin is lost; and the surprising part is that they continue doing their work long after the usual methods of calculating depreciation have wiped them out of existence.

The illustration shows an old planer on the scrap heap in Cambridge, Mass. This planer was built by the old Warner & Whitney Co., of Nashua, N. H., and probably



AN OLD PLANER WAITS FOR JUNK MAN

belongs to the vintage of the late fifties or the early sixties. The crossrail is controlled by a central screw working through the arch or yoke, with the bearing on each end. At first glance, it seems as though the bolts at the end of the yoke formed the crossrail bearing, but a closer examination shows this to be a narrow V planed on the front edge of the upright. From all appearances this was a 24-in. planer with an 8-ft. bed, and it was probably a chain-driven machine.

Manufacturing the 1-Lb. High-Explosive Shell--II*

BY ROBERT MAWSON

SYNOPSIS—In this installment are described other operations in the making of the 1-lb. shell. These cover the manufacture of the gas check and its insertion into the body. The shellacking operation on the inside of the shell is also shown in diagrammatical form. Two types of washing arrangements to remove the oil and dirt from the inside of the shell body are illustrated in detail.

A detail of the washing tank is shown in Fig. 28. It will be noted that the shells are held by clips being inserted by hand. A steam pipe will be installed in the tank so that a jet of steam will impinge the open

bodies. These parts are being made on both Chicago automatics and Wood turret lathes.

A view of one of the former machines is shown in Fig. 31 and of the latter in Fig. 32, performing the operation of manufacturing gas checks.

Details of the tools used on the Chicago automatics are illustrated in Figs. 33 and 34. The tools used on the Wood turret lathes are described in detail in Figs. 34 and 35. The gages used for testing the gas checks on the machines are shown in Fig. 36. The operations followed when machining the gas checks are illustrated in diagrammatic form in Fig. 37.

The gas checks are then chamfered and faced in the lathe shown in Fig. 38. The check is held on a threaded

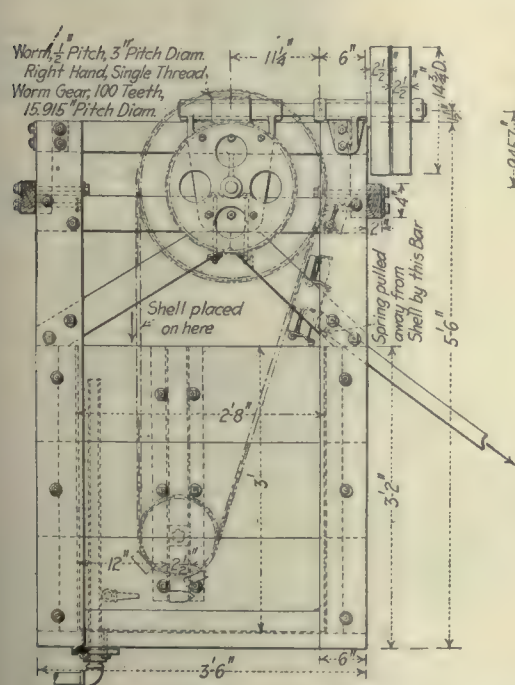


FIG. 28. DETAIL OF THE SHELL-WASHING TANK

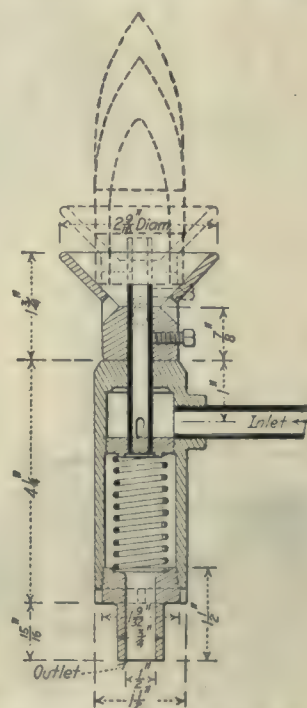
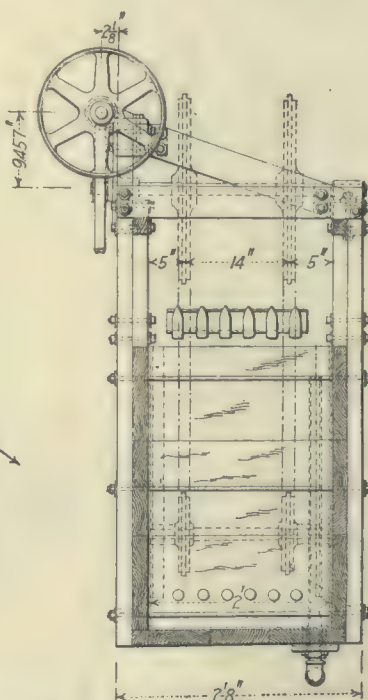


FIG. 29. ALTERNATIVE WASH-
ING ARRANGEMENT

end of the shell. It is also intended to arrange a chute with a plate so that as the shells are brought against it the clips will be pushed back and the shells automatically drop down the chute. To remove the grease the shells are then washed in soda water heated to 180 deg. F.

In Fig. 29 another washing arrangement is illustrated. In this device the shell is placed in the funnel and steam is forced through the inlet pipe. As the shell pushes down the funnel to the position shown the steam enters the shell and cleans it. When the funnel is allowed to raise, by action of the spring, the steam and condensation passes under the piston and through the outlet. The operation is shown in diagrammatic form in Fig. 30.

The manufacture of the gas checks will be next described. These are made from 1¼-in. cold-rolled steel with an analysis similar to that of the steel used for the

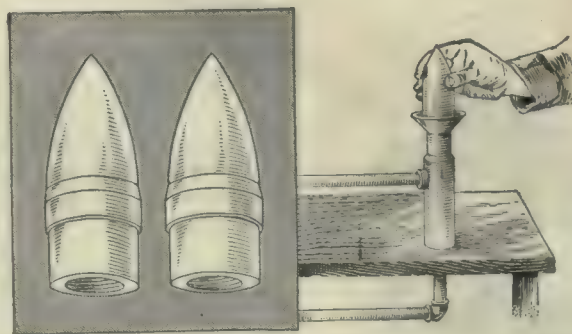


FIG. 30. OPERATION 12: WASHING

Machine Used—Special washing machine and attachment.
Production—120 per hr.
References—Figs. 28 and 29.

drawback chuck. The tool carried in the toolpost is then fed across the revolving part, the outer edge faced and the outer edge of the threaded hole faced. This opera-

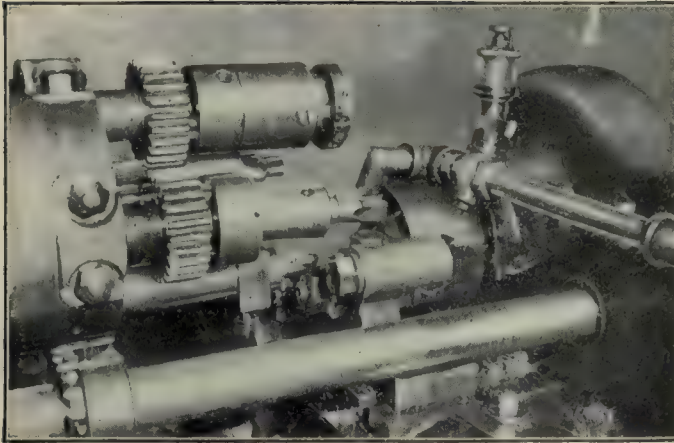


FIG. 31. CHICAGO AUTOMATIC MAKING GAS CHECKS

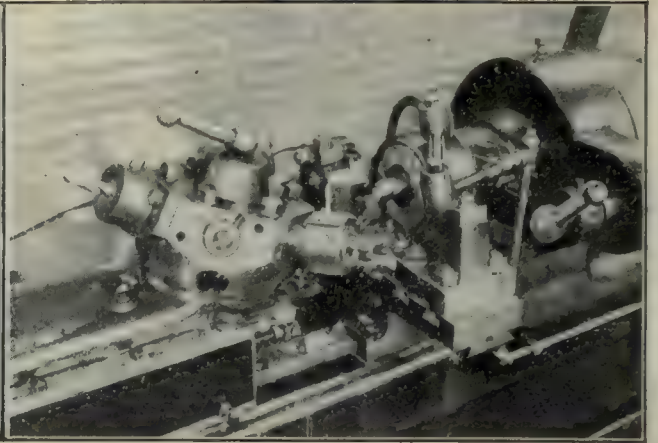


FIG. 32. WOOD TURRET MAKING GAS CHECKS

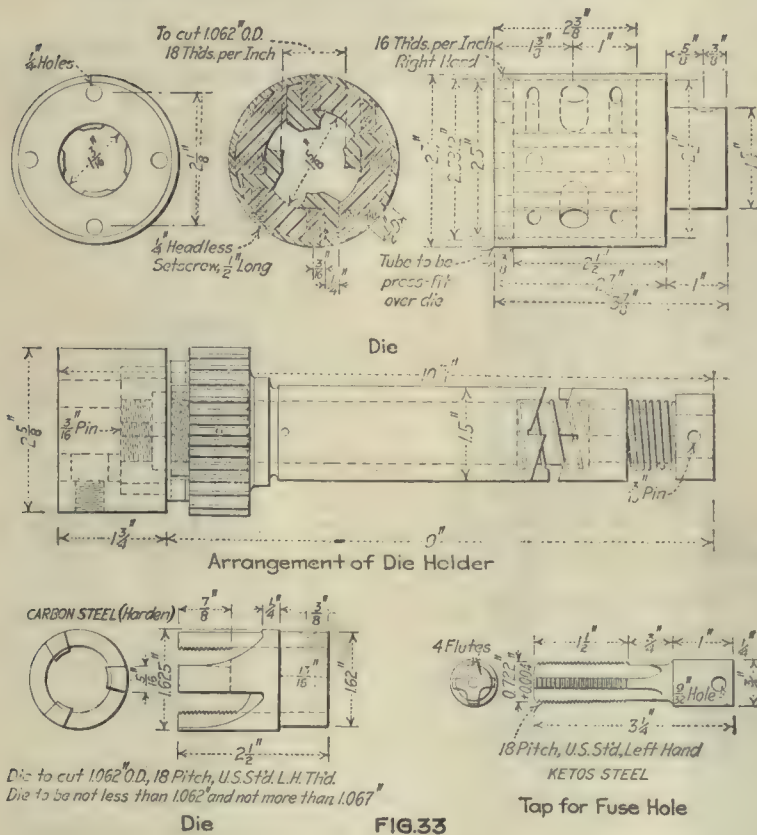


FIG. 33

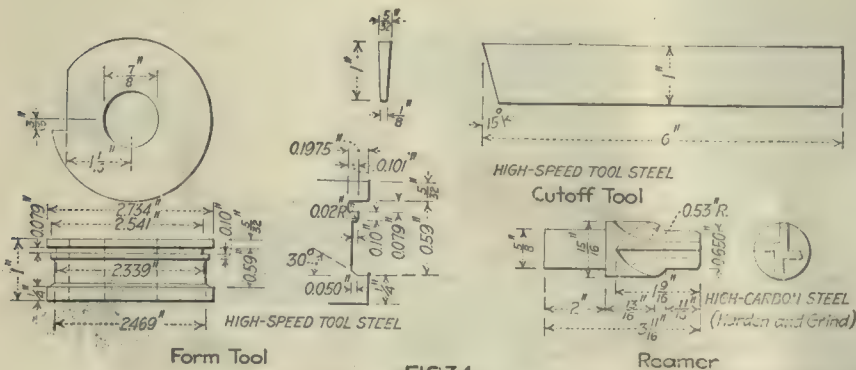


FIG. 34

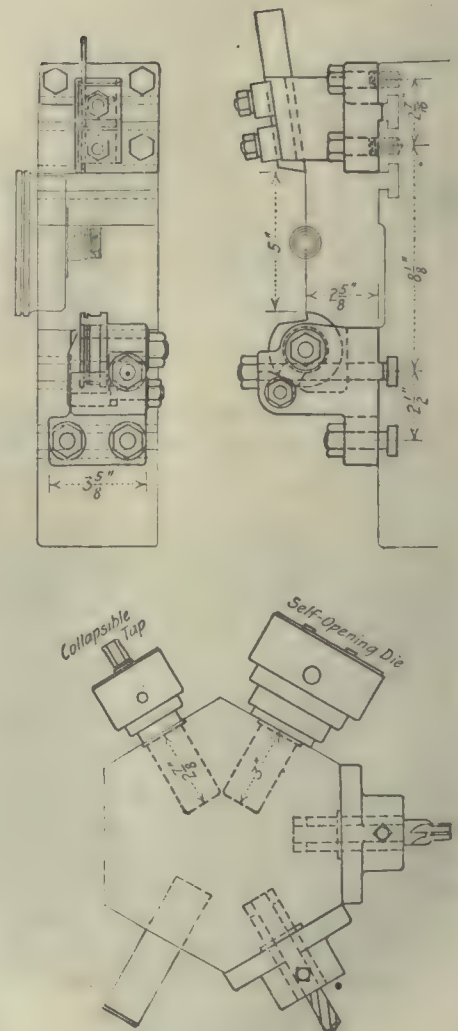


FIG. 35

DETAILS OF TOOLS AS USED ON WOOD TURRET LATHE

tion is also shown in diagrammatic form in Fig. 39. As the next operation the gas check is inspected, the gages used for this purpose being shown in Fig. 40. The shells are then covered with shellac on the inside,

using a small brush for the operation. The purpose of this shellac is twofold—to prevent rust and to obtain the best possible coating of the shell for the reception of the powder, as shown in diagrammatic form in Fig. 41.

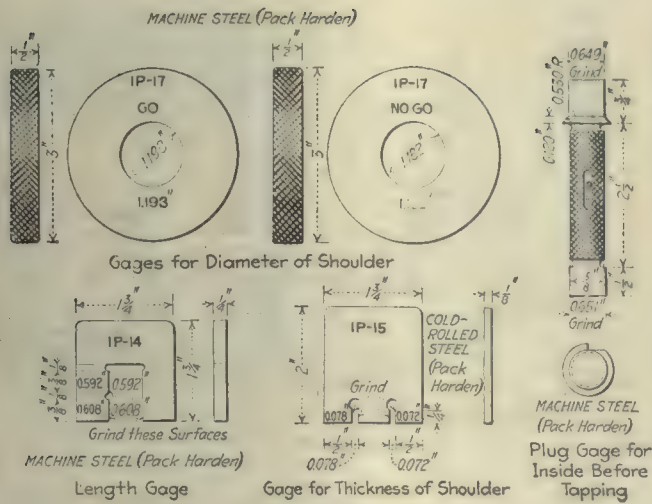


FIG. 36.

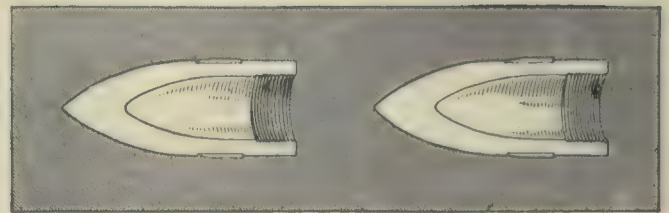
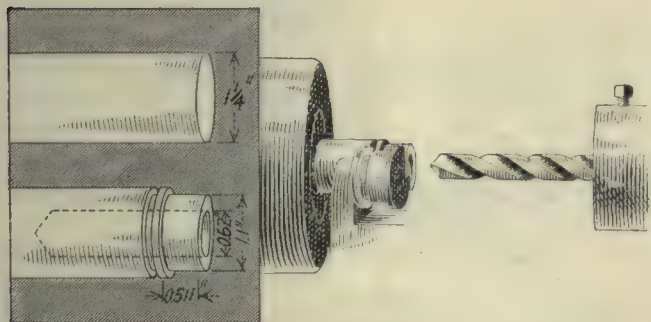
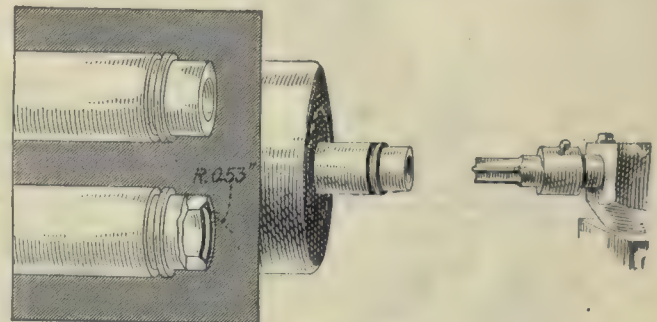


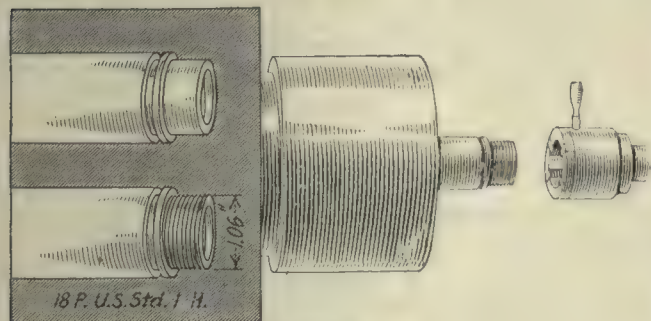
FIG. 41. OPERATION 13: SHELLACKING INSIDE OF SHELL
Production—1 man lacquers and starts gas check in shell at the rate of 120 per hr.



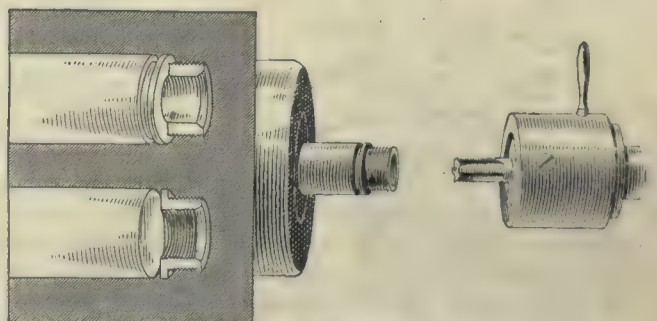
Operation 1



Operation 2



Operation 3



Operation 4

FIG. 37. OPERATIONS 1 TO 4: DRILL AND FORM, REAM COUNTERBORE, THREAD OUTSIDE, TAP AND CUT OFF
Machines Used—Chicago No. 3 automatic and Wood turret lathe.
Production—20 per hr.
Cutting Compound Used—"Alco," made by Texas Fuel Oil Co.

References—Figs. 31, 32, 33, 34, 35 and 36.
Note—Speed of machine when turning, 340 r.p.m.; when tapping, 130 r.p.m.

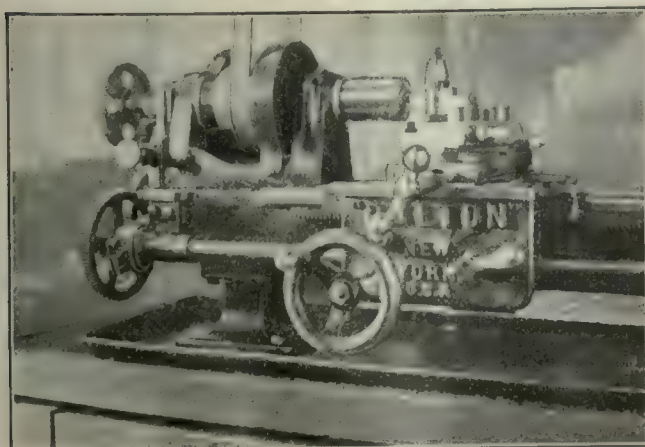


FIG. 38. CHAMFERING AND FACING GAS CHECKS

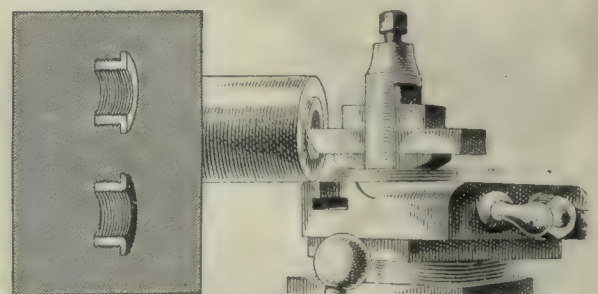


FIG. 39. OPERATION 5: FACING AND CHAMFERING END
Machine Used—Dalton lathe.
Production—100 per hr.
Reference—Fig. 38.

FIG. 39-A. OPERATION 6: INSPECTION
Production—1 man inspects 150 per hr.
Reference—Fig. 40.

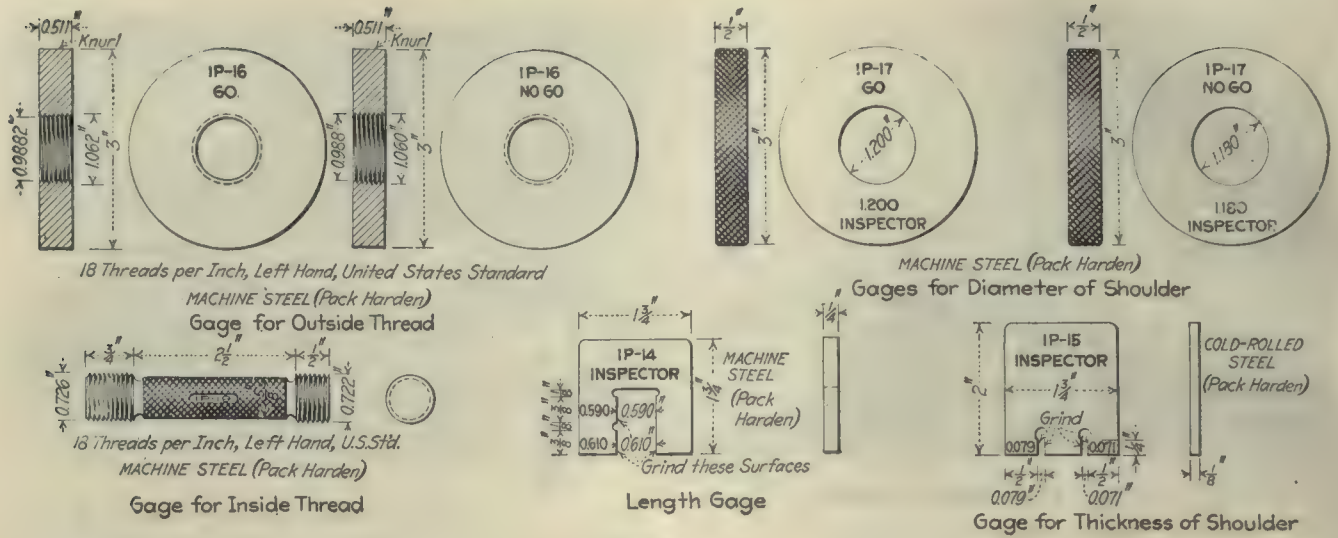
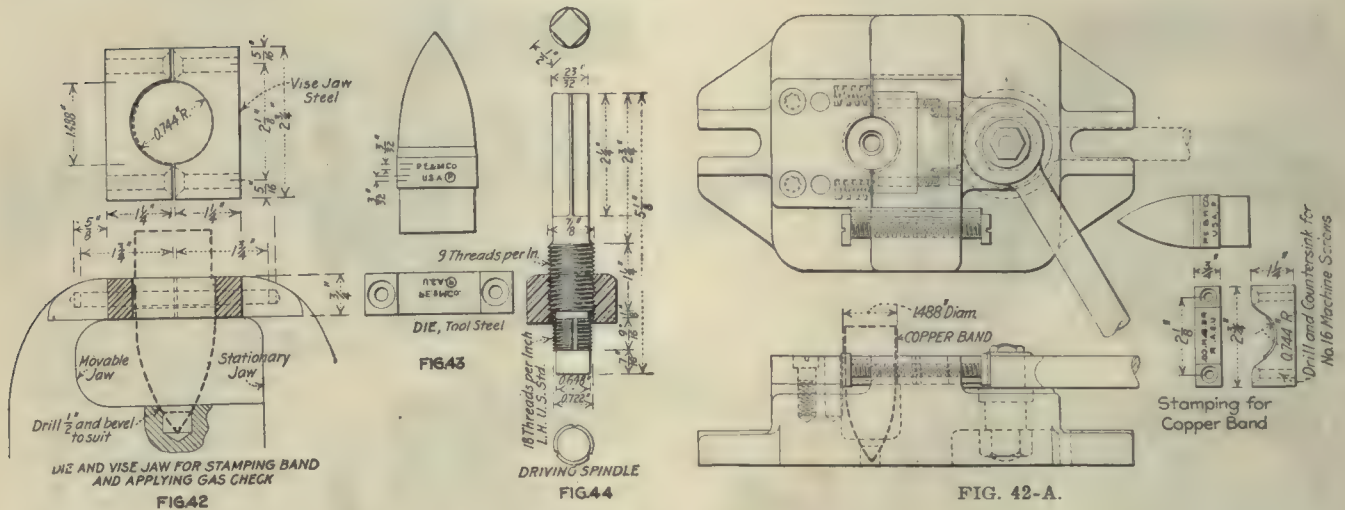


FIG. 40.



After the operator has shellacked a shell he screws in one of the gas checks as far as possible with the fingers. This saves a motion on the part of the man who performs the next operation, which is screwing the gas check down tight. While doing this work the shell is held in the special vise jaws, Fig. 42. It will be observed that these jaws not only hold the shell, but also stamp the maker's name on the copper band.

An improved type of stamping device consisting of a die and vise is shown in Fig. 42-A.

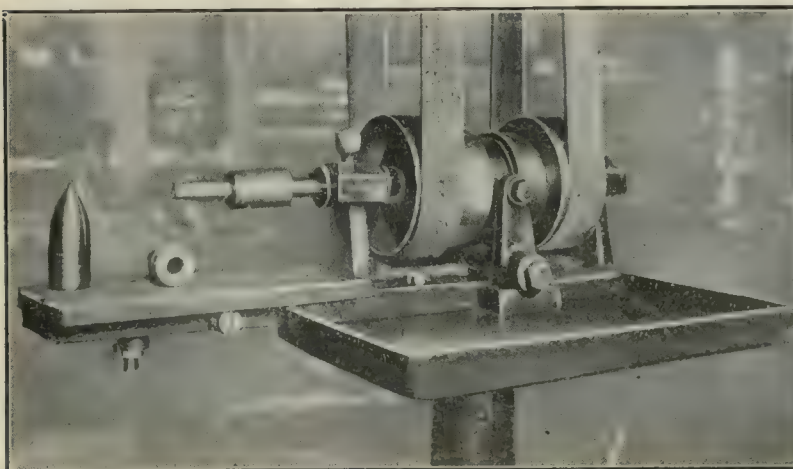
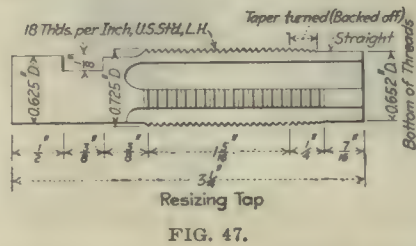


FIG. 46. RETAPPING THE GAS CHECK

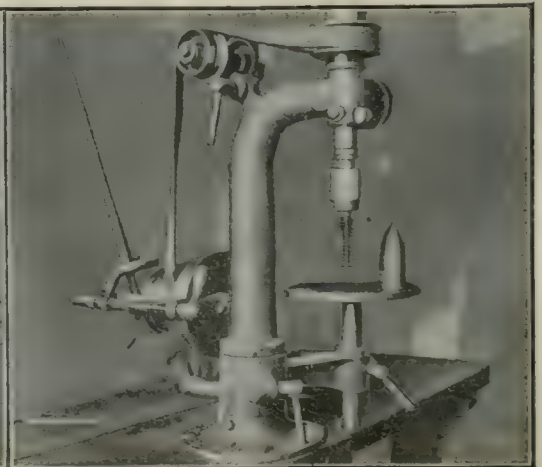


FIG. 49. CLEANING DIRT FROM THREAD

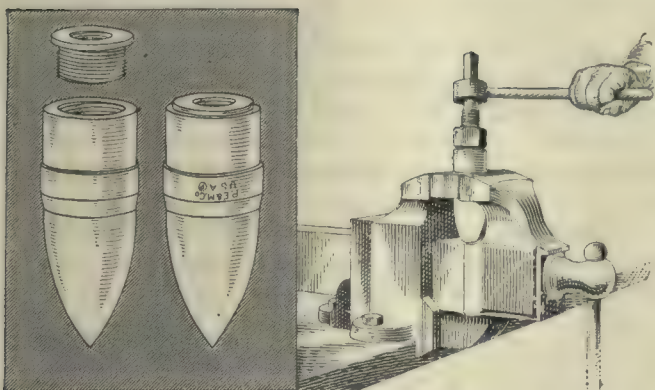


FIG. 45. OPERATION 14: SCREWING DOWN GAS CHECK
 Fixtures Used—Special vise jaws and arbor.
 Production—1 man 120 per hr.
 References—Figs. 42, 43 and 44.

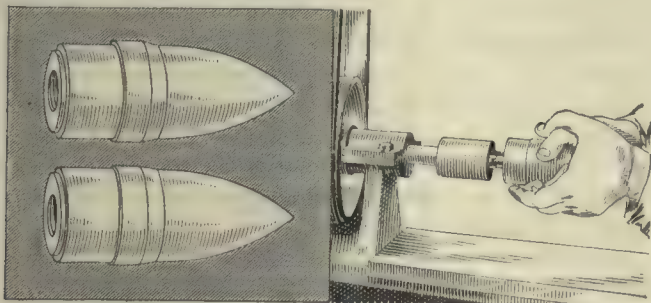


FIG. 48. OPERATION 15: TAPPING
 Machine Used—Harvey-Hubbell horizontal taper.
 Production—1 man 120 per hr.
 References—Figs. 46 and 47.

FIG. 48-A. OPERATION 16: CLEANING OUT DIRT FROM THREAD

Machine Used—Vertical drill with circular wire brush.
 Production—120 per hr.
 Reference—Fig. 49.

FIG. 48-B. OPERATION 17: FINAL INSPECTION
 Production—1 man inspects 600 per hr.
 References—Figs. 8, 10, 16, 25, 27, 40 and 50.

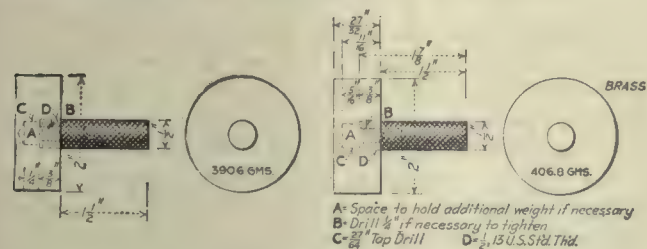


FIG. 50.

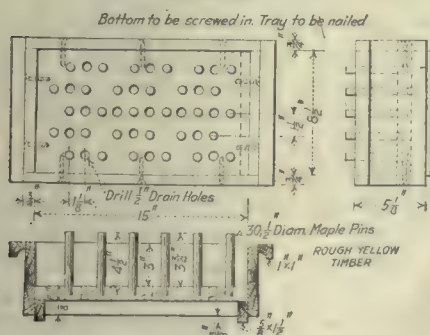


FIG. 51.

The shell, where the copper band has been compressed on, rests against a jaw for half of its circumference. The other jaw that carries the stamping die is forced against the band and makes the impression on the copper band of the shell. Tension springs fitted in holes of the stationary jaw press against the movable jaw and thus prevent any binding action. This vise also holds the shell while the gas check is being inserted.

A detail of the impression placed on the shell is shown in Fig. 43. The arbor for screwing the gas check down is shown in detail in Fig. 44. The operation is also shown in diagrammatic form in Fig. 45.

The next operation is retapping the gas check. The machine set up for this work is shown in Fig. 46. The special tap used for this operation is shown in Fig. 47. The operation is also shown in diagrammatic form in Fig. 48. The dirt is then removed from the threads with a circular brush driven by the drill press, as shown in Fig. 49. The shell is then finally inspected, using the

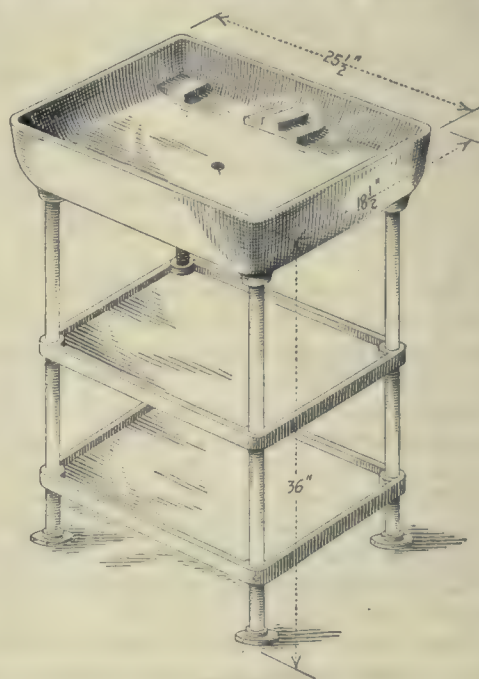


FIG. 52.

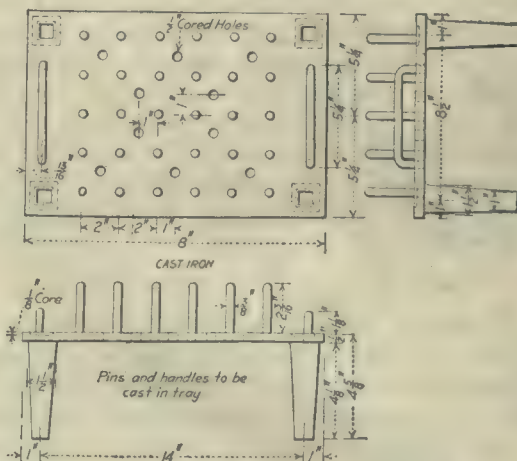


FIG. 53.

gages, Figs. 8, 10, 16, 25, 27, 40 and 50. The gage or weights, Fig. 50, are used for testing the weight of the finished shell with the gas check in position. They are used with a pair of ordinary scales and the shell must register more than the minimum and less than the maximum weight.

In Fig. 51 is shown the tray used for conveying the gas checks to different parts of the machine shop as required. A handy stand, Fig. 52, has been fitted to the automatics to support the tray, Fig. 53, which holds the machined shell blanks. With this arrangement the oil from the blanks drains into the trough and through the pipe shown back to the automatic.

Draftsmen Who Ought To Have Been Machinists First

BY JOHN R. GODFREY

Once more we are in the throes of a discussion as to whether a draftsman should also be a machinist or should have graduated from the shop into the sacred precincts of the drawing office. It is a subject which never grows old and which will and should be discussed until the drafting room can design machines and make drawings so that they can be made in the shop and repaired after they get into service. For in too many cases they have the habit of piling one piece on top of the other until it takes a whole machine shop to make even the simplest repairs.

One of the worst offenders at the present time is the designer of automobiles, with all the real "innards" of the animal hidden in its dark interior in the fond hope that the owner will never have to treat it for colic or indigestion.

After more or less intimate knowledge whereof I speak, I am convinced that no draftsman should ever be allowed to design even the simplest part of an automobile without first serving an apprenticeship in a garage or as a mechanic for some driver who is guaranteed to put any car out of commission in a fifty-mile run. A few hours spent in thoughtful meditation lying on one's back in a dusty road, with oil dropping in one eye, trying to get a square-end brake-rod pin through the three holes in the clevis and brake-rod, will give him a real appreciation of the importance of little things that look insignificant on the drawing board.

Don't think for a moment that I have reached the state of affluence which permits indulgence even in a second-hand flivver; but a more fortunate friend with a second-hand car of a well-known make allows me to do most of the work on it for the proud privilege of cranking his motor and riding on the driver's seat when there is no one else along. And my observations are all first-hand impressions, unbiased by any theory except the vain notion that the question of possible repairs might well enter into the design before it becomes a piece of cold and irresponsible metal.

SQUARE-ENDED BRAKE-ROD PINS

That brake-rod stunt is no dream. It actually happened on a hot August day, and took a solid hour of utter discomfort trying to hold the pieces in line so as to enter the square-ended pin through the clevis and the brake rod. This looks easy enough on paper or even in the erecting shop, but when you lay under a car with your head cocked up like a turtle and try to do the work of three hands with only two hands available, it is more of a tragedy than it seems as I tell of it. A beveled edge on the end of the pin, or a rounded end, would have made it an easy job; but these little jobs are not always easy to do out in the country and mighty few tools to work with.

Another interesting trick which is all too common is to line up the magneto, circulating pump and occasionally one or two other bits of apparatus on one shaft in such a way that it is impossible to take out any of them without undressing the whole side of the engine. Simple flange couplings, after the manner of the English method of putting up a pipe line, is mighty handy in cases of this

kind. We used to laugh at the clumsiness of the method as compared with our screwed-joint pipe line, but we are using it just the same where we ever expect to replace a valve or a fitting. A similar scheme applied to the aforementioned appurtenances of the automobile motor would save much unnecessary labor, and a huge wastage of profanity could be conserved for more urgent occasions.

Then there is the nut with so little clearance as to make it impossible to use any but a special wrench; hand holes that look as though you could get at the whole works but which only uncover part of the innards—and it's always the other one that needs fixing; belts that can't help rubbing on the edge, and throttle and spark connections that are so bent they refuse to lie still on the bench.

But the crowning achievement of the nonmachinist draftsman recently came to light in connection with the car of ancient vintage before referred to. The clutch began to get uneasy at times and developed a rattle which was annoying to the sensitive ears of a chipping-hammer machinist. Then, too, it occasionally displayed a grasping tendency that was annoying when the driver tried to ease it off in traffic or make a grand-stand finish in drawing up beside the curb.

So we finally decided that the clutch must come out for examination in order to determine just what sort of a malady had developed. If we had dreamed of the trials and tribulations that one insignificant-looking clutch can furnish, we should be minus a lot of experience but have several more square inches of skin and much more sleep to our credit. But once started there was nothing to do but pursue the quest to the bitter end, which meant in this case the rear axle of the car.

DISSECTING THE WHOLE RUNNING GEAR

We started hopefully at the universal joint under the floor boards and soon had it exposed to view. This developed the interesting information that to all appearances it was necessary to pull the whole running gear apart lengthwise to take this apart. This seemed so foolish we quit work at about 11:30 that night and then sought the agent the next day to find a short cut out of our troubles. But alas, there was no royal road. The design had been changed the next year so this could be exposed by taking only half of the car apart, but in our particular model it was necessary to take down the whole transmission box, jack up the car body, disconnect the whole rear axle and driveshaft and run the wheels out from under the car.

But even this sounds easier than it is, for it meant five evenings of a hot week in July, including Saturday afternoon and Sunday, before church, ere we got the clutch out, the trouble fixed and the whole machinery back in place again. The whole trouble was that the balls in the thrust collar had worn flat and rattled when they were not acting as cams and grabbing the clutch. Repairs were cheap, so far as the actual cost for materials went. But we spent many precious hours, learned a few new and expressive cuss words, while the balls themselves cost but *fourteen cents*.

It's a safe bet that no draftsman who had ever been through such an experience as that would design a clutch that could not be repaired without taking the whole car apart to put in fourteen cents worth of balls.

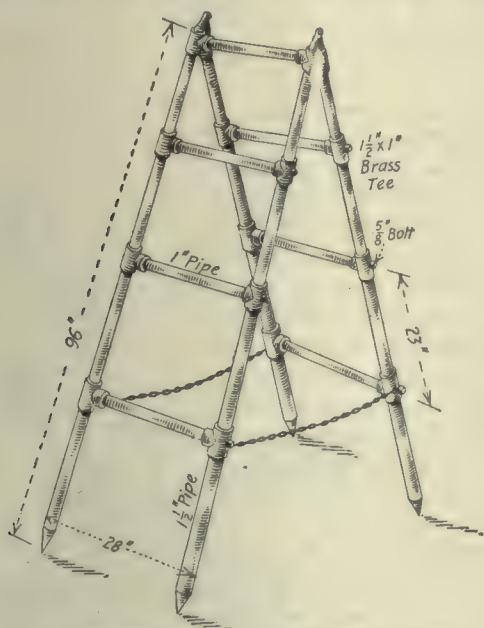
. And the next Sunday it rained.

Letters from Practical Men

Ladders Made from Short Pieces of Pipe

Herewith is shown a new form of ladder for use in boiler-erecting and car shops for men working on locomotives, boilers or cars. Two such ladders are often used with a plank reaching from one to the other for men to stand on. This type is considered the best, as it is strong, safe and economical.

It is built of pieces of $1\frac{1}{2}$ -in. pipe about $21\frac{1}{2}$ in. long, which are generally too short for other pipework.



BOILER-SHOP LADDER MADE OF PIPE

The pipes forming the rungs are a little longer and are of 1-in. diameter. Sixteen $1\frac{1}{2}$ x1-in. brass T's are used in building this ladder, together with eight $\frac{5}{8}$ -in. bolts, each of which goes through rungs and T's. The ladder is hinged at the top as shown, and pointed irons are screwed in the pipe at the bottom. There is also a chain to prevent uprights from sliding and the ladder from falling.

This design is somewhat heavier than the old wooden ladder, but does not need any repairs. It is more solid and is safer in every way.

JOSEPH K. LONG.

Renovo, Penn.

Saving Undersized Taps

Recently I came across a quantity of discarded shell taps that had worn undersize, although they looked practically new. Measurement showed that they were from 0.002 to 0.005 in. undersize top, root and also the pitch diameter.

As they were perfect threads, even if undersize, I looked around for a cure and found it in the following method.

I assumed the tap to be symmetrically 0.005 in. small on the thread and turned an arbor of good machine steel

or 3 per cent. nickel and ground it to a finish. The diameter of the arbor I decided as follows: Diameter of bore of tap + amount the tap is small + 0.005 per in. diameter of bore of tap.

Heat the tap up to hardening temperature, insert arbor and harden in the usual way. It is an easy matter to bore the arbor out of the tap and regrind. Bore to a second standard. This means a second tap arbor, but they are cheaper than taps.

It will be found that the tap has contracted on the arbor and consequently expanded equally between the flutes, bringing the lands or threaded portion up to standard size again.

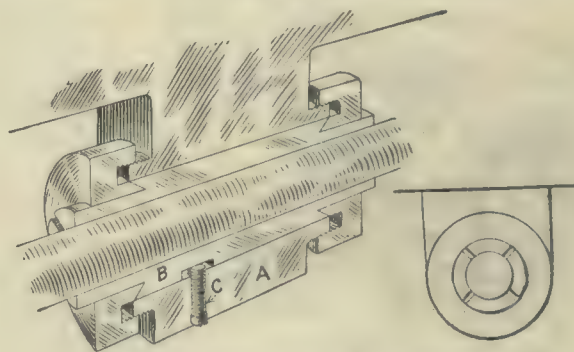
ARCHIBALD YOUNG.

Luton, England.

Adjustable Bearing

The illustration shows an adjustable bearing which I had occasion to make some time ago and which has proved very satisfactory.

The cast-iron housing *A* is bored out, tapered 3 deg. and both ends are threaded 18 pitch on the outside. A bronze box *B* is fitted into the taper and undercut on 45 deg. both ends. Nuts are fitted to the ends of the housing and to the ends of the bronze box, which is then spaced and



BEARING ADJUSTABLE ON A TAPER

sawed into four sections. Pasteboard of the same thickness as the saw is cut into the shape of the box and placed between the sections. A small countersunk screw *C* with a tit prevents the turning of the box, and a slot allows movement longitudinally.

By loosening and tightening the nuts one way or the other the box is made larger or smaller. By tightening both nuts the sections of the box are forced against the inner wall of the housing, and a solid bearing is obtained.

Chicago, Ill.

HENRY LORCH.

Remedy for Slippery Iron Plate Floors

In one part of our shop we had installed a large area of sheet-iron floor-plates that were entirely satisfactory until the corrugations wore off, after which the smooth-worn plates gave considerable trouble owing to several

nasty falls of the men that resulted—the trouble being enhanced because of the presence of considerable oil and grease. Roughening the plates by means of chipping was tried, but this could not be done very satisfactorily nor without excessive wear on the plates.

It then occurred to us to try to corrode the plates slightly as often as necessary, to prevent them from becoming too slippery. Since a deep rusting effect was not desired, because of excessive eating away of the plates, we arranged to take care of it in the following manner: We take a small amount of powdered salamoniac, which is used as a corroding agent in our work, and mix it up thoroughly with a large quantity of fine sand. This mixture is then sprinkled over the floor so that all parts are covered and then the whole mass is watered, using an ordinary sprinkling can, and left to lie over night. In the morning the sand is swept up, a rust coating being produced by the action of the salamoniac that will last for several weeks, after which the process is repeated.

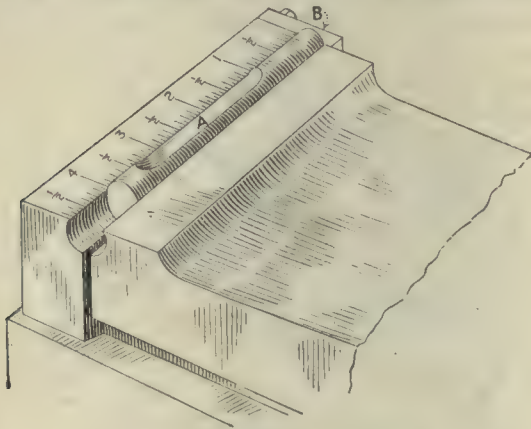
We found that this method involved less time and cost and was more effective in eliminating danger from slippery iron plate floors than any other of which we have heard.

W. A. LAILER.

Philadelphia, Penn.

Graduated Milling-Vise Jaws

The illustration shows a pair of vise jaws for the hand miller. The one fastened to the stationary jaw is graduated, as shown, and is convenient for approximate measurements. This eliminates the use of the pocket rule and



GRADUATED VISE JAWS

is a time saver in setting up for straight milling of rods, as shown clamped in position at A and resting against the stop B on the graduated jaw.

GEORGE F. KUHNE.

East Rutherford, N. J.

Information Wanted on Limits in Cylinder Boring

Perhaps some of the readers of your magazine are able to advise what is considered good standard practice with reference to the bore of steam cylinders. The steam piston is seldom made an exact fit to the cylinder. Furthermore, a steam cylinder is seldom bored perfectly round or perfectly parallel. What are the maximum and minimum limits permissible in the diameter of a piston for the following sizes: 3, 4, 5, 6, 7, 10, 12, 14, 16, 18, 20, 22, 24, 26, 30, 36, 42 and 48 in.?

What is the permissible distortion of steam cylinders corresponding to the above-sized pistons?

The character of the steam engine no doubt will somewhat influence the permissible variation from standard, as for instance, the high-speed engine practice may not require limits so close as a low-speed engine, or the permissible variation may be different for a vertical and a horizontal engine.

Similar information applying to stationary gas-engine cylinders would be valuable.

ROBERT E. NEWCOMB.

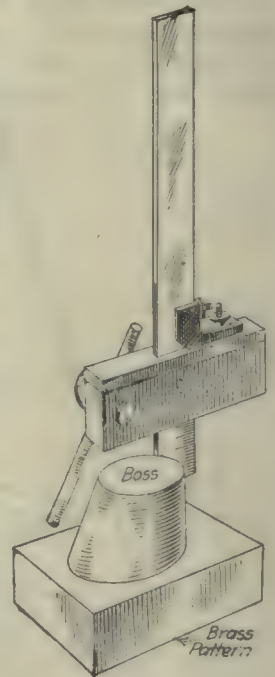
Holyoke, Mass.

A Combination Tool

The pattern shop may be said to be a promoter of invention due to the frequency with which necessity makes its appearance within the pattern-shop door. Especially is this true with regard to the metal pattern department where irregular shapes and peculiar forms are frequently encountered.

The illustration shows an interesting tool I recently used. Having a number of brass patterns to change over, with a boss, I used parts of the following combination tools to make a gage: 6-in. scale, attachment for combination squares, the narrow blade of a double steel square and depth stock. The narrow blade of the double steel square, owing to the fact that it was shorter, was used in place of the scale that goes with the depth gage. Tools of this kind are frequently found of use in the pattern shop whereas in the more regular work of the machine shop they are seldom needed.

Naugatuck, Conn.



A COMBINATION TOOL

A. E. HOLADAY.

Delivery of Small Shipments

I wish to call attention to a plan we have just instituted in our shop, believing it may help others. On all express shipments going out "collect" we use a heavy white tag. On all express going out "prepaid" we use a yellow tag.

This is to assist the express clerks in their work and to make mistakes less liable. It also conforms to the recommendation of the Interstate Commerce Commission. We believe that the adoption of this simple device saves time in our own shipping room and office, as well as all along the line, and perhaps saves annoyance to our customers at the other end.

If all manufacturers used this white tag for collect shipments and the yellow tag for paid shipments—and used good heavy tags—less shipments would go astray.

I also believe that a special class for freight shipments should be demanded by all shippers of less than carload lots. I would label this class the "yellow-ticket" class and include everything less than 500 lb., making it optional with the shipper for lots over 500 lb. The use of such a

yellow-ticket class would insure immediate delivery to consignee's address by a reputable truckman.

The railroad could in this way empty the greater part of its cars at once without the bother of storing the goods in the freight house. The consignee would get his goods two to three days earlier. It would do much to prevent congestion, as it speeds up delivery. It would simplify bookkeeping.

The only objection might come from those running their own teams—but if they figure the cost of the time that the teams lose in waiting around the freight office, they also would consider this cheaper. L. F. BUFF.

Boston, Mass.

Some Blacksmith and Copper-smith Art Work

The *American Machinist* has from time to time shown illustrations of blacksmith work made by foreign and domestic art-blacksmiths. The illustrations herewith show examples of both iron and copper artsmith work



FIG. 1. ART COPPERSMITH AND BLACKSMITH WORK

made by B. Borden, blacksmith with the C. E. Lipe Co., Syracuse, N. Y. The large vase is about 9 in. high. It is made from a piece of boiler tube hammered all over and flared at the bottom for the base plate, which is brazed on. The roses and poppies are forged from Norway iron. Over all this piece is about 18 or 20 in. high

and took about 18 hr. to make. The small vase is also forged from boiler tubing, and brazed. It represents with the roses about 9 hr. of work. The spray of wild briar at the base of the large vase was made in a couple of hours. The difference in color is accounted for by the fact that it was sand-blasted, while the two jars were finished in dead black.

The most remarkable piece of all is the small rosebud to the right. This is forged from copper and the petals



FIG. 2. BACK OF BRIAR SPRAY AND COPPER ROSEBUD

are welded, not brazed on. Anyone who has attempted to weld copper will appreciate what a difficult job this is, and furthermore the work was done with an ordinary blacksmith's fire. I have seen several fine specimens of forged copper work made by this artsmith, but at the time the photographs were taken for Figs. 1 and 2 none of these more pretentious pieces were available.

In Fig. 2 the back of the briar spray is shown so that the clean welds can be seen. The copper rosebud also appears in this illustration. E. A. DIXIE.

New York, N. Y.

Good Effects of United Effort

The effect of the happenings of the last two years has been to emphasize the value of nationalism. Some of the lessons will do no harm if applied to more domestic and lesser ends.

A workshop or manufacturing concern is a nation itself drawn to a small scale, reduced in size but not in complexity. The cardinal function of right organization, and this includes all hands from top to bottom, is unity of purpose. If department works against department, if official refuses directly or tacitly to assist official, then business cannot live.

Interdepartmental jealousy and acute personal feeling must always be held subordinate to the larger interests of the firm. Fretted nerves and incommensurate personal qualities, fatigue or long hours lead to friction. An attitude of obedience to orders, even if they break the owners, is perhaps too common in large concerns.

Technical competence and efficiency are qualities of great value, but another impalpable quality—loyalty—whose assessment is less easy, is a priceless asset to any firm. And the fostering or cultivation of loyalty is not lost sight of by first-class managers.

A disloyal or jealous individual, unwilling to sink personal grievance for the common good, who is constantly

finding affronts to his personal dignity, is a danger spot greater than poor equipment or more easily recognized material factors.

Vital national need has served to show how a recognized common end may help in the stimulation of production and general good-will. It is hoped that the obvious lesson is being noted for the future. Interested in our work, we forget time; filled with the right spirit we suffer less fatigue. Not merely may longer hours be worked at a pinch, but the intensity of effort may be safely increased. It is more than probable that where the interests of workman and employer coincide, both having the same feeling as to the issue in hand, prosperity results automatically.

It is certain that subordination of personal feeling and the cultivation of a spirit of loyalty is worth an effort. Many a man otherwise individually endowed lacks this feeling of team effort and thereby hangs more than one tale of nonsuccess.

It is one of the defects of the large organization that the personal element of the ruler is less evident to those ruled. With invisible directors and unapproachable executives, unaccountable trouble may ensue. It may broadly be stated that where those in authority are workers taking an active and visible share in the management the relations between all hands are happier than where the reverse conditions operate. This need involve no interference as between those to whom authority is delegated. The desirable spirit to cultivate is not so much a bargain at market rates as a feeling of loyalty akin to patriotic fervor.

The distinction between salary and wages of staff and labor forces is certainly too marked in the majority of instances. Class prejudice, that bane of every reform, is stimulated and encouraged. The man believes rightly or wrongly that reward, other than that inclosed as bonus in his pay envelope, is not bestowed for diligence. He feels he represents just exactly the same asset as any pulley or machine tool, and no more. He is hired by the hour, paid exactly what he earns, and since this basis is set he does not feel the sense of loyalty that seems always the prerogative of the "staff."

To overcome the sharp distinction, to smooth the corners, is not an easy task; but nothing is beyond human ingenuity. The question of labor has to be faced, and it is certain that kindly human consideration is not the least asset toward improved relations. A. L. HAAS.

Tooting, England.

Acetylene Torch Prevents a Long Shutdown

A large municipal stone crusher had just started work in the morning when one of the men dropped a 20-lb. sledge hammer so that it fell between the jaws of the crusher. The belt came off and everything stopped. It was found impossible to release the hammer. An examination showed that the way to get it out was to dismantle a goodly section of the machine and platform, which, it was foreseen, would take at least all of the day.

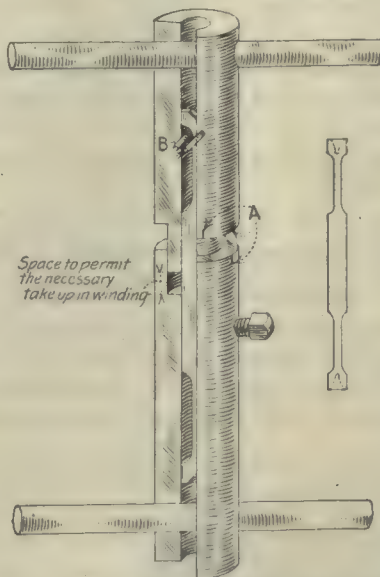
One of the workmen suggested that we use a portable oxyacetylene outfit. The hammer rapidly melted away before the flame of the torch. In an hour and a quarter the crusher was at work again.

Middletown, N. Y.

DONALD A. HAMPSON.

Making Fish-Tail Cutters

While with the Precision Tool Co., of Canton, Mass., I had a lot of fifty fish-tail cutters to make. The shop had no universal miller, so I made a simple device to twist the cutters cold. It did the job very nicely. The cutters were twisted as shown, the lines A giving the limits of the



TWISTING FIXTURE FOR FISH-TAIL CUTTERS

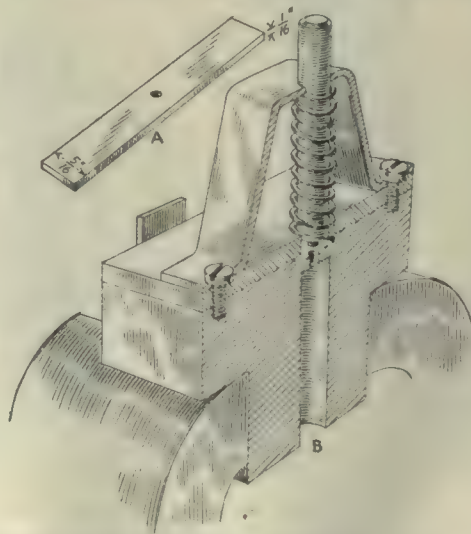
twist. The $\frac{3}{32}$ -in. holes B were $\frac{3}{32}$ in. apart, permitting the two pieces of drill rod to straddle the flat. After twisting, the cutters were hardened, ground on centers, then the extra length ground off and the V ground.

Boston, Mass.

J. J. McHENRY.

Punching Springs with Hand-Operated Punch and Die

A number of flat steel springs had to be punched as shown at A. Not having a small punch press, we decided to make a punch and die as shown in the sketch B. The base with the die is held in the vise, and the punching is done by hitting the upper end of the punch with a



HAND-OPERATED PUNCH AND DIE

machinists' ordinary hammer. The lower end of the punch is of course hardened, while the upper end may be left soft to prevent cracking. J. LIMBRUNNER.

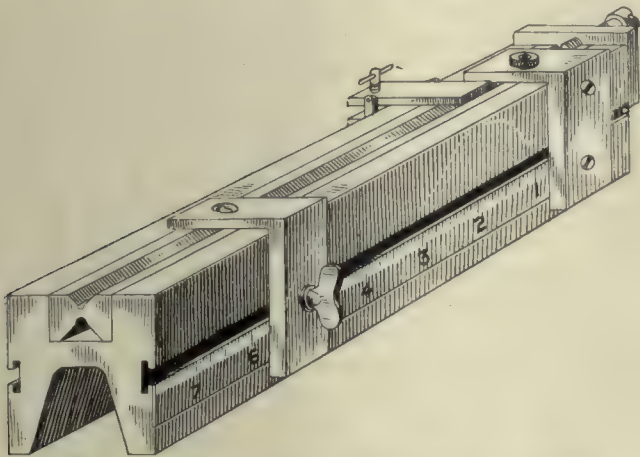
Shelton, Conn.

Discussion of Previous Question

Universal Drill Jig for Small Shafts

Having noticed descriptions of a jig for drilling cotter-pin holes in small shafts—by W. Burr Bennett on page 428 and by Francis J. Dittmar on page 732—I wish to submit one of my design, which proved successful.

When this jig was constructed, there were between 700 and 800 individual jigs, many of them duplicates on



ONE JIG THAT REPLACED SEVERAL HUNDRED

different drawings, which were retired from active service and later scrapped, as it was found that these universal jigs could handle to much better advantage all shafts from $\frac{1}{8}$ in. to 1 in. in diameter.

The illustration shows clearly how the jig is quickly adjustable to any shaft within its range and to any distance between centers of the holes to be drilled. Particular attention is called to the scale embedded in one side of the jig. This scale is so placed that the right-hand edge of the movable bracket indicates the distance between centers of the drill bushings, thus eliminating any necessity of measuring or calipering when setting up for any particular job.

As the drafting department has standardized the drilling size for cotter pins, but four sizes of slip bushings are required to drill any shaft between $\frac{1}{8}$ in. and 1 in. in diameter.

L. L. DODDS.

East Pittsburgh, Penn.

✱

The Small-Shop Notebook

The small-shop notebook, besides being an excellent topic, as Mr. Van Deventer has proved, is something that every enterprising mechanic should build up for himself.

In the shop we are constantly seeing things that it would be well to remember. Unless such matters are noted or otherwise firmly impressed upon our minds, they will be almost immediately forgotten. Also, the man who has not cultivated the habit of looking for these things will not see them and learn.

The man who builds up a notebook not only cultivates the habit of looking for the various interesting shop procedures, but in jotting them down he more firmly plants these things in his memory, the book serving to hold all the details that would be hard to remember.

I distinctly recall an instance in my shop career when the value of the notebook was conspicuous through its absence. I had previously used chucks for turning oval-shaped pieces in the lathe and had had ample opportunity to examine their principle and construction. However, I was disinterested, and the knowledge gained was simply how to use them. Later, when working in a shop where I was the sole mechanic, the superintendent expressed a desire to have me build such a chuck. I had to admit that I did not know how. Had I previously possessed a notebook, I could have added a little to my reputation on this occasion.

To get the most value from the notebook the mechanic should not stand by and merely copy a device. The simplest memorandum should be made upon a scrap of paper immediately and the paper placed in a pocket, where it will call attention to itself in the evening at home. The subject should not be examined too closely, as it is best to do a little thinking before putting it in the book. This practice tends to develop the faculty of thinking and at the same time impresses the matter firmly upon the memory. Also, when putting the idea in the book in this manner, the original may be improved upon. In fact, it is seldom that some improvement is not suggested. If when trying to remember certain points or to dope them out, the mechanic fails, it will be interesting the next day to see how the other fellow did it. The value of the shop notebook as an educator is hard to beat.

GUSTAVE A. REMACLE.

Newark, N. J.

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The Advantages of Machinist Draftsmen

While the subject of machinist draftsmen has been discussed many times, the need for a sensible understanding of the case is more necessary than ever. Mr. Badge on page 31 states that the machinist draftsman who has actually built machines will in general be a profitable man to have on the board; more so in fact than the strictly creative theoretical draftsman, who has imbibed his knowledge of machines less strenuously.

The draftsman may be creative, but the machinist could be several times as productive if the draftsman's creations were practical, if they had correct dimensions and were not changed before the lot was well started. If anyone doubts this let him get inside figures on the cost of drafting-room errors, the cost of changes due to improper or impractical design and other faults which lie all too heavily at the door of the drafting room.

There can be little doubt that the draftsman who has had shop training will draw fewer pieces which it is

impossible to machine, than the man who does not know the limitations of shop tools. All machinists will not make good draftsmen any more than all draftsmen will make good machinists, nor do all of them want to become knights of the pen in spite of clean hands, flossy clothes and a salary instead of wages. But it is far more important for the draftsman to know shop work, not to change his occupation, but to make him a better draftsman.

FRANK C. HUDSON.

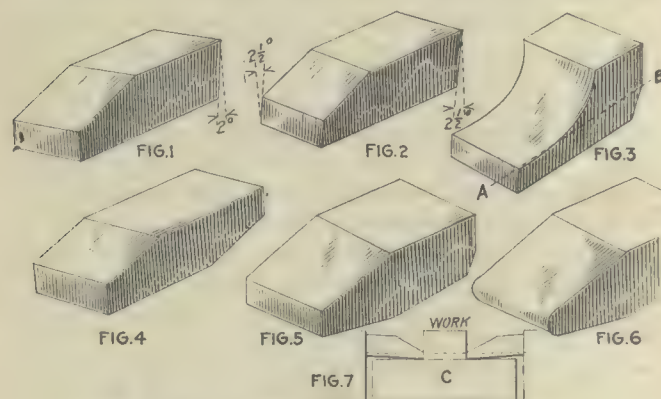
New York City.

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Design of Holding Jaws

I have noticed several "hold-downs" lately in the *American Machinist*. Those on pages 385 and 387, Vol. 44, are open to criticism, as are both of those advocated by Mr. Beuter, on page 1002. In Figs. 1 and 2 are seen the hold-downs shown by Mr. Beuter. The ones previously described are similar to Fig. 1.

Both of these shapes have been tried in the shop where I am employed. The kind illustrated in Fig. 1 will work fairly well, but that in Fig. 2 is very unsatisfactory. The style used at present, seen in Fig. 3, is efficient. The



FIGS. 1 TO 7. TYPES OF HOLDING JAWS

back side is straight for about one-half the thickness of the piece, the remainder being at an angle. The amount of this angle is immaterial, but it should not be less than 2 deg.

A good emergency "hold-down," which may be made in a few minutes from an odd piece of cold-rolled steel, is illustrated in Fig. 4. Shapes that will hold work successfully are shown in Figs. 5 and 6. I have seen a number of both shapes in use, but the one in Fig. 6 is apt to mar the work if much pressure is applied. Those shown in Figs. 1 and 2 are not good, because the pressure is not applied correctly. It should not come at a point lower than the line AB, Fig. 3. In use, Fig. 1 will rise till the whole angular side is in contact with the vise jaw before it begins to "bite," and by that time its holding-down powers are slight, as a glance at Fig. 7 will show.

As a test of the holding-down powers of various styles, try the following: Place a piece of work between two hold-downs, as in Fig. 7, and try to remove the parallel C after tightening the vise jaws. When using hold-downs similar to those in Figs. 1 and 2, it will usually be found a simple matter to push out the parallel C, which will leave the work suspended between the hold-downs. But, on the other hand, if this test is made with the hold-downs shown in Fig. 3, it will be found hard to remove

the parallel, and upon removal, the work and hold-downs will drop to the bottom of the vise. This proves that the jaws in Fig. 3 have holding-down power far in excess of those illustrated in Figs. 1 or 2.

H. M. DARLING.

Greenfield, Mass.

✽

Measuring Screw Threads in the Small Shop

After reading John H. Van Deventer's article on page 1063, Vol. 44, I am led to tell how we do thread-cutting in cases where extreme accuracy is required. We do considerable work of this nature, such as jig and fixture parts, gages and so on.

Bolts and nuts for jig or fixture parts must be right to assure that they will function correctly and continue in use without frequent adjustments and repairs. Gages, of course, must be as accurate as they can be made.

The idea of producing a thread form so the gage will "shut out light" is no accuracy at all, and for this reason—unless the face line of the gage corresponds exactly to the longitudinal center line of the work the thread, whether true or not, will show "off."

If the gage be made of sheet stock it must be held exactly perpendicular to the center of the work or the thread will show heavy at the top, or at the bottom (root), according to whether the gage is inclined toward or from the user; here is a good example and proof—take a lathe center, hold it up to the light and try it with a center gage; slightly incline the center gage first toward you, then from you, and see what you will get. This little experiment will show, quickly and clearly, the point I wish to make.

The method sometimes used of first inclining the gage toward you, then moving it until it inclines from you, is wrong; for how can you keep the gage true with the longitudinal center line?

Perhaps the shortest way to the end of this article would be to take a screw as an example, and carry it through to completion. I am considering an adjusting screw for a small, full automatic internal bench grinder of our own design and make. The screw is $\frac{5}{16}$ in. in diameter, the threaded portion 3 in. long; single square thread, sixteen to the inch. Two are required. For this we choose our newest and best lathe.

The centers are lined up with an indicator and test bar; the test bar being reground for this particular job. After the first line-up the test bar is turned end for end, and the line-up proved again; the reason for turning the test bar end for end and realigning the centers is to see what variation there is between the live and dead centers; also to see if the tailstock spindle varies any when it is moved outward. It must be remembered that the centers in the test bar may be slightly at fault; if so, this turning of the test bar end for end will show the error.

The test bar must be of the same length as the piece to be threaded, so the tailstock need not be moved, and the tailstock spindle will be locked at the same point in its length for both the test bar and the work. After we are satisfied as to the truth of the centers we grind and set the square thread tool as accurately as possible, and thread a "test piece."

When this test piece is threaded full depth it is turned end for end, and the tool being left set for full depth

of thread, a cut is carefully run from this end. This is the test cut and proves the setting of the tool.

The test piece is shouldered at each end for the driving dog, the thread being cut on the central portion, which should be of the same diameter as the work. The lead of the thread is measured with an inside micrometer between a ground parallel clamped to the lathe ways, and a cupped-head stop screw is tapped into the carriage on the tailstock side.

If everything goes right up to this point the test piece is removed and laid aside. The piece to be threaded is turned down 0.0015 in. under size, placed in this prepared lathe and the thread cut; the depth being set on the crossfeed screw and being 0.002 in. less than full depth. The stop is then adjusted to this setting, the tool backed out and successive cuts taken until the crossfeed comes into contact with the stop.

Then, having an allowance of 0.002x2 in., or 0.004 in., a variation of the three-wire system is put into use to measure the diameter at the root of the threads; only three square pieces are used, ground to size, and coming flush with the top of the threads when the latter are full depth; the reading of the micrometer over these three pieces shows exactly how much stock remains to be removed. Each cut now must be regulated carefully until the screw is properly cut; that is, until the three square test pieces will slide freely under the micrometer when the latter is resting on the top of the threads.

Going back, for a moment, to the test cut; it must be remembered that if the tool shows an error when the test piece is turned end for end the apparent error is twice the actual error, and so an adjustment must be made equivalent to one-half the apparent error. This adjustment is made by means of the screw of the compound rest in connection with the crossfeed screw.

At the same time, of course, no dependency for accuracy is placed on either the crossfeed screw or the screw of the compound rest. If either is accurate it is probably by accident. These screws are used simply to move the tool to and from the center of the work in the case of the crossfeed screw, and to advance or retard the tool in the case of the compound-rest screw. The thread tool, whether for square thread or for some of the 60-deg. threads, is ground all over, the shank being surfaced true, or fairly true.

After being ground as nearly true on the cutting edge as possible, it is tested for truth by being placed on a surface plate upon which two parallels are fixed permanently at right angles. The shank of the tool bears against one, while the cutting edge is brought against the other.

The smallest possible amount of Prussian blue is rubbed on the cutting edge and a piece of paper is then drawn through between the parallel and the cutting edge; any variation out of square will then readily show on the paper. The tool may then be replaced and the high side "favored" in grinding.

When setting this tool a square is used to square between the side of the work and the shank of the tool. However carefully all this has been done, some slight adjustment will most likely be necessary when the tool starts the cut—that is, as shown on the test cuts.

Tools for any of the 60-deg. threads should also be machine-ground all over if you are using a forged tool. A Rivett-Dock or a Pratt & Whitney thread tool are

good devices to use here, but we ourselves use a forged tool.

After the shank is surfaced true, the tool is placed in the grinder vise, right side up; the vise is turned to 30 deg., as near as possible, and the table raised $\frac{1}{16}$ in. above the center of the grinder spindle and the first side, called "A," is ground. Notice the letters used to designate each grinder cut, for they must be referred to again in the proof grind. When side "A" has been ground the vise is turned to 30 deg. in the opposite direction, and the side "B" is ground; this completes the 60-deg. angle. Now the table of the grinder is lowered to $\frac{1}{16}$ in. below the center of the grinder spindle and the tool is set upside down. While this leaves the vise still set for grinding the "B" side, a test cut is tried over the "A" side. This cut must be light; a bare scrape.

By setting the tool upside down the cut is reversed, as will be readily seen, while the setting is transferred to below the center of the grinder spindle, to maintain the original clearance of the tool. When the tool shows true in the grinder it is removed to the surface plate and tested in a way similar to the test for the square thread tool, only a center gage is placed flat on the parallel at the cutting point. Having rubbed a little Prussian blue on the point of the tool, a piece of paper is drawn through, first on one side then on the other; the center gage is then turned over and tried again to see if the center gage itself is true; otherwise the procedure is the same as for the square thread tool. In all cases you may expect to make some slight, final adjustments of the tool while threading the test piece.

A tool of first-class quality should be used and all cuts be light and carefully made so the tool will not require regrinding while cutting the true thread. If it does require regrinding, it will not be a difficult matter to reset it if you already have the true thread deep enough to serve as a gage. The thread may be tried for form, although this is not necessary, by placing the gage on a parallel in a flat position and rolling the screw against the side of the parallel. Allow the gage and the screw threads to mesh, using a little Prussian blue.

The height of the parallel should be the radius, or one-half the diameter of the screw, *minus* one-half the thickness of the gage, in order that the center of the screw and the gage may be true in the same horizontal plane; attention should be paid to this. If a thread is developed by a first-class workman in the manner stated it will be as true as it can be, or needs to be made.

Another point where especial care should be used is in making the test cuts; it is hardly to be expected that the tool will show O. K. in every respect at the first or the second trial, and a little patience will be worth considerable. It may be necessary to make six or eight trials before the lathe is ready to begin a real thread-cutting job.

After the screw is finished, in so far as the thread-cutting is concerned, it should be lapped lightly, not so much as a sizing operation, to produce a good finish.

The lap used is sometimes made of brass or hardwood and charged with flour emery. The brass lap is round, while the wooden lap is flat, like a chaser. The threading tool is ground in a vise in a tool-grinding machine, so the cutting edge may be as nearly square as possible. Since the compound rest is set at 30 deg. all necessary adjustments, as shown when the test thread is being recut

from its reverse end, are made by tapping the shank of the tool in the required direction and advancing or retarding the tool by means of the screw of the compound rest, during which adjustment the lathe must be stopped.

It will be noted, also, that any error in the thread form will be shown when the test piece is reversed, or turned end for end. All that has been said above about cutting the square thread applies equally to any other thread in general use.

Precision thread-cutting is something wherein the skill resulting from practical experience discounts all the instructions that could be written. In the foregoing I have endeavored to be explicit, yet as brief as possible, giving all vital points and leaving out all things the ordinary lathe hand is supposed to know.

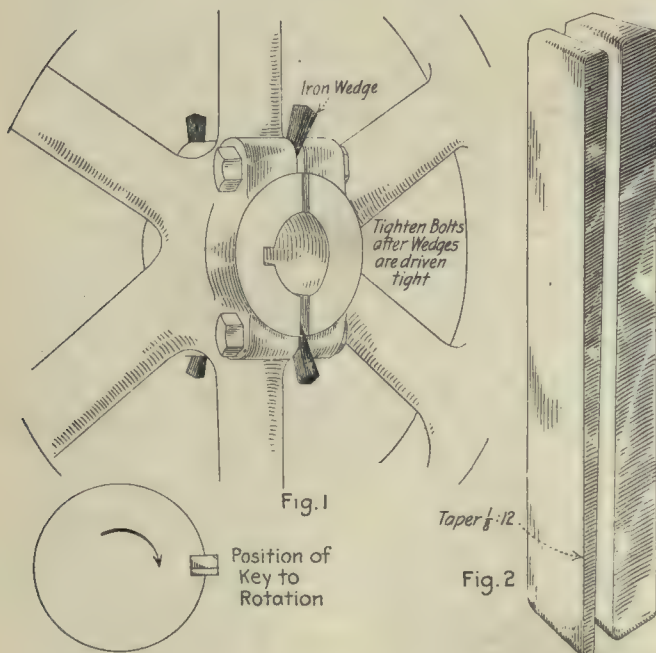
In the method given here, as in everything else requiring a high degree of accuracy, extreme care is the price of a first-class job.

J. B. MURPHY.

Plainfield, New Jersey.

Fitting Flywheel Keys

On page 1087, Vol. 44, are shown some of the difficulties one must contend with when keying flywheels to engine shafts. The flywheel hubs are of two classes: those that are solid and those that are split and clamped by two or more bolts to the shaft. It is with the latter that a lot of these troubles can be eliminated. First the hub should be bored to fit the shaft closely. This is ac-



FIGS. 1 AND 2. DOUBLE OR SPLIT KEY FOR HUBS

complished by inserting four iron wedges on opposite sides of the hub as shown in Fig. 1. These wedges should not be removed until the flywheel is in proper position on its shaft, when solid rims and split hubs are used. The keyways should be kept close to the required dimensions in both hub and shaft. The key under discussion is to fit sidewise only. This is made split, or in two pieces, the thin key being one-third the thickness of the thick key with a taper of one-eighth to the foot. This is shown

in Fig. 2. This key can be fitted and removed without any special tools. If both keyways are of the same width and cut true to the axis of the shaft the key requires practically no fitting whatever.

I have used this style of key for flywheels with keys from $\frac{7}{8}$ in. wide and $\frac{3}{4}$ in. deep to $1\frac{3}{4}$ in. wide and $1\frac{1}{2}$ in. deep—that is, the keyway was one-half the depth of key in the shaft and hub. I have never had any trouble with this style of key. At first I used to dowel them, fearing that they might work loose, but further experience showed this to be unnecessary. I have used this method on gas-engine and steam-engine flywheels for ten years without any trouble.

In regard to finishing ordinary flywheel keys from the rough forging, or reducing oversize keys, the disk grinder has everything "stopped." Keys ought to be drop forgings instead of being milled from the solid as is usual. A steel of 45 point carbon is commonly used, but where there are severe stresses good tool steel should be employed.

Brooklyn, N. Y.

G. STROM.

Blueprints Without Tracings

For making blueprints from pencil drawings as discussed on pages 803 and 960, Vol. 44, I make the drawing on a good grade of light-weight unsensitized blueprint paper with an H or HH pencil. This paper has a smooth, flat surface, stands erasing well, is cheap, and makes good prints on sun or electric paper.

Use black carbon paper, face side up, under the drawing, and main outlines or any special features can be shown up as clearly as if inked in. Dimension lines can be made without carbon, and will be fainter than outlines, and so different in appearance that it is easier to read the prints than where all lines are of the same density.

For typewritten bills of material, drawing lists, specifications and price lists, use the same paper with black ribbon and black carbon, and the prints will come out very good.

F. A. DEW.

Pomona, Calif.

Carbonizing Small-Shop Steels

Recently an incident occurred in a small shop that brought to mind Mr. Van Deventer's article on page 489, Vol. 44.

It is usually necessary in the small shop to wait until enough pieces accumulate, to fill one of the cast-iron boxes such as is shown on page 489. As is often the case in these days of rush and bustle in getting out tools, a few small pieces had to be pack-hardened immediately.

The pieces were packed in a tin box that had previously contained hand soap and put through the usual process. Excellent results were obtained in this manner. The tin cover served to keep in the necessary gas and the tin box was so thin and light in construction that the pieces were hardened to the required depth with a minimum amount of gas. There was also a saving in the time required for packing.

Being light in construction, these tin boxes cannot absorb much of the free carbon, the pieces therefore getting the benefit. The boxes can only be used once.

Newark, N. J.

GEORGE A. REAMER.

Editorials

The Problem of Hiring Men

In spite of all that has been talked and written, the methods used in hiring men for large corporations too often belong to the dark ages. If anyone has doubts on this question, it is only necessary to visit some of the so-called employment bureaus or offices and apply for a job. Even those applying for "positions," as draftsmen and foremen prefer to call them, meet with the same unintelligent treatment in many cases.

Men are too often herded together in small waiting rooms, subjected to petty annoyances of office boys, and finally put through a cross-examination that would do credit to an inquisition. Family affairs, political preferences and religious convictions are all pried into by employment agents who have no conception of the real requirements of employees to produce economical work. Too many employers still cling to the mistaken notion that they are philanthropists and that employing a man whose labor will add to their profits is an act of charity.

The employment of men, which is the buying of labor, is just as much a problem for study as the purchasing of material, and in many cases it is even more important. Personal prejudices as to the color of the hair, the choice of language or the kind of necktie have no place in the employment office. The changing of men is an expensive operation, and it should receive far more consideration than is usually the case. Getting the right man for the place is seldom easy, and it is made far more difficult by the czar-like attitude of some men who hire employees for large firms. Neither these men nor the heads of such firms ever know to what extent the shop output is lowered by this kind of hiring. The best men resent such treatment and only take a job in a shop of this kind from sheer necessity. The actual money loss is far greater than we realize.

This loss has assumed almost unbelievable figures if we take into consideration the lowered production when an expensive machine stands idle or a new man is getting accustomed to it. Then too much actual damage to machines can be readily traced to new men, and this often amounts to far more than the increase in wages which would have kept them satisfied for a long time to come. And consideration counts as well as wages.

Some of the larger and more advanced firms have made great progress in this direction and have found it a very profitable investment. The employment bureau in such cases is handled by a high-salaried man with a broad grasp of the principles involved. The right men for this kind of work are not easy to obtain, as it requires a wide experience in handling men, a knowledge of the principles of production and a much broader and more human interest than we find in most workers in this position. It may even afford opportunities for men and women trained especially for this kind of work.

It is never a position to be intrusted to a cheap clerk or to anyone who cannot rise above personal grouches. The voice with a smile wins in this capacity.

An Era in Aviation

The general preparedness program carries with it an appropriation that is evidently trying to make up for lost time in the development of aviation in this country. The amount appropriated—which will probably be about \$20,000,000 in contrast with \$2,500,000 last year—is so enormous that we are apt to underestimate the task it imposes on those in authority when they attempt to spend this amount intelligently and for the best interests of all concerned.

Our governmental neglect of aviation in the past, coupled with the deterrent effect of the litigation that has burdened our courts for several years, has limited our experience in actual aeroplane work to an alarming extent. In fact it may be said that our experience in producing aeroplanes in quantities that at all approach a manufacturing basis is limited to that of supplying machines for use in the present war in Europe.

The development of aviation requires flying fields, aeroplanes and men to fly them. The fields and the men can be easily obtained when the machines are available in sufficient quantities and with proper equipment. Not that aeroplanes cannot be made in fairly large quantities if all makers were given the opportunity to supply their particular make of machine, but this would mean a great variety of both planes and motors, with the added expense of maintenance, not to mention the increased difficulty and danger of operation.

The engineering of aviation has not yet reached the point where many details can be standardized, unless it be the use of one method of control. The form known as the Deperdussin, or more commonly the "Dep," seems to be the general favorite and is being used on many machines.

Plane construction has made a marked advance in the last two years and is fast assuming manufacturing proportions; this also includes the body or fuselage, the landing gear and motor mountings. All have made rapid progress in spite of the constant demand for larger and faster machines. Motors have been much improved, but the constant demand for more and yet more power has made this a more difficult problem. The jump from the old thirty-horsepower Wright to the three hundred-horsepower Curtiss, in a single twelve-cylinder motor, is a more difficult problem than it appears on the surface.

The motor situation is likely to improve in the near future, as several well-known firms are taking it up. Some of these firms have a large automobile experience behind them and have also the advantage of a well-organized and well-equipped manufacturing department. With this experience and organization they are not likely to make the manufacturing mistakes made by some of the exclusive aeroplane-motor builders. This combination will enable the automobile-motor builders to build aeroplane motors at a much lower price than the six to eight dollars a pound charged in some cases by other builders. The price per pound is not a safe unit of

measurement, unless we use it in connection with a similar product; but when we find motors of less than 140 horsepower selling in the neighborhood of \$4,500, it indicates that an increase in production and a corresponding reduction in cost is necessary.

There are more problems in the design and construction of an aeroplane motor than appear on the surface. It must be as light as consistent with safety and durability, but on the other hand it must withstand greater punishment than any other type of motor. Unlike the automobile motor, it must run at full speed and maximum power nearly all the time; there is no slowing down or stopping for traffic officers or idling along at a fraction of maximum power at any time.

Then there are the accessories that are almost as necessary as the machine itself, as in the case of the automobile. Most important of these accessories are the tachometer, barometer, clock, synchronized drift set, angle of incidence indicator, air speed indicator and wireless set. Most of these should be part of the regular equipment of every machine as being necessary to safe, intelligent flying. The stabilizer, while not an absolute necessity for flying, is such a valuable device that it is difficult to consider a machine really complete without it. It is not only a safety device that prevents many accidents to both the aviator and his machine, but it is an invaluable aid in bomb dropping, in taking photographs or observations and in many other ways.

As before stated, standardization is difficult at this time, and yet we should begin working with that end in view. A man who can fly one machine should be able to handle another with no more trouble than a motor-truck driver changes from one make of truck to another.

This is particularly necessary in view of the development which is promised by the new appropriation. The plan, it is understood, calls for thirty-six squadron of air craft, each squadron to consist of twenty-four machines. Even this will give less than a thousand aeroplanes, but is such a tremendous increase as to be particularly gratifying at this time. But it also emphasizes the necessity of standardization by different makers so that, while retaining any special good points due to their design, their machines can be flown by those who are familiar with standard machines.

These details are merely cited to indicate some of the problems that confront those responsible for the expenditure of the large sum that has been appropriated. The question of first cost is not the only consideration, for builders must be encouraged to develop not only their machines, but their manufacturing facilities as well. All orders at high prices should be given with the understanding that future orders should be filled at a more rational cost, based upon modern manufacturing methods. Unless this is done we shall continue to pay too much for aeroplanes, and production costs can be reduced here as elsewhere.

These and many other questions are difficult to solve with any data or experience we have at hand. The best available engineers should be freely consulted and be made to feel their responsibility in assisting decisions. While this is not so spectacular as deeds of heroism on the battle field, the engineer who assists in the safe and economical upbuilding of our national defenses is just as truly patriotic. There is no higher form of patriotism than serving one's country honestly.

Universal Military Training

If any one has been disposed to doubt the profound influence that the European War has had upon American thought and purpose, he must now be convinced. On Aug. 1, 1914, hardly a voice could be found that dared to speak in favor of compulsory military training in the United States. Two years later the business men of the United States have overwhelmingly voted in favor of universal military training. This overturn in belief is sufficient to mark an epoch in our national life.

A committee of the Chamber of Commerce of the United States drafted into ballot form this referendum report:

The committee, recognizing military obligation equally with the civic obligations as a fundamental duty of democratic citizenship in a republic—and to establish a system which will affect every man alike—recommends that universal military training be adopted as a fundamental democratic principle of our military policy, and be enforced by law to furnish adequate land, sea and industrial forces in peace and war.

The result of the ballot gives 889 votes in favor and only 56 opposed. The organizations in twenty-six states voted unanimously in favor; in sixteen other states the vote was overwhelming, though not unanimous; five states failed to vote; in only one state—Alabama—was the vote against. Such a disclosure of public opinion on questions of this kind is without precedent in the United States.

It must be remembered that this expression comes from conservative men who will be closely concerned with paying the costs and meeting the economic problems that any system of universal military training must impose. Congress has acted to increase the standing army, to provide additional equipment for its use and to accelerate the work of developing an adequate navy for the defense of our coasts.

The fortifications appropriation bill also carries a large sum of money for the increase of our coast defenses. Still another bill among those which can properly be considered as a part of the preparedness program is the one providing for a national council for defense. This organization when perfected, in connection with the Naval Consulting Board, will provide the means for studying and developing the possibilities of industrial preparedness. It is earnestly hoped that there is yet time to introduce into the business of the present Congress a bill drawn with great far-sightedness to provide for universal military training and have it enacted into law.

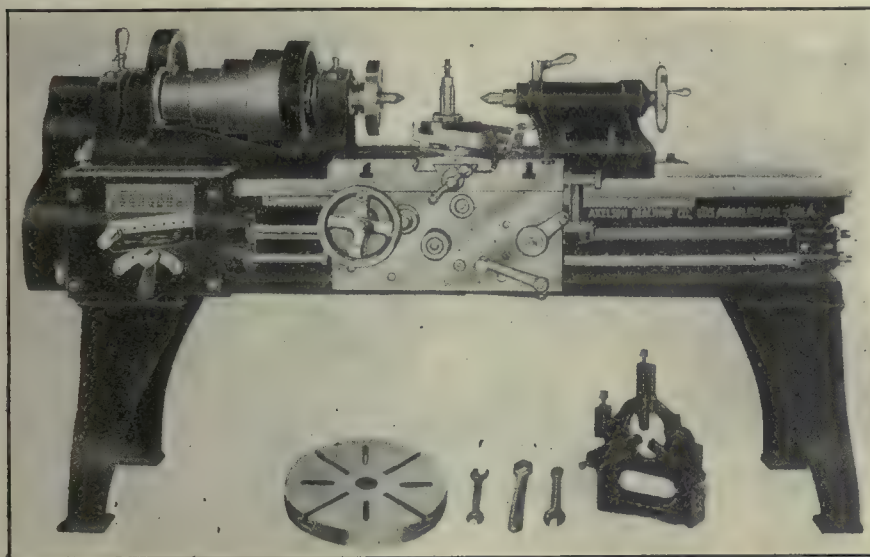
It is probable that the business men who have registered their opinion through this amazing vote are not unmindful of the benefits of proper military training in turning out better balanced and more self-disciplined young men. Correspondents in our columns have frequently referred to this during the past few months. A sane system of compulsory military training like that in force in Switzerland or Australia should bring nothing but good.

It is pointed out that homicides are fewer per thousand of inhabitants in all of the countries that have compulsory military training than in the United States. It is also maintained that this same compulsory training is a powerful factor in developing skillful industrial workers from the green boys of the country and the untrained lads of the city.

Shop Equipment News

Cone-Driven 16-In. Lathe

This lathe recently brought out by the Axelson Machine Co., Los Angeles, Calif., is built for heavy duty, as are most modern lathes. It has a four-step cone pulley, single back gears and quick-change gears. Particular attention is paid to the spindle and bearings, which are of bronze. The spindle is turned from the center hole, so as to in-



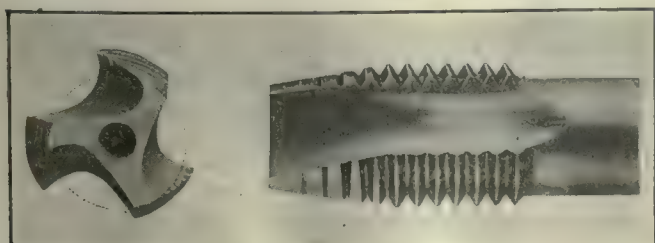
CONE-DRIVEN 16-IN. LATHE

Swing, 17½ and 10½ in.; bearings, front 2½x5½, rear 2½x3½; back-gear ratio, 9.6 to 1; tailstock spindle diameter, 1½ in.; lead screw, 1½ in. in diameter, 4 pitch; spindle speeds, 6.67 to 350 r.p.m.; threads, 32 changes, 3 to 46, including 11½; weight, 6-ft. bed, 2,400 lb.; extra weight per foot, 110 lb.

sure an even thickness of wall and be in running balance. The apron is of the double-plate pattern, has an interlocking device between the feed rod and lead screw and a reverse for all feeds. There is an automatic stop for the feed rod, and a chasing dial for thread cutting is provided. The main dimensions are given under the illustration.

The "Gun" Tap

The new style of tap is familiarly known as the "gun" tap because it shoots the chips ahead of the tap in long, unbroken curls. Its chief claim of excellence is in its construction at the point, the cutting edges being ground at an angle to the axis of the tap, as can be seen. This



TAP THAT HAS A SHEARING CUT

enables the tap to cut with a shearing motion, and the angle deflects the chips so that they curl out and ahead of the tap and do not collect and break up in the flutes, obviating the tendency to clog. The taps do not have to be backed out frequently on deep holes to clean the flutes from collected chips. The decided hook to the cutting edge causes the tap to work very freely and make clean, sharp threads. The balance of the threaded portion of the tap acts as a lead screw, without any cutting action of its own, and tends to hold the work true to lead. By using only two or three shallow flutes to the tap, instead of four, little stock is removed, and the tap is very strong.

If it should break, either from carelessness or unusual condition of stock, it will only chip off the sharp cutting edge, which can be easily reground. It is said to cut close to size and hold its size well.

The gun tap is ground on the angular cutting edge instead of in the flutes, and can be reground until there are only two or three full threads left and still maintain its size.

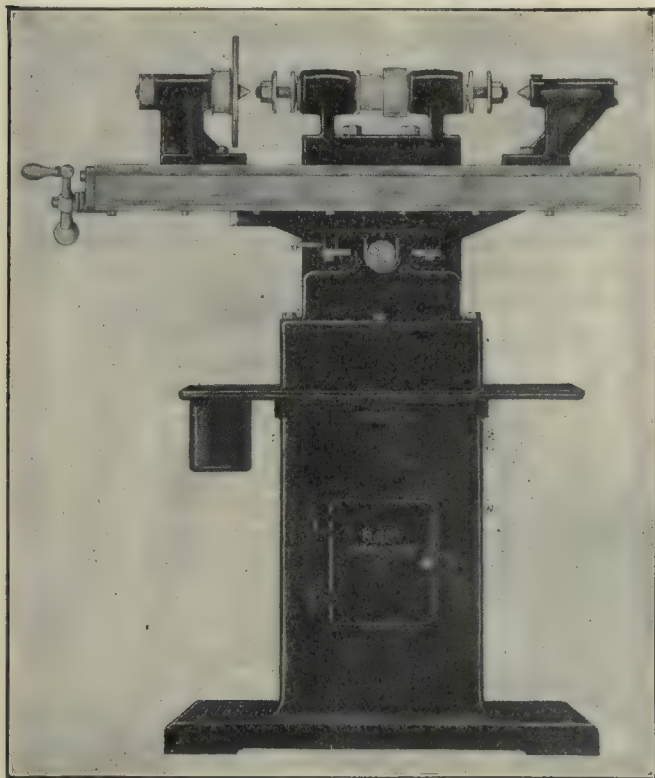
A single gun tap is recommended in many places where two and three taps used successively have been required, as its free cutting qualities permit working under difficult conditions and in tough materials. It is commonly

reported that 90 per cent. of taps break in use, and this form has been developed with the aim of making a tap that will wear out before it breaks. It is made by the Greenfield Tap and Die Corporation, Greenfield, Mass.

Plain Horizontal Grinder

This machine is of convenient size, 10x31 in., for a large range of plain grinding work. The crossfeed is operated by means of a screw with a graduated collar. A special nut makes it possible to take up all backlash in the screw. The ways, protected by metal guards, are solid with the column, making a rigid construction. The table is operated by means of a graduated-collar screw and has adjustable stops. The table ways are protected and have ample means for oiling. The front end of the headstock spindle is threaded for a chuck or faceplate. It also has a taper hole for a center. The spindle runs in adjustable bronze bearings. The headstock is secured to the table by a tongue fitting the T-slot of the table and by two clamping bolts. The tail spindle is also of tool steel, hardened and ground. The sliding spindle is operated by a lever for the quick placing of work. The base and column are of box construction,

with closet for tools. Additional accessories, such as universal headstock, table for taper grinding, chucks, internal-grinding attachments, faceplate and steadyrest, are furnished only when they are especially ordered.



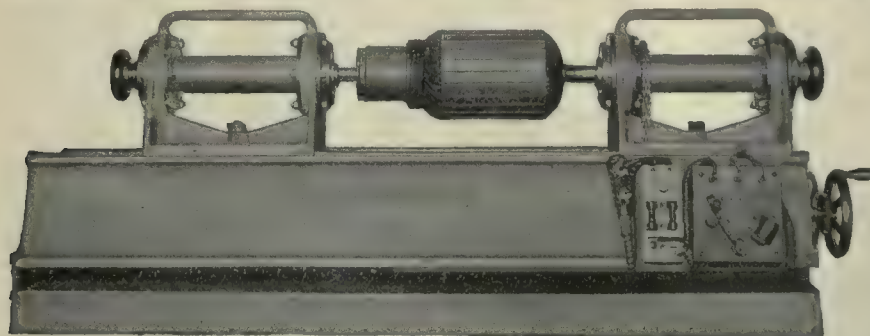
GRINDER FOR STRAIGHT AND TAPER WORK

This machine is made by the Ram Engineering Co., Richmond, Ind., and is the latest addition to its line of manufactured machines.

Small Dynamic Balancing Machine

The illustration shows the smallest size of dynamic balancing machine now made by the Dynamic Balancing Machine Co., Philadelphia, Penn., being designed for small motors, couplings, etc., and running at speeds up to 1,140 revolutions per minute.

The balancing member corresponding to the usual cage is located inside the ways, together with the $\frac{1}{4}$ -hp.



MACHINE FOR BALANCING SMALL ROTATIVE PARTS

motor. Each tailstock is provided with a quill, containing a spring chuck or collet, which takes in any diameter up to $1\frac{3}{8}$ in. These collets vary by $\frac{1}{16}$ in., which is an

advantage with armatures having bearings of different sizes on each end.

The wheels on the right control a set of wheels that operate the balancing member. This construction makes it unnecessary to stop the machine to secure any amount of correcting unbalance, though of course the machine must be stopped for adjustment of the angular position of the rotor with respect to the balancing member. With spring chucks this is a matter of only a few seconds. The underlying principle is of course exactly identical with that of the larger machines previously illustrated.

Multiple Drilling Head with One Reversing Spindle

The first illustration shows a five-spindle drilling head in place on a small bench drilling machine. This is a turret head, only the front spindle being operative, an arrangement that allows four sizes of drills and a tapping spindle to be used on work that comes within its capacity.

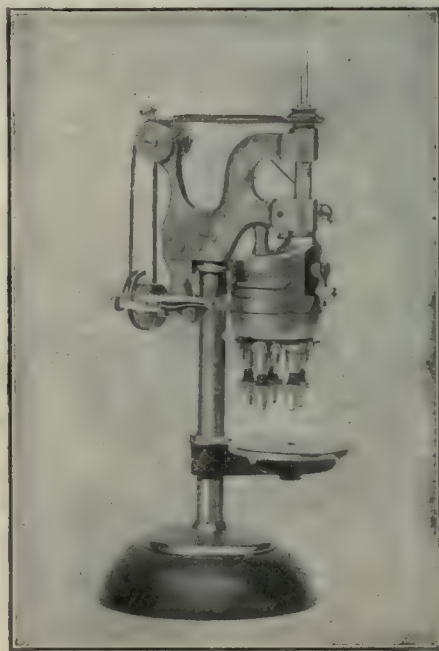


FIG. 1. A FIVE-SPINDLE DRILLING TURRET

Details of the construction of the tapping spindle are shown in Fig. 2. The spindle drives the upper collar, which carries a gear just below it. This drives the vertical jackshaft at the left, the second gear on this jackshaft driving the upper toothed clutch. The lower gear on this jackshaft, driving through an intermediate gear, gives the reverse motion to the tapping spindle below. The pin shown between the two toothed clutches controls the direction of the tapping spindle, the pin being operated either by hand or by an automatic throwout for reversing at a given depth of tapped hole. As these clutches run in opposite directions, engaging either one or the other gives the motion desired. The gears used give a tapping speed of 150 r.p.m. and a reverse speed of 250 r.p.m. This tool is made by J. N. Landau, 239 W. 68th St., New York City. The drive is

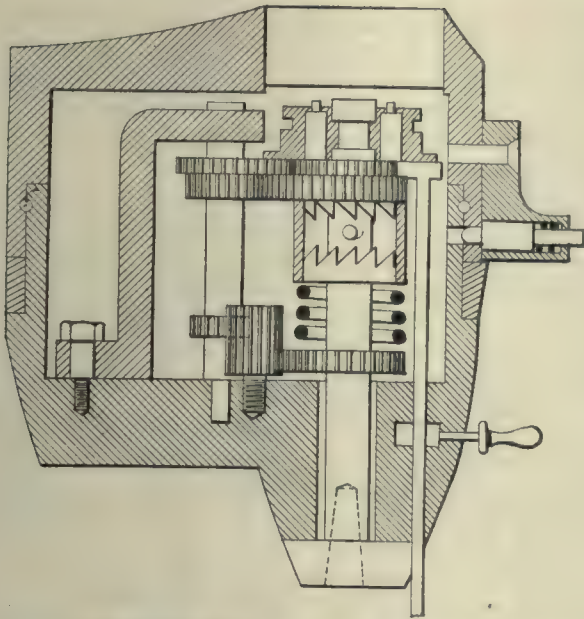


FIG. 2. SECTION THROUGH FIVE-SPINDLE HEAD

by means of an endless round leather belt which eliminates the risk of drill and tap breakage and yet has plenty of power for the work that comes within range of the tool.

✱

Motor-Driven Grinder

The accompanying illustration shows the No. 35 grinding machine of the Ransom Manufacturing Co., Oshkosh, Wis. It carries two 18x3-in. wheels. The guards are made of tank steel and steel castings fitted with eye-glass shields.

The foot treadle in front is used for starting and stopping the machine. This is particularly useful in cases



GRINDER WITH AUTOMATIC STOP AND STARTING DEVICE

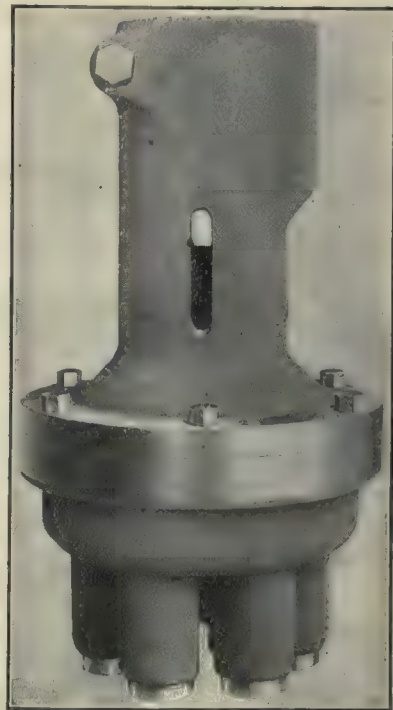
of intermittent grinding, where the workmen often allow a machine to run continuously rather than shut it off after a grinding operation. As shown, it is necessary for the operator to put his foot on the treadle before the ma-

chine will start, and it automatically stops the minute he leaves the machine. When the foot lever is pushed down, it throws in a single-pole switch used in connection with an automatic accelerating starter.

✱

Multiple Drilling Head

The central drive of the multiple drill heads illustrated herewith consists of an internal gear attached to a driving shank made to fit a machine spindle. This arrangement gives, without the use of intermediate gears, the correct rotation for drill spindles and also allows an increase in speed, which for small drills is very desirable. Spindles can be made either fixed or floating, and



DRILLING HEAD COMPLETE

adapted for drilling or tapping. It will be noticed that the gears are completely inclosed in a housing designed to form an oil bath, giving the maximum life to the gears and ample lubrication to the spindles.

These heads are manufactured to order by the Superior Machine and Engineering Co., Detroit, Mich.

✱

Hot-Bearing Treatment

Nearly every engineer has a favorite treatment for hot bearings by the use of a variety of substances. In *Power* F. E. Wood states that he has used coconut oil on boxes that were dangerously hot, and it is remarkable what it will do toward "holding" them. It is claimed to excel, especially on bronze or brass bearings. A little is all that is needed generally, and it is not expensive.

In tropical countries coconut oil is in a liquid form, but in a cooler climate it solidifies somewhat and must be heated a little. In one case an engine with a main bearing so hot that a shutdown seemed inevitable was kept running for three hours without doing damage to the bearing. In several other cases, as in heavy sugar machinery and the like, this oil has given excellent results.

Care of Leather Belts

By J. O. BENEFIEL

It is very easy to drive a belt fastener into a piece of leather, but it is just as well before doing so to think how much it will weaken the belt at that point and how much service you will lose from your machine through the failure of the fastenings.

The most satisfactory method of joining belting is by making a cemented lap joint. This is a simple operation when once learned, and there is no good reason why most of the belts in a mill or factory should not be put together that way.

As an example, a 10-in. double leather belt, Fig. 1, should have a lap 12 in. long. First measure back 12 in.

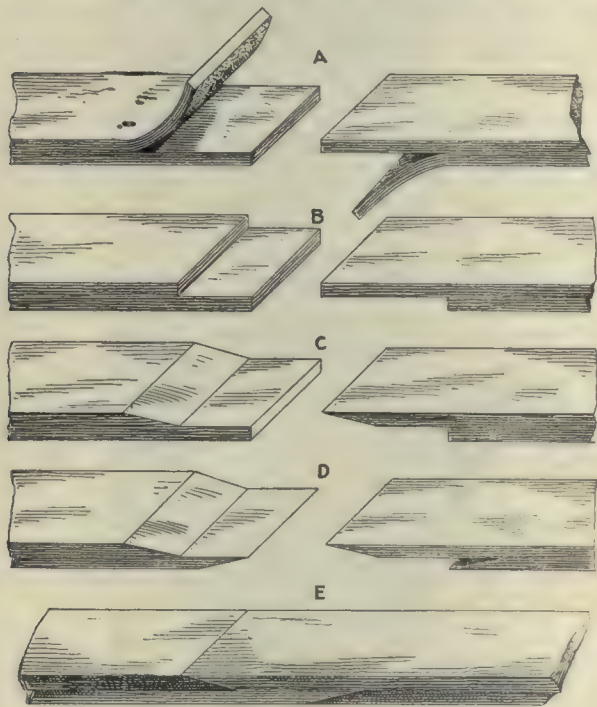


FIG. 1. PROCEDURE IN PREPARING A TWO-PLY SPLICE

and draw a line across square with the edge of the belt, then separate the plies with the opener back 9 in. and cut off one ply *B*, and with a plane or heel-shave bevel the top ply back to the 12-in. line *C*, then turn the belt over and bevel the end 3 in. back on the opposite side, as at *D*. Bevel the other end of the belt to match, which of course would be just opposite; then with the belt scraper go over the lap, making it all even and smooth so both plies will come in contact at all points. This completes the preparatory work, and the joint is ready to cement. Be sure the glue is not too thick and very hot but not boiling; if the room is cold, it may be necessary to heat the belt before cementing it together—using hot bricks or boards. Apply the cement to both surfaces with a brush, rubbing it in thoroughly but not too liberally, for the less the amount of glue left between the surfaces the stronger the joint. The surfaces are to be entirely coated with the glue or cement. Rub and hammer the surfaces of the lap together thoroughly to drive out all the air, proceeding a little at a time until the entire surface is cemented and hammered so that the surfaces are in close contact. The rubbing is done with what is called a slicker, and the hammer is usually a shoemaker's pegging hammer. Pay particular attention

to the edges and ends of the lap. If the belt is large, do not attempt to cement too much surface at one time and do not allow the cement to become chilled. After two hours in a reasonably dry, warm room, it will be safe to take off the clamps, if they have been used, and put the belt to work.

Sometimes the belt has to be spliced on the pulleys—especially if it is of considerable size. It should be put on so that the inner point of the laps already made point in the opposite direction to that in which the belt runs and the new or joining lap comes the same when the ends are in position for cementing together. Place the clamps on the belt, one of them about 6 in. back of the end of the lap and the other as far back as the length of the rods will permit, with the belt exactly in the center of the clamps and square with the edge. Draw the belt up a little tighter than the running tension to allow for the slack between the clamps. A board just wide enough to go between the rods and long enough to extend under the entire lap, fastened to the rods, makes a handy table on which to shave the laps down and fit them together. After the lap is fitted and before cementing together, see that the edges of the belt are straight. This is done by drawing upon one of the rods to bring it in line, after which it is sometimes necessary to refit the lap. A little clamp slippage will throw the edges out of line and the laps out of square, and it is found necessary in some cases to square the clamps with a rope attached to opposite corners of the clamps and twisting the rope with a short stick until the laps

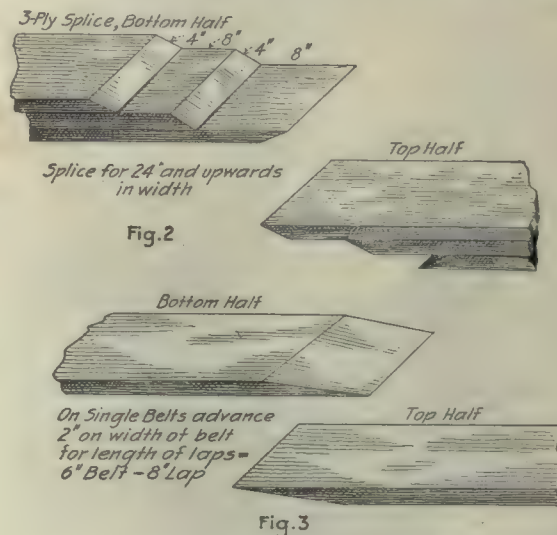


FIG. 2. THREE-PLY AND FIG. 3, A SINGLE-PLY SPLICE

come square with each other. The cementing is then proceeded with as described.

For 3-ply belt the cementing and clamping is the same as for 2-ply, and the laps may be made as shown in Fig. 2. A single-ply splice is made with a straight bevel all the way across the surface of the lap, as shown in Fig. 3. Pulley diameters for thick belts should be proportioned to the thickness of the belt. A heavy 3-ply belt will not last well on a pulley of less than 8 ft. diameter on account of internal stress set up in the belt.

The tension is of great importance, both to the life of the belt and the consumption of power. If too tight, there is a waste of power in friction and a loss of life in the belt by excessive straining. On the other hand,

if too loose, the belt may jump off the pulleys, especially with a variable load, and continual slipping causes a loss of efficiency in the machine driven—strive for the happy medium. A loose belt that does not slip or run off the pulley is most economical in both the foregoing points.

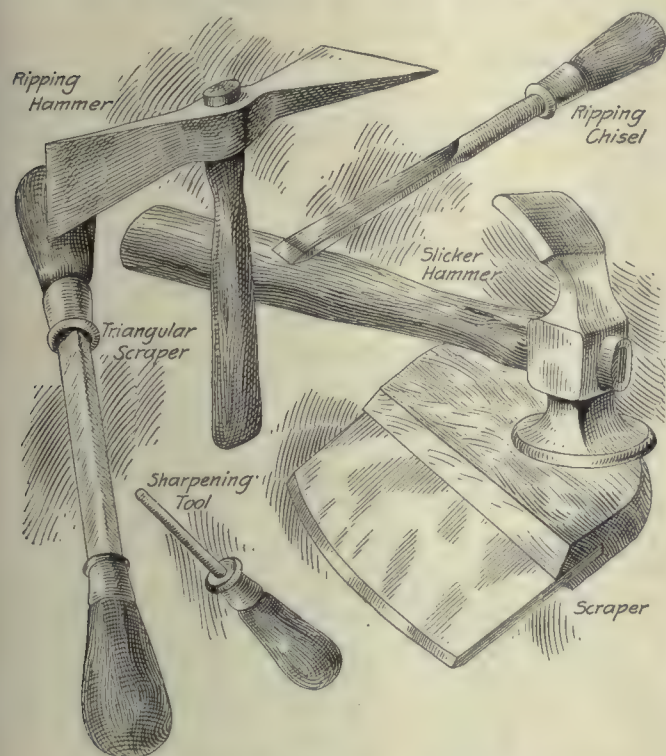


FIG. 4. PART OF THE BELT SPLICER'S OUTFIT

The following are good general rules: Keep the shafting and pulleys in line. Run the belts as loosely as they will work efficiently. Avoid sticky belt dressings; put a good dressing into a too-dry belt and take the grease out of belting that is too oily. Keep all driving surfaces clean. Run belts at as near a uniform tension as possible. When taking up a heavy belt, it is well to examine hanger and pedestal bolts; if the bolts are slack and the box moves, a kinked shaft is the result. Too much grease is injurious to leather and mineral oil in particular rots it, so where it is in danger of becoming soaked with oil, means should be used to keep the oil away. When belts become oily, they should have the oil neutralized or extracted with naphtha, gasoline or carbon tetrachloride, or by packing the belt in dry sawdust or shavings. If it is not possible to remove the belt, wiping it with a dry cloth or some absorbent material will help. Washing the face of the belt with gasoline gives good results, taking care to wipe it thoroughly and being sure there is no fire around.

It must be borne in mind in installing belting and taking it up that it is considerably affected by atmospheric conditions—lengthening or shortening according to the humidity of the air. Instances are known where

shafting has been pulled down and babbitt melted out in damp weather.

Belting is ruined by pulleys and shafting being out of alignment. Under such conditions belts are kept on the pulleys by guides or run against hangers or parts of the machine, and a lap is soon opened, catching in something, and the belt is torn or stretched unevenly and will not run straight, gives trouble by coming off and is eventually ruined.

An oil-saturated belt can be cemented successfully by thoroughly washing and soaking the lap in gasoline, then allowing it to dry well before making the joint.

When belting appears dry, it should be cleaned thoroughly of all dirt or gum sticking to it, by rubbing it with a cloth dampened with kerosene. In bad cases use a wooden or metal scraper to give a clean surface, then apply some good belt dressing. This should be allowed to soak in before more is applied, repeating at intervals to keep it in good condition.

A good formula for belt cement is as follows: For a common-sized pot of belt cement use three-fourths good grade of common glue to one-fourth gelatin soaked in water about five hours. Then mix in two tablespoonfuls of tannic acid, one tablespoonful of boracic acid and one teaspoonful of oxide of zinc before putting on to cook. As soon as it is all melted and is about the consistency of the white of an egg, it is ready to use. This cement will not deteriorate with age.

The length of the lap for a good joint should be about 2 in. greater than the width of the belt.

The following outfit of tools is needed for belt splicing: Clamps and rods, belt scraper, slicker, belt shave, small plane, turning steel for turning the edge on the scrapers, awl, ripping hammer, pegging hammer, glue pot and kettle, one 3½-in. first-quality brush, one square and one good knife. One each of these tools is required, except there should be two or three scrapers, and for a variety of belts, several sets of clamps will be needed.

To find the length of belt required for a given drive when the pulley diameters and distance between centers are known and the pulleys are the same or nearly the same diameter, add ½ the circumference of each pulley to twice the distance between shaft centers, the result the belt length less that required to make the splice.

When one pulley is considerably larger than the other, square the distance between the centers of the shafts, add to this the square of the difference between the radii of the two pulleys, from this total extract the square root and multiply by 2, thus acquiring total *A*. Add the diameters of the two pulleys together and multiply this sum by 3.1416. Add to one-half of this product the total *A* and you will have the required length less the amount required for lap.

The rules are very good when getting the belt lengths on a job that is not yet set up is necessary; but where the pulleys are up, a steel tape or if necessary two such tapes wired together is entirely satisfactory.—From *Power*.

An important factor that has already been hinted at in the estimate of the exports made during the last year has been brought to notice again by the official figures: The superiority of New York as a port of shipment for machine tools. Of the \$28,162,968 worth of machine tools exported, \$24,522,844 worth went through the Port of New York.



FIG. 5. COMRADES

Charles W. H. Kirchhoff

Charles William Henry Kirchhoff was one of the best known trade-paper editors in this country, and even though he retired from the active duties of editor-in-chief in 1910, his name will be thought of in connection with the *Iron Age* for years to come. His death which occurred July 22 at his home near Asbury Park, N. J., will be sincerely regretted by his many friends in the engineering and journalistic fields.

Born in San Francisco in 1852, his education was obtained both in this country and in Germany, graduating from the Royal School of Mines in Clausthal, Germany, in 1874. He then became chemist of the Delaware Lead Refinery in Philadelphia. During the Centennial he acted as correspondent for English, German and Cape-town papers, his first editorial work being on the *Metal-lurgical Review*. He went to the *Iron Age* in 1878, but left in 1881 to become managing editor of the *Engineering and Mining Journal*. He returned to the *Iron Age* in 1884 and later became its editor-in-chief. His work in this capacity is too well known to require comment.

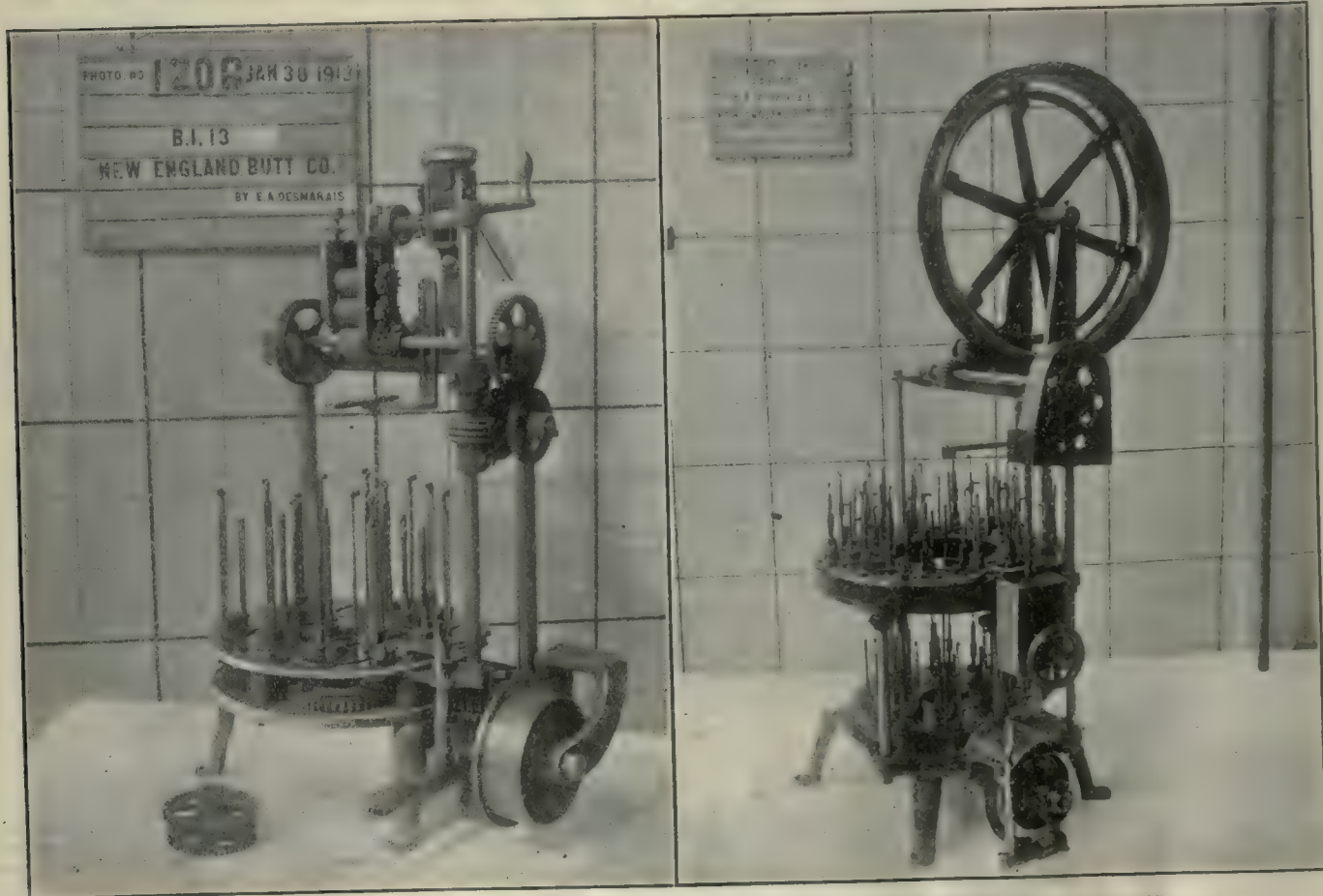
In addition to this Mr. Kirchhoff served as special agent of the United States Geological Survey for the collection of productive statistics of lead, copper and zinc during the period of 1883 to 1906, and in other special capacities. He was a member of the American Society of Mechanical Engineers, the American Iron and Steel Institute, the Iron and Steel Institute of Great Britain, the Franklin Institute and the Verein Deutscher Eisenhüttenleute, as well as of the Engineers Club and the Century Club of New York. He is survived by his widow, two sisters and one brother.

Cross-Section Screens To Show Size of Machines

In taking photographs various methods are used to give an approximate or exact idea of the size of the parts shown. A familiar device is to place a rule or scale alongside the pieces and include it in the photograph. It is not so common to attempt to show the size of finished machines, but a method of indicating general dimensions is followed at the plant of the New England Butt Co., Providence, R. I. This method is illustrated in Figs. 1 and 2.

Behind each machine is set up a cross-sectioned screen on which the larger squares are 12 in. in size and the smaller ones 4 in. on each side. The screen is set up behind the machine to be photographed and as close to it as possible. The resulting effect is seen in the illustrations. Fig. 1 shows a comparatively small machine—a braider, which is nearly 3 ft. high. The other view also shows a braider, but a larger machine, for it stands 5 ft. 3 in. high from its feet to the top of the pulley.

As a matter of interest, these screens were originally made for Frank B. Gilbreth and were used principally to show the length of motions in his motion-study analyses. The same idea may possibly be applied to advantage to photographs of machines for catalog and advertising purposes, particularly in those cases where it is necessary to convey an idea of the size of the machine or part and difficult to do so by ordinary means. While this will not of course convey the exact measurements of the object it will give a very good idea of proportions and approximate size.



FIGS. 1 AND 2. USE OF CROSS-SECTIONAL SCREENS TO SHOW SIZES OF MACHINES

Production, Properties and Use of Thermalene

SYNOPSIS—Both the nature and range of usefulness of this new gas are of unusual interest. It may be used for welding, heating, lighting and other purposes. Its low inflammability and small range of explosibility render it so safe that the risk in using it is almost negligible. The method of generation is novel. Details of the welding torch and some of the work are shown.

In composition and method of production, thermalene differs from any gas heretofore used for welding purposes. It is a combination produced by the decomposition

ing mixture is carried in a tin can or cartridge that is inserted from the bottom into the cartridge chamber, as shown at *C*. Previous to inserting the cartridge, however, care is taken to pull up the cam lever *D*, which closes the water valve *E* and prevents any water entering the cartridge chamber. After the cartridge has been inserted through the door in the bottom of the chamber, the door is closed and the bar *F* brought up and locked by means of the handwheel *G*. To generate gas the cam lever on top is pulled down as far as it will go. This admits water from the water chamber *H* into the cartridge chamber through the center tube to the bottom of the cartridge, from where it begins to work upward. The

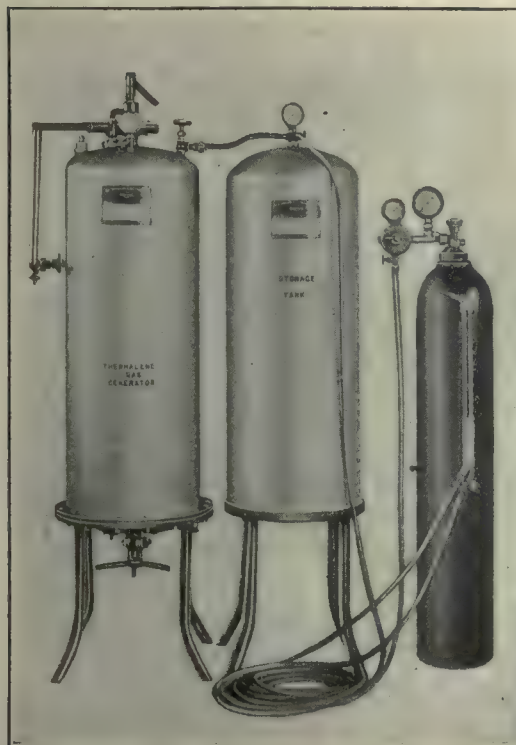


FIG. 1. THERMALENE WELDING OUTFIT

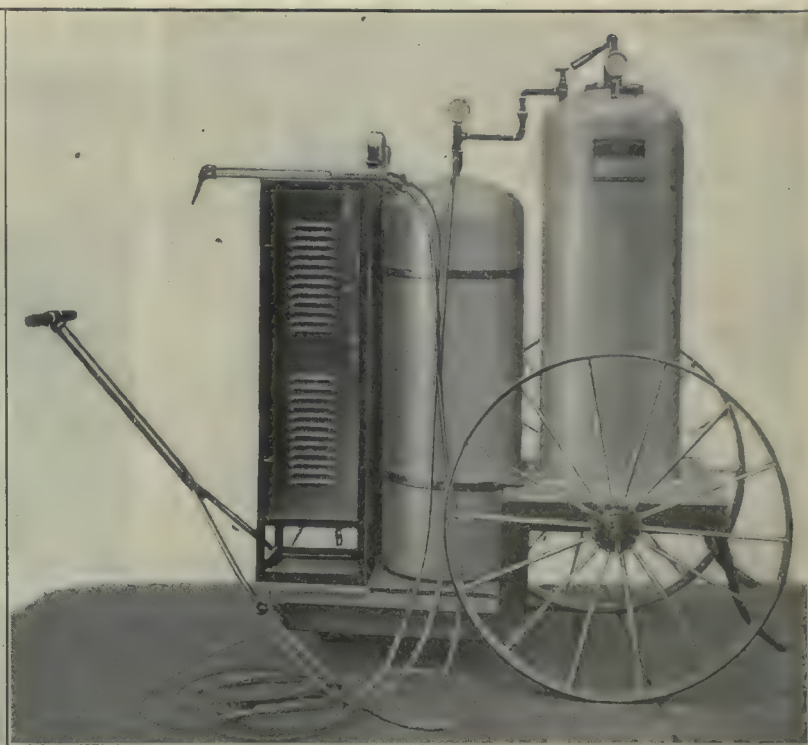


FIG. 2. PORTABLE WELDING APPARATUS

of calcium carbide and hydrocarbon oils, the heat generated by the carbide being used to vaporize the oil. It is the discovery of Karl Frederick Linus Wolf, of Zurich, Switzerland, and is handled in this country by the Thermalene Co., Chicago Heights, Ill.

At present thermalene is principally used for welding or cutting metals, in which it is used together with the proper mixture of oxygen. The nature of the gas will be better understood by first giving a description of the method of producing it. In Fig. 1 is shown a welding or cutting outfit as used in a shop. At the left is a thermalene generator, in the middle a storage tank, and at the right an oxygen tank with a torch hanging on it. Fig. 2 is a similar but more easily portable outfit used by a city water department.

A phantom view of a generator is shown in Fig. 3. To prepare this generator for operation, water is poured in through funnel *A* until it will run out of pet-cock *B*, which fills the casing about two-thirds full. The generat-

cartridge is packed with alternate layers of calcium carbide and crude oil mixed with sawdust. The water as it rises slacks the carbide and generates acetylene gas. The heat caused by the slacking of the carbide layer vaporizes the oil in the layer of mixed oil and sawdust immediately above the layer of slacking carbide and generates oil gas. When the gas pressure as indicated by the gage is up to 5 lb., the valve *J* is opened, which lets the gas enter the hose leading to the storage tank or torch. The pet-cock at *K* is used to drain off the impurities, such as phosphor-hydrogen, ammonia and water, which have been separated from the carbide gas in the process of generation. At *L* is a check valve, which allows gas to escape from the cartridge chamber, but effectually prevents any return of either gas or water. As soon as a cartridge is exhausted it is easily removed, carrying all of the dirt and sludge with it.

With the use of a storage tank, enough gas is carried to run a torch while a new cartridge is being put in place

in the generator, if needed. The maximum pressure required for welding or cutting is 15 lb. When this pressure is reached, a regulating diaphragm automatically cuts off the water feed and stops the generation of gas. This diaphragm is placed at the top of the generator, on the inside, where the gas pressure acts directly on it. The diaphragm is connected to the feed-valve rod in the center, so that as the diaphragm is forced upward by the gas pressure, the water valve is partly or wholly closed. It is so arranged as to be easily set for various desired pressures.

As previously stated, the cartridges are made up of alternate layers of calcium carbide and oil-soaked sawdust. Now it is well known that the volume of lime into which calcium carbide is converted by the slacking process is greater than the volume of the carbide. Therefore, when carbide is packed tightly in cartridges, as desirable, the expansion is liable to burst the case, and in some instances might cause the cartridge to jam in the chamber, as well as interfere with the successful working. One of the objects then is to so make the cartridge as to allow for the expansion of the contents. Another is to prevent the oil from coming in contact with the carbide, as this would interfere with the action and decrease the gas output. To summarize, the cartridge components must be so arranged as to promote free action of the carbide; free action of the heat evolved from the carbide on the volatile substance; to prevent action of moisture on the carbide layers not being acted upon purposely; and to promote the free discharge of the generated and volatilized gases.

All of these points, as well as a number of others, have been considered in the makeup of the cartridges, as shown in detail in Fig. 4. As made at present for commercial purposes, there are four sizes corresponding to the different outfits. The cartridges consist of a tin can of suitable size, the smallest being $4\frac{3}{8}$ in. in diameter and 8 in. high, weighing 6 lb. and having a gas-producing capacity of 25 cu.ft., sufficient to supply a welding torch from four to five hours. The largest size is $9\frac{3}{4}$ in. in diameter and 16 in. high, weighing 40 lb. This has a gas production of 200 cu.ft., or eight times the capacity of the smallest size previously mentioned.

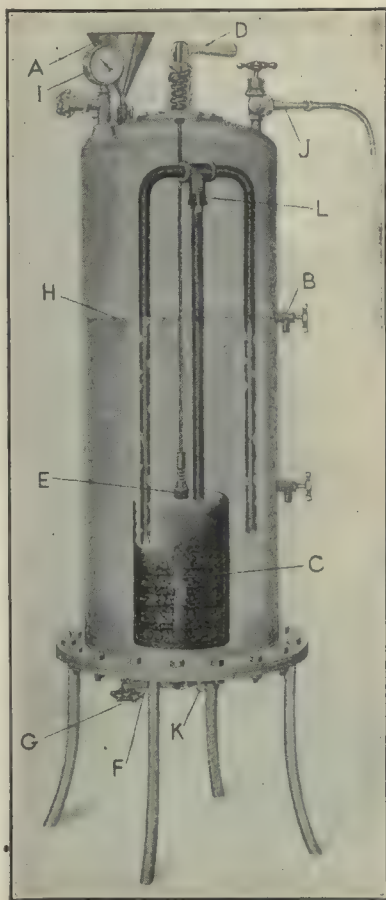


FIG. 3. PHANTOM VIEW OF GENERATOR

Referring now to the illustration, a cylindrical screen *A* is first placed in the can to be filled and then a layer of carbide is placed in the bottom of the can around the screen tube. An unglazed cardboard disk *B* is next placed on top of the carbide. A spacer *C*, made of thin metal bent so as to lie edgewise, is placed on top of the cardboard and then a disk of screen is put over it. Sawdust impregnated with crude oil in a cloth "sack" made of two cloth disks sewed together is laid on the screen. On this is another screen, then a spacer and a cardboard disk, and so on to the top, ending with a sack of oil-soaked sawdust covered with a piece of screen that has no hole in the center for the cylindrical tube. The end of the can is closed with a cover for handling, which is removed before placing in a generator.

As previously mentioned, the water feeding in through the valve in the cartridge chamber drips down through the cylindrical screen tube and starts slacking of the lower layer of carbide, the heat of which vaporizes the oil in the sack above it. The cardboard disks, while strong

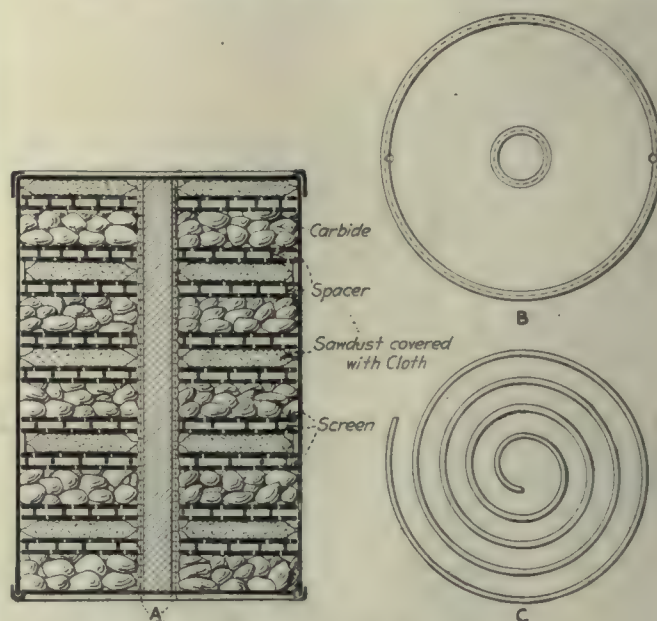


FIG. 4. DETAILS OF CARTRIDGE

enough to hold the layers firmly in place while dry, begin to soak up as soon as the feeding starts, and consequently become soft, so as to give way under the pressure of the expanding carbide, allowing it to be forced into the spacing between the carbide and the oily sawdust. This space is so calculated as to keep the various layers firmly in place until the cartridge is exhausted. Another thing is that as any liberated steam or water vapor must pass through the absorbent cardboard as well as the oil, before it reaches the next layer of carbide, action of the steam on the carbide above is prevented. This insures that the respective layers of carbide will not be acted upon until the water becomes level with them in turn. In consequence, a cartridge can remain in a generator a long time without becoming spent. The screen disks on top and bottom of each layer of oily sawdust furnish efficient volatilization and egress of the gas.

By the method of producing thermalene, the heat evolved by the generation of acetylene is absorbed, at the place of generation, in the production of the oil gas. This utilization of heat serves to keep the temperature down, since the heat generated is used and dissipated by

the latent heat of the oil, so that radiation and absorption by water is not necessarily depended upon. The gas combination that results passes out through the T-pipe ends and bubbles up through the water into the upper part of the generator. The low temperature causes the impurities to drain back into the chamber, from which they are easily removed. The layers of carbide and oily sawdust are so proportioned as to cause only the vaporization of the lighter oils, such as benzine, naphthalene, kerosene and the like. The temperature is not high enough to vaporize the tar oils, as these are heavy and give a deposit of lampblack. These heavy oils are therefore not utilized, but remain in the cartridge. The temperature in the cartridge is maintained between 200 and 300 deg. C. (390 to 570 deg. F.), depending upon the rapidity with which the gas is being used and the amount which is generated and delivered. It is not intended that an actual boiling take place at any time, for if the temperature is too high there will be a vaporization of the heavy oils, causing deposits in the pipes

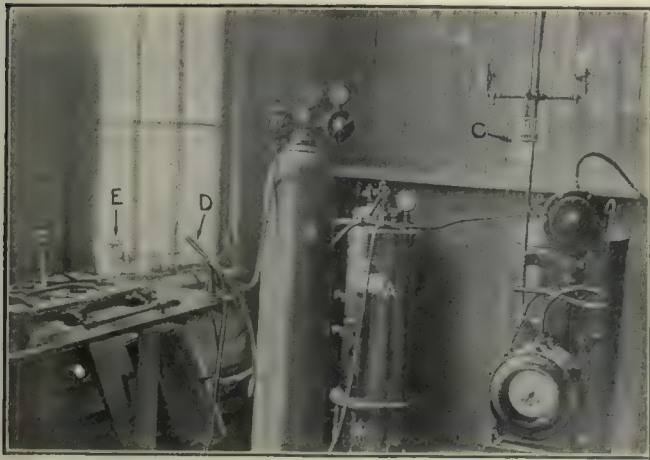


FIG. 5. PART OF TESTING LABORATORY

and also an increase in the impurities. The gases passing through the pipes cooled by the water of the generator are kept between 60 and 70 deg. F. In the passage through the cooled pipes the impurities are removed in the following manner: Acetylene has a comparatively high specific heat, so that its rate of cooling when passing through the pipes is low. The specific heat of oil gas is, however, only one-eighth of that of acetylene, so that its cooling effect will be eight times as great. Now if the two gases are passed together along a cooling surface, the temperature of low specific heat will decrease rapidly and cause a rapid lowering of the temperature of the other gas. This causes a deposit of the vapors suspended therein. So this action results in the deposit of the sulphur, phosphorus and silicon compounds, and of the ammonia. In order, however, to bring about this precipitation the temperature must be sufficiently low—that is, as stated above, between 60 and 70 deg. F. If the gas finally issuing from the pipes and water was too hot, the impurities would not be thrown out.

In this process the acetylene and oil gas, generated and cooled, will combine in the pipes after the impurities are removed. It is important, however, that the impurities be removed and the product sufficiently cooled, since no real combination will take place at too high a temperature. For instance, if the water is above 180 deg. F. the oil burns and no proper combination results.

The combined gas produced, named thermalene, possesses marked characteristics that distinguish it from oil gas; from acetylene; and from the usual mixture of the two. The density is higher than air, being 1.1 taking air as unity. The issuing gas can be seen to sink when thrown through a sunbeam. The specific heat is low, being a little over one-eighth of that of acetylene. Thermalene liquefies at between 1,400 and 1,500 lb. pressure per square inch at room temperature, and in its liquid state is nonexplosive and stable. A very noticeable thing is the odor, which is not at all like the odor of either acetylene or of oil gas, but is a soft, sweet smell, not strong or offensive in any way. The color is white, but with a predominating proportion of the red and yellow parts of the spectrum. The maximum flame temperature has been found to be about 6,500 deg. The high density of the gas has a number of advantages. It has more body than acetylene and does not need so much oxygen. Moreover, it mixes better with oxygen. It does not explode as readily as acetylene, so can be mixed with greater proportions of air. In a Bunsen burner it is possible to mix as much as 32 per cent. of air without causing a flare-back. It can readily be turned down without causing a flareback, and it can be used with a Welsbach mantle to advantage. The upper and lower explosive limits are 12 per cent. and 30 per cent. Less gas is required for a given flame than with acetylene for the reason that this gas is denser and richer, resulting in higher efficiency.

SOME ADVANTAGES OF THERMALENE

When used for welding and cutting, thermalene has numerous good points. It does not require an excess of oxygen, and for this reason does not absorb carbon from the iron. The flames, therefore, produce a soft weld, especially in cast iron. When welding it is noticeable that less sparks are thrown off than when using acetylene. It can be used at a lower pressure also, owing to its higher specific gravity and greater calorific value. Owing to the removal of the various impurities, there are no corrosive effects on fittings, nor poisonous effects. It is also for this reason that there is little or no danger of explosion. Neither does the spent cartridge give off explosive gases, for the reason that the gases liable to cause explosion are separated and drained off from the generator chamber. Corrosion of interior walls, due to water action, is prevented by the oil vapor which is always present and forms a protecting and sealing effect throughout. Safety lies in the feature that the pressure in thermalene apparatus never exceeds the atmospheric pressure of 15 lb.

A corner of Mr. Wolf's testing laboratory is shown in Fig. 5. Here A is a small size generator and B is an oxygen tank. On the extreme right is a house-lighting outfit supplying several kinds of burners. At C is a regular inverted light, 60 c.p., estimated to cost 0.7c. to operate. At D is a blow torch and at E a calcium light. This is made practically the same as other lights of this character, a heating flame being thrown onto a piece of calcium which is heated to incandescence. A gas plate with two burners is shown at F. This last gives as good a demonstration of thermalene as any of the other apparatus. The burners are the usual perforated ones, and after the gas is turned on a single point of long yellow flame can be made to shoot out of one of the holes. There is no flashing around the burner of all the outlets.

The torches used were also designed by Mr. Wolf, and under all sorts of tests showed no tendency to flash back. One of the torches is shown in Fig. 6. This is the cutting and welding type. Another torch designed for cutting circular pieces is shown in Fig. 7. An adjustable

there will be only burnt gas in the restricted channel and around the oxygen tip. Now since only pure oxygen is discharged from the nozzle of *C*, this oxygen will cool and blow out the flame. The result is that the flame will die out in the restricted channel between the gas and

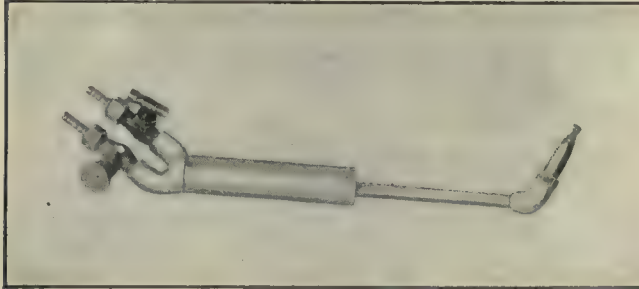


FIG. 6. WELDING AND CUTTING TORCH

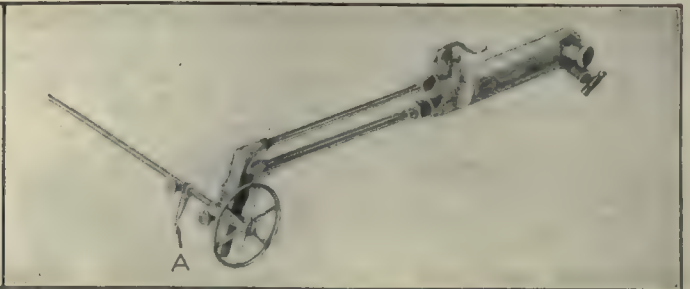


FIG. 7. TORCH FITTED FOR CUTTING CIRCLES

center *A* is placed in a punch mark, and then the torch is slowly wheeled around the circle, cutting the metal as it goes.

The construction of these torches is shown in detail in Fig. 8. Here the oxygen enters at *A* and the thermalene at *B*. The oxygen nozzle is at *C*. Screens are placed at *D*. One of the great troubles with torches is the fact that frequently a flashback will occur, reaching the oxygen nozzle in the gas chamber. Here a cutting flame would be formed which would burn out the entire copper tip. In the type of torch shown this does not occur. By referring to the illustration it will be seen that the gas chamber is comparatively large, while the orifice leading from the gas chamber to the mixing chamber is restricted and elongated. This orifice is enlarged abruptly to the mixing chamber in the nozzle, so as to form sharp corners at *E*. The mixing chamber gradually con-

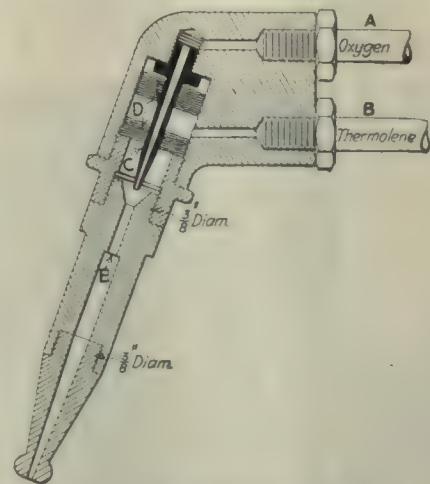


FIG. 8. DETAILS OF TORCH

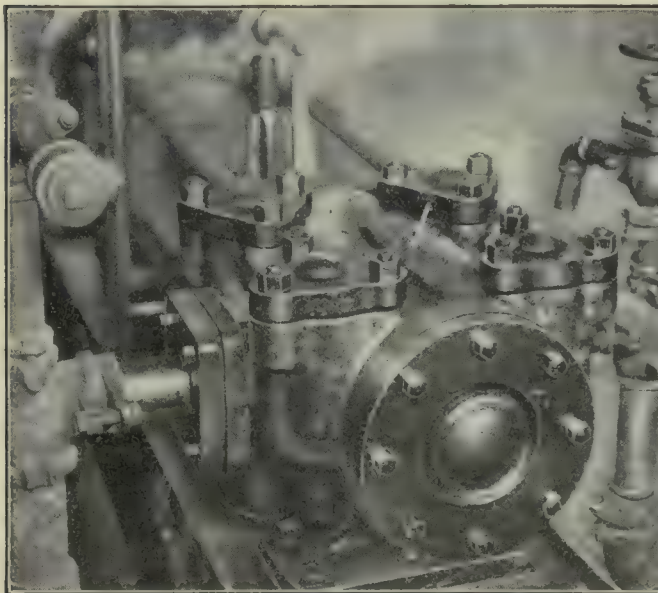


FIG. 9. CRANK WELDED IN AMMONIA COMPRESSOR



FIG. 10. NINE DEFECTIVE RIBS FILLED UP

tracts to the outer opening in the nozzle. As a result, if a flashback should occur, it will cause a whorl or eddy at the shoulder *E*, which in itself will prevent the flame from running back through the restricted channel. Moreover, such propagation of the flame into the mixing chamber will cause the gas in the chamber to be pressed back by the increased expansion and pressure, so that

mixing chambers, so that a cutting flame is never formed at the oxygen nozzle. It is necessary, however, that these parts should be properly proportioned to obtain the desired results.

For various cutting and welding purposes twelve sizes of tips are made to be screwed into the torch bodies. These tips run from 2 to 4 in. in length, and the outlets

vary from the size of a No. 80 to No. 33 drill. All have $\frac{9}{16}$ -in. wrench-holds on them for screwing into the torch bodies.

The table will furnish a good idea of the amount of thermalene and oxygen used per hour for different thicknesses of metal, the torch being fitted with the proper nozzle in each case.

TABLE OF QUANTITIES OF THERMALENE AND OXYGEN USED IN WELDING OPERATIONS PER HOUR

Tip No.	Thick- ness of Metal in Inches	Consump- tion of Thermalene, Ft.	Consumption of Oxygen with Thermo- lene, Ft.	Oxygen Pressure, with Thermo- lene, Lb.
1.....	$\frac{1}{8}$ to $\frac{1}{4}$	2.15	2.55	1.0
2.....	$\frac{1}{8}$ to $\frac{1}{4}$	3.32	3.99	$2\frac{1}{2}$ to 3
3.....	$\frac{1}{8}$ to $\frac{1}{4}$	5.51	6.52	3 to $3\frac{1}{2}$
4.....	$\frac{1}{8}$ to $\frac{1}{4}$	8.29	10.11	$3\frac{1}{2}$ to 4
5.....	$\frac{1}{8}$ to $\frac{1}{4}$	11.78	14.21	5 to $5\frac{1}{2}$
6.....	$\frac{1}{8}$ to $\frac{1}{4}$	16.48	20.10	$6\frac{1}{2}$ to 7
7.....	$\frac{1}{8}$ to $\frac{1}{4}$	21.40	27.51	10 to 11
8.....	$\frac{1}{8}$ to $\frac{1}{4}$	25.00	35.01	11 to 12
9.....	$\frac{1}{8}$ to $\frac{1}{4}$	33.60	54.21	15
10.....	$\frac{1}{8}$ to $\frac{1}{4}$	48.05	75.30	20 to 22
11.....	$\frac{1}{8}$ to $\frac{1}{4}$	70.35	101.62	25 to 28
12.....	$\frac{1}{8}$ to $\frac{1}{4}$	91.10	159.20	25 to 30

Two examples of large work done with thermalene are shown in Figs. 9 and 10. In these pieces, the fact that strong, soft welds could be produced was of especial advantage.



Manufacturing Efficiency*

By W. ROCKWOOD CONOVER†

In selecting the head foremen of departments it is obvious that broad-gage men, in the fullest sense of the word, are required to fill these positions. The successful foreman must not only have had a broad training in shop mechanics, but he must be well trained as an executive. He needs to bring to his position an extensive experience, a knowledge of human nature and a large degree of competency in supervising and handling productive labor. It is sometimes advisable to train men from the ranks of workmen to fill the position of assistant foremen; but these men do not, as a rule, measure up to the requirements of the position of head foreman, and the manufacturer is often compelled to select the latter from those who have received a good experience and training in this capacity in other shops.

It is necessary, if we are to secure the highest degree of efficiency in shop processes, that the foreman and his assistants exhibit at all times a spirit of loyal coöperation with the management and all in executive authority under them. There must be a complete understanding of instructions and sympathy with the plan and scope of manufacturing, to secure the best productive results. The foreman should not be satisfied with giving a portion of his energies in return for the salary paid him; he should seek to make himself more valuable to his employer as time goes on and to accomplish more than the terms of his contract call for. Assuming that his salary is reasonably liberal and just, is sufficient to provide proper comforts in life and to afford satisfaction and inspiration in the pursuance of his duties, it should not be necessary to pay him an additional premium or profit at stated intervals in order that he assume the full responsibility of his position and give his utmost endeavor in loyally striving to advance the interest of the company by which he is employed. He should in like manner exact the same degree of loyal coöperation from his assistant

foremen and all others under him having to do with the productive and expense labor forces of the shop.

It is evident that neither the manager of a plant nor the division superintendent can know and follow all the manufacturing details of each individual department. It is here that the function of the foreman and his assistants is clearly indicated. Their duty is not only to secure a high standard of quality in the product of their department, but also to secure the largest production possible at a reasonably low factory cost. If, on the other hand, the foreman is to act only in the capacity of a business executive, to adopt and put into practice the systems of books, he has lost in a great measure his original identity as a person of mechanical skill and inventive genius whose natural function was to devise tools and special methods for obtaining the best product possible from every machine tool and from every employee, within the limits of reason and judgment.

NEED OF EFFICIENT METHODS AND PROCESSES

When we seriously consider the fact that every machine tool and every foot of floor and bench space represent valuable and costly investment, it naturally follows that one of the first and chief duties of the foreman is to see that every efficient method or process is put into practice which will earn the greatest return on each dollar invested. As an illustration, it should not be necessary to hire efficiency specialists to point out to the foreman of average intelligence that he can grind many surfaces of castings sufficiently accurately and well to pass inspection at one-third to one-fourth the cost of facing them on the lathe. Nor should we expect to find a workman finishing on the planer or shaper surfaces that could be done more rapidly in the lathe or on the grinder. But the numerous instances of this nature in almost every factory point to the fact that there is something needing adjustment in the routine management of the shop department. There is a more or less wide range of adaptability of various classes of machines to the various classes of mechanical work, and this is clearly one of the phases of departmental supervision in which the judgment and experience of the foreman and his assistants should be plainly visible at all times.

It is manifestly good shop practice that a piece of work should not be placed on a given machine (except in cases of emergency) until the question of economic adaptability is considered. In a large percentage of factories throughout the country the expensive practice still prevails wherein the castings follow the time-worn route and custom. When brought onto the shop floor from the foundry, the labor gang delivers the castings to the lathe or planer or shaper, as the case may be, as it has previously been accustomed to do. The job card is issued by a clerk, with the usual routine operation or operations, and the machine hand performs the work as he has repeatedly done for months and possibly years before.

GIVING WORKMAN A JOB FOR WHICH HE IS ADAPTED

The adaptability of the workman to his work may be said to be of almost as vital importance as the adaptability of a machine tool to an individual or special operation. This is at least relatively true. A workman who has proved only a partial success, or even a failure, on one line of work will in frequent instances, if trans-

*Prepared for the author's forthcoming book on "Industrial Economics." Copyright, 1916, Hill Publishing Co.

†Factory economist, General Electric Co.

ferred to another, not only prove efficient in his new duties, but discover in himself some degree of inventive genius; and if given opportunity, he will go on developing this quality to the advantage of both his employer and himself. Manufacturers in general are not giving this subject the full consideration that it merits. In studiously following out our present-day theories of scientific methods of manufacturing we are bringing about a condition that may prove most unhealthful in its reaction. So long as the workman produces a reasonable daily output and his product is passed by the inspector, we have little concern, as a rule, about his personal identity. We are thus losing a valuable asset in the thinking powers and inventive genius of the individual employee. We are supplying him with everything needed in his work—even to brains. We are making of him a specialized machine, a tool for the performing of a definite mechanical process, as specifically so as any other tool in the shop equipment. In doing this we are losing the coöperation of his inventive faculties and paying the price of our unscientific wisdom out of the other hand.

In manufacturing, as in other lines of commercial undertaking, we are compelled to look to the individual workman for a large measure of efficiency in productive processes. He is a potent factor in all successful business operations. Upon his skill and energy depend the economic labor basis of factory costs and, in no small degree, the measure of profit to be derived from the factory's product. Into all our computations, either of product manufactured or of estimated cost on new business, into the plans for additional buildings, extension of floor areas or purchase of tool equipment he enters as an important governing factor through the modicum of his personal labor.

VALUE OF CONFIDENCE AND COÖPERATION

If we are to secure the highest degree of efficiency of the working force of the factory, we must first gain the confidence and coöperation of the individual. The progressive manager is already beginning to perceive and recognize the truth of this statement and is working toward this end. The workman must be made to feel and understand that he is a living, human factor in the success of the business. He must be led away from the idea that the company's interest in him is the same in nature and degree as in the machine that he operates. As soon as he learns that he is respected as an individual, human personality by his employer, he will not only begin to respect himself and his task in life, but also the company by whom he is employed.

Protection from injury, proper sanitary conditions, health and contentment in employment, the satisfaction and comfort derived from a liberal scale of wage are all elements affecting the producing power of the individual employee, which are more and more coming to be looked upon by the thinking manufacturer, not as undemonstrable theories, but as potent factors in the securing of better efficiency among his working forces. Not alone this. These matters have a direct economic bearing on the year's expense incurred by accident and sickness and on the maintenance of the factory's tool equipment. It is evident that in conjunction with these helps the intelligent coöperation of the workman can be better secured by providing him with the modern types of tools having the various features of improved control, change of feed,

speed and adjustment than by setting up before him an array of special, formulated studies intended to demonstrate that he can increase his output with the antiquated equipment with which he is already provided.

Coëxistent with a low degree of efficiency will be found unscientific and uneconomical practices in the shop. Do these conditions prevail in so many factories throughout the country because the manager does not read a sufficient number of books on scientific management or does not study sufficiently the theories of shop efficiency? Is it because he does not employ a specialist to point out to the department foreman and his assistants improvements in processes and methods, which he rightly expects to be devised and put into practice by men whose position presupposes not only executive ability, but also the capacity for careful insight and intelligent investigation?

TENDENCY OF FOREMANSHIP TOWARD EXECUTIVE WORK

There are evident indications of a growing tendency for the position of foreman in the modern factory to resolve itself into one chiefly of an executive nature. It is obvious that the head of the shop department must carefully look over the orders and engineering notices, production schedules and instructions that he receives; he must know something about the work being turned through on work cards, as well as keep in touch with the amount of rejected work reported through the inspection office, if he would be posted on what is going on in his department. It is also plainly the duty of both himself and his assistants to see that the employees under their charge are punctual in attendance; that the men are reasonably clean in person as well as about their benches and machines; that they keep their tools in an orderly manner and report any damage or breakage immediately to their superior; that they are diligent and faithful in their work and also that they are given opportunity to advance and improve along the specific lines in which their adaptability or genius appears most clearly indicated. All these things are admittedly essential to successful departmental management, but in consistently following out these requirements of good foremanship the other elements of successful supervision should not be lost sight of or left entirely to the care of the specialist.

■

Treatment of Chrome-Nickel Steel Automobile Gears

Automobile gears, which are pushed to the limit of strength, require particular heat-treatment. These are made of chrome-nickel steel containing not more than 25 points of carbon. They are carbonized and allowed to cool, then reheated to 1,600 deg. F. and quenched in oil, which refines the core, reheated again to 1,400 deg. F. and quenched in oil to harden and refine the case. Sometimes the hardness is let down in an oil bath after this by heating in the bath to from 300 to 400 deg. F., to toughen the case. The wood-charcoal-barium-carbonate mixture is the best to use for nickel and chrome-nickel steel carbonizing. A mixture of 60 parts of wood charcoal and 40 parts of barium carbonate is the best for this purpose. The material should be pulverized into grains the size of a pea.

Gumption in the Small Shop

BY JOHN H. VAN DEVENTER

SYNOPSIS—A Dave Hope story, in which the attempt is made to isolate the germ of success.

Dave was quite busy when I called at his shop last week. He has been making an addition to his equipment in the shape of two plain millers and a universal grinder. As a result he has had to do considerable scheming to get the new machines into the shop without discarding an equal number of old ones, the shop being what one would call well filled before the arrival of these acquisitions. Finally he had succeeded, moving and shifting most of the old machine tools; gaining an inch here and a foot there by so doing.

"Funny thing about a shop," exclaimed Dave, as he proudly surveyed the result of his planning, or rather juggling. "There's always room for just one more machine in it. Sometimes you'd swear there wasn't, but after you get to scheming and shifting, it slips in as easy as a kid into a movie show."

"If that is so, Dave, why is it that shops sometimes move to larger quarters?" I inquired.

WHY SOME MACHINE SHOPS MOVE

"The shops that move are not the ones that buy a single machine tool at a time," explained Dave. "If you have a crowded shop, you'll scheme considerable to get one more machine into it; but if there's three or four of them at once, it strikes you as easier to move than to work out such a Chinese puzzle." At this juncture, Dave walked over to the millwright who was preparing the overhead works, and gave him a few directions.

"Let's go into the office and have a smoke," he suggested on returning. "I've been looking at those blamed machines until I'm crosseyed and dizzy."

After the cigars were well lighted, and Dave had assumed his customary pose of comfort, with his feet higher than his head, I broached the object of my visit. "I want your ideas on what it is that makes a man successful, Dave," said I, "and perhaps if they are original and illuminating, we will print them in the *American Machinist*." At which Dave properly looked pleased and impressed. I have a notion that he likes to see his views in print.

"I've given considerable thought to that subject," said Dave reflectively, "as no doubt has every man who comes in contact with men and tries to size up their strong and weak points. But first, let's make it clear what you mean by success—not just making money, I'm sure."

SUCCESS NOT THE SAME THING AS SOME THINK

"No, indeed, Dave, there are a lot of most miserable failures who have succeeded in filling their pockets with money, just as a successful hog noses the others away from the trough and stuffs himself with garbage. But that's not the kind of success I mean. It's the ability to do something worth while, either on a small or a large scale; to become a first-class toolmaker or a crack-a-jack lathe hand or a real captain of industry. In all of these cases it's the same germ, the only difference being that it bites some people harder than others."

"I get you," said Dave. "There's an old-fashioned word that fits that germ to a dot, according to my way of thinking. It's *gumption*. If a man hasn't got it he needn't worry about dying; he's a dead one already. But a man that has *gumption* is only dead once, and then his *gumption* is likely to live quite a while after him. In my experience, one man with it to nine men without is a fair average in the ordinary shop, although I've been in some where there apparently wasn't any of that commodity in stock, even in the office. When a man has *gumption* you can't keep him down. He isn't the kind that waits for opportunity to knock on his door—no, indeed—he gets up before daylight, jumps on his mustang, and scouts around until he crosses opportunity's trail (and it's surprising how easy it is to run across it when you go out to look for it). First thing you know he has a rope around her neck, and by nine a.m. he has her back in the office and fairly tamed. It's a cinch that opportunity isn't going to get a chance to knock on many doors in that neighborhood as long as this live wire lives in the district!"

"Think *gumption* can be acquired, Dave?" I asked.

"Not all of a sudden," he replied emphatically. "I once worked alongside of a fellow who thought he'd like to cultivate some of it in order to raise his pay. He saw an advertisement in one of the monthly magazines about a book or a course or something of that kind to improve will power and concentration. So he fell for the price of the course and studied it nights and Sundays. After a month or two he told me he had passed the official examination and had received a diploma, and that he intended to use his powers on the boss that morning and get a raise. He said that I could watch the proceedings and see how easy it is to accomplish difficult things when you know how."

WORKING THE CONCENTRATION SCHEME

"Every time the boss came in sight that morning, this big dub kept his eyes glued on him and made the most horrible faces. I could see it was beginning to have an effect after an hour or two, but not the kind that Jack, my shopmate, had anticipated. After a while he came over to me. 'I have him going,' he whispered, 'next time he comes past I'll finish the job!'"

"Pretty soon along came the boss, not looking any too pleasant, and as soon as he reached Jack's machine, Jack threw off the power, stepped out into the aisle and fixed him with a horrible glare. I was in a good position to see the expression on his face and he sure did look like a crosseyed gorilla with the toothache, bent on murder. I wasn't a bit surprised when the boss swung and landed right and left with both fists square in the middle of that map of misery! That's as near as Jack came to getting a supply of *gumption* by mail, and it's about as close as any one else ever will, either."

"I ran across a good illustration of *gumption* last week in Cleveland," continued Dave, "but it was the home-grown, not the transplanted or imported variety. This was in Old Bill Rice's shop. I happened to drop in to see him on a matter of business just at the time the old man was giving his son an object lesson in follow-

ing father's footsteps. They had just come through an eight weeks' strike, one of the concessions made to the men being an hour a day off the working time with no reduction in wages. Old Bill was catechising his son with the idea of drawing out his views. 'Well, son,' said he, 'you've been to colledge and learned to figger and do proportion an' sech things, and now here's a chance to put your stock of knowledge to use in a practical way. Here we've been gettin' out twelve engines a week with forty men workin' ten hours a day. Now the hours are reduced to nine a day. Can ye figger out what the output had ort to be?'

"The young fellow bit at it like a pickerel does at a frog. 'That's easy dad,' says he, 'the answer is 10.8.'

"And how do you arrive at that result?" asks the old man.

"By simple proportion, dad," answers the boy.

"You're dead wrong," says old Bill, 'the answer is thirteen a week by simple gumption, and if you don't believe it you watch me work out that answer on that pack of rapsallions out in the shop!'

"Which," remarked Dave, "shows that gumption can not be transferred as part of an educational process, since it often successfully overturns the best established laws of science and mathematics!"

HERE'S WHERE WEBSTER IS WRONG FOR ONCE

"Another strange thing about it," continued Dave, "is that a man does not have to be what you'd call smart in order to have gumption. Webster says it's one and the same thing, but I'm ready to go to the mat at any time with him on this question. One of the most successful fellows I ever knew was Sam Pettingill, of the Harvester works. He didn't know a cussed thing himself, and knew that he didn't, but he always knew where to find somebody who did know just what was necessary. As a result, he's wearing purple and fine linen today and is a director in some forty corporations. He's a valuable man, not because of what he knows, but because of what those that he knows know. Sounds kind of complicated, but it's really simple, and it's a system that can be adopted by a good many others who will never become corporation directors in any other way."

"How much connection is there between patience and gumption, Dave?" I inquired, with the purpose of drawing him out on the subject from another viewpoint.

"No connection at all," said Dave emphatically. "In fact the two qualities don't often go together. Patience, to my way of thinking, is a negative sort of virtue anyway, a very common variety being called laziness. A coon loafing on the levee at New Orleans has got more of this patience stuff than enough for six ambitious men; while a mud-turtle on a log can give a coon cards and spades on the subject. The only thing that can beat a mud-turtle for patience is an arctic explorer. What gets me is the high regard that most people and the Government in particular have for patience, and the low esteem in which they hold gumption. I have a couple of examples in mind that will make this clear.

"Peary discovered the North Pole, or at least he says he did, although he didn't bring back a piece of it to prove his statement. The process consisted in getting aboard a boat furnished by the Government and filled with eatables from the same charitable source, and then letting her drift for several years in an ice pack until

she came within walking distance of the pole. If you can tell me a job that requires more patience and less gumption, I'd like to know about it. Peary was used to it, however, as he had been after the pole at the Government's expense ever since he was big enough to tote shoulder straps and carry a Government pay envelope. Finally he got the pole and copyrighted it and published it and got rich out of it and was made an Admiral on account of it. If any one ever had a monopoly of anything, Peary had it on the North Pole; and no one ever prosecuted him under the Sherman act on account of it either. I wish that some one would tell me what good finding this climax of desolation ever did any one except Peary, or why the Government should underwrite the expense of acts of patience where it discourages acts of gumption."

"How do you mean 'discourages acts of gumption,' Dave?" I asked with curiosity.

SUCCEEDING IN SPITE OF THE GOVERNMENT

"Ever hear of Tom Perkins?" asked Dave. Rather an unnecessary question, for everyone has heard of this famous Captain of Industry. "Well," continued Dave, after my nod of assent, "thirty years ago the police in Chicago were kept busy interrupting Tom's naps on the park benches. He was a little shaver, and what one would call a street urchin—never knew whether he was born or just happened. For five years he was kept busy dodging cops and trying to make a living and the process must have bred considerable gumption in him. In some way or other he got a job in a foundry at the age of thirteen and by the time he was sixteen he had picked up as much as the average molder learns in a lifetime. All of this time he had to keep one eye open for the truant officer who wanted to make him go to school to learn his A B C's and other useless things that Tom didn't care in the least about.

"When he had learned all he could in Chicago, Tom hopped a freight with his belongings tied up in a sock and landed in a little town in Pennsylvania. After an exciting race with a railroad detective, he reached a foundry on the other side of the town and secured a job as molder. Pretty soon he got to be foreman and before long part owner of the plant; putting up \$5,000 he had saved by going without automobiles and silk underwear, to say nothing of meals.

"Shortly after he had put up the money his partner disappeared, taking the cash resources along with him and leaving some heavily encumbered plant, bills, debts and other disagreeable things. Tom had hard work to keep out of jail this time, but his former experience stood him in good stead and he managed to duck out of town safely.

"Well, to make a long story short, he tried again and again, paying his own bills, minding his own business, helping to support his country and voting the Republican ticket. Now he is a millionaire many times over, but he seems to find as little encouragement from the Government as ever, for now the Federal attorneys are laying awake nights figuring out some way to dissolve him for being a trust.

"Yes, indeed," concluded Dave, "patience is its own reward; but gumption had better watch its step if it wants to keep out of jail! But if you are ever given a choice of the two, take a supply of gumption every time!"

Making Small Precision Parts for Typewriters

BY FRANK A. STANLEY

A few illustrations of operations on small precision parts for the Noiseless typewriter are presented herewith. Fig. 1 shows a small fixture used in a sensitive drilling machine for milling the ends of ribbon cams.

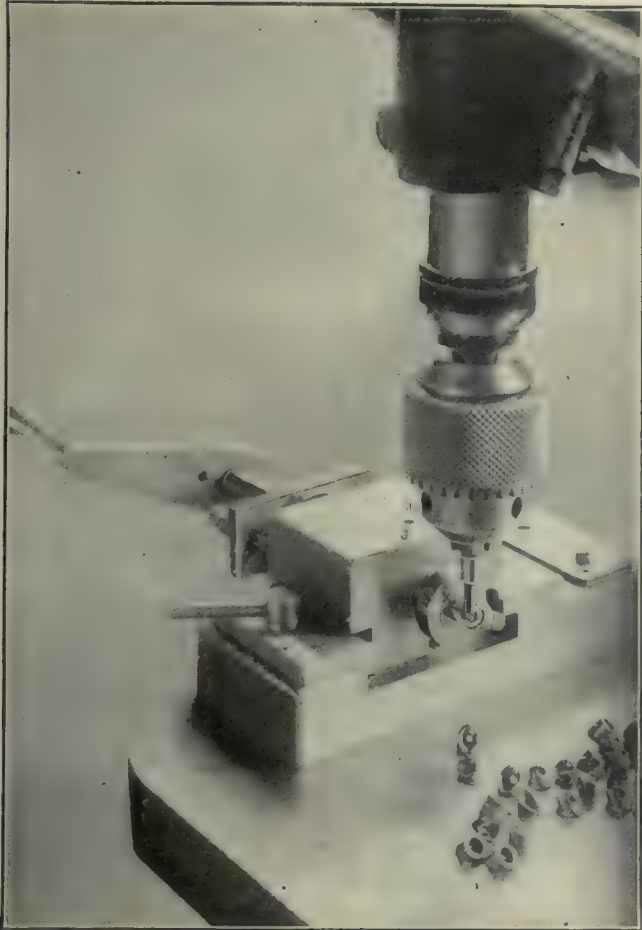


FIG. 1. A SMALL CAM-MILLING FIXTURE

base block, which is secured to the sensitive drilling-machine table, with a guide surface at the top in which the fixture head is adjustably secured by a gib and a clamp plate with handle at the front. The spindle that carries the work is rotated by hand by a short crank at the rear end, and in unison with the motion of rotation the spindle is given a longitudinal movement by an internal cam corresponding in contour to the cam surface required on the end of the work.

The cam to be milled is secured in the fixture on the end of the spindle by a small knurled-head clamping stud that draws the square end of the small cylinder snugly against a seating lug at right angles to the face of the fixture. When the handle at the rear is revolved, the small cam is fed past the cutter teeth and, owing to the action of the master cam inside of the fixture, is at the same time moved forward against the cutter during half of the cutting movement, and then drawn back for the cut on the opposite side. The work is, of course, fed quite slowly to the cut, but the milling cutter running at high speed enables the piece to be machined quickly and with accurate results.

GRINDING SMALL STEEL ROLLS

A method of grinding small double conical rolls—that is, a roll with a deep V-groove around the center—is shown in Fig. 2; here a bench lathe with a traverse spindle grinder is mounted upon the cross-slide. The grinder attachment is swung around to the necessary angle and the small wheel, which has been dressed off to leave a narrow cutting surface, is passed back and forth across the narrow surface of the work by pressure of the hand on the knob at the rear end of the spindle. The opposite angle is ground by reversing the work between centers. This method is a fast and accurate one and becomes almost automatic as the operator attains experience.

Two rubber rolls, which are carried by the adjustable fingers at the front of the platen to hold the end of the paper back as it is fed forward through the typewriter, are about $\frac{1}{2}$ in. long and slightly conical in form. These rolls are mounted upon a small steel spindle and are finished to correct size and taper in a bench lathe with

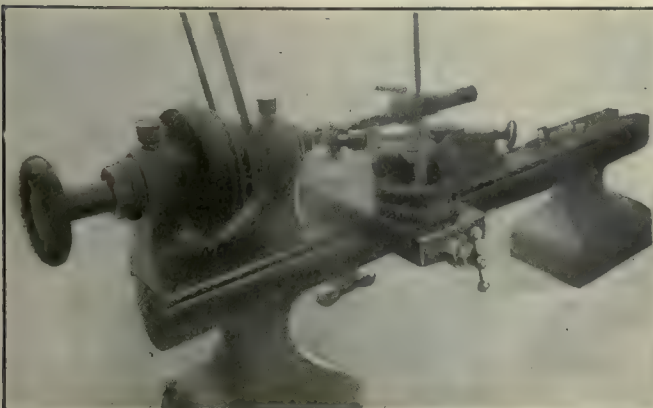


FIG. 2. GRINDING SMALL CONES IN THE BENCH LATHE

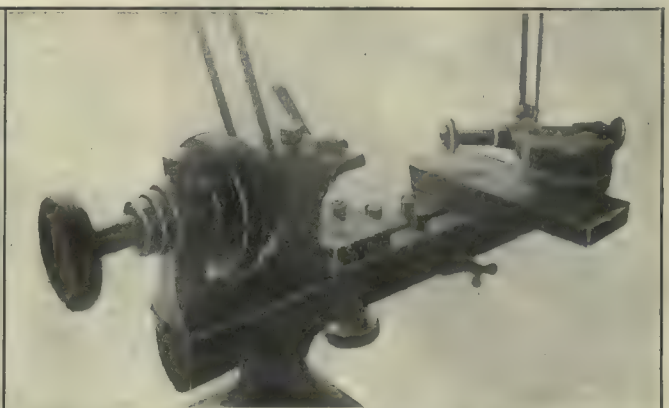


FIG. 3. GRINDING CONICAL RUBBER ROLLS IN THE BENCH LATHE

These parts are $\frac{1}{4}$ in. in diameter and are made of sheet stock blanked out and formed up in punch-press tools. The cam surface, cut at one end, is a double helix that is produced by the use of a very small milling cutter carried in the drill chuck. The fixture consists of a

a grinding wheel, as in Fig. 3. Here again the wheel is carried by a traverse spindle grinder set round to the necessary angle for producing the correct degree of taper. A few passes of the wheel suffice for finishing the rubber surface of these feed rollers as required.

Methods Used in Machining an Aeroplane Cylinder

BY ROBERT MAWSON

SYNOPSIS—In this article are shown tools for machining an aeroplane-engine cylinder. There are several interesting features about this engine, which is made in both eight- and twelve-cylinder types, the cylinders being cast and machined in separate units. The engine is air cooled, and a rather novel method of supplying the air to the cylinder is employed.

The Ashmussen Manufacturing Co., Providence, R. I., makes aeroplane eight- and twelve-cylinder power plants. The engine is air cooled, and the tools for machining the cylinders are here described.

The casting is made with a number of circular ribs, and forced into these are hollow tubes. The air, passing through these tubes, acts as a cooling medium for the outside wall of the cylinder and then enters the carburetor. It will be seen that by such a system the air tends to cool the cylinder equally and also heats the entering gas in the carburetor, providing an economical and positive explosion that would be more difficult if the air for mixing with the gasoline were cold.

The casting is first rough-bored in a drilling machine. The cylinder is located by flanges at the upper and lower

ends. The boring bar is guided in a bushing driven in the center of the machine table. The flanges are then machined in a lathe, the cylinder being located by an expanding arbor. The casting is finish-bored, being located by recesses at the upper and lower ends. The tool for the finish-boring is also guided through a bushing in the table in a similar manner to the roughing operation. Gang tools are used to machine the outside surface of the cylinder, which is held and driven by an expanding arbor. A simple plate jig serves for drilling the holes into which the air flutes are forced. The jig used in drilling the holes for lubricating the cylinder is provided with a register for the lower end and a recess at the upper end. The jig elements are then held together over the cylinder with a wing nut and a bolt. Of particular interest is the second operation, in which the entire surface of the cylinder is finished in an automatic chucking machine, cross-slide tool holders on either side holding multiple tools for making the cuts.

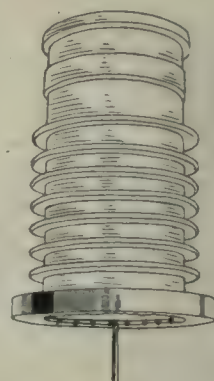


Fig. 6

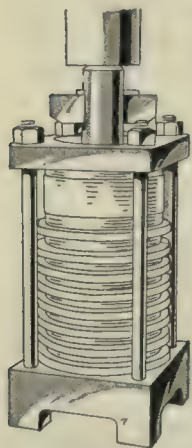


Fig. 2

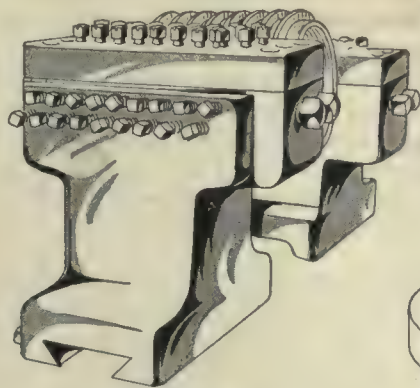


Fig. 3

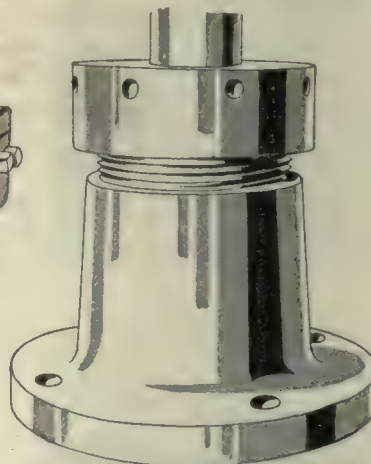


Fig. 4

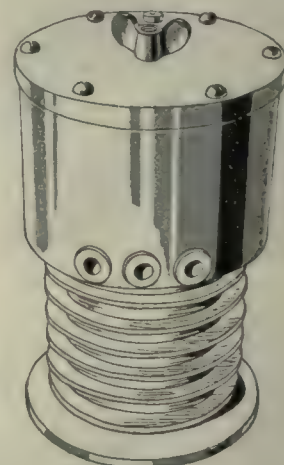


Fig. 5

AEROPLANE-ENGINE CYLINDER SHOWN IN PLACE IN ITS JIGS

FIGS. 2 AND 2-A

Operation—Rough-boring the cylinder, Fig. 1. The casting is located in recesses in the flanges at the upper and lower ends. The jig is held in place with the four bolts that force together the flanges over the cylinder. The bar is guided through a bushing forced into the machine table.

Holes Machined— $3\frac{1}{2}$ -in. bored.

FIGS. 3 AND 3-A

Operation—Machining outside of cylinder. The casting is located on the expanding arbor shown, which is held and driven by an automatic turret lathe. One tool head is placed at the rear and the other in front of the cylinder. The tools are designed so that the entire surface of the cylinder is machined at one operation.

FIGS. 4 AND 4-A

Operation—Finish-boring the cylinder. The casting is placed in the lower part of the fixture, being located in a recess. The upper part of the tool, which is made with a

thread, is then placed over the lower element of the fixture. This part of the tool is also designed with a register to locate the casting at the upper end.

Holes Machined— $3\frac{1}{2}$ -in. bored.

FIGS. 5 AND 5-A

Operation—Drilling hole for lubricating the cylinder. The casting is located by a flange that has a register to fit into the finish-bored hob of the cylinder. The upper part of the jig is provided with a turned surface to fit on the outside of the casting. The two jig elements are held together with a thumb-nut and a bolt.

Hole Machined—One $\frac{3}{8}$ -in. drilled hole.

FIGS. 6 AND 6-A

Operation—Drilling for the air flutes, or channels, in the cylinder. The jig plate is bored so that it will fit the machined register of the turned flange.

Holes Machined—Twenty-four holes to suit the punched air flutes, or channels.

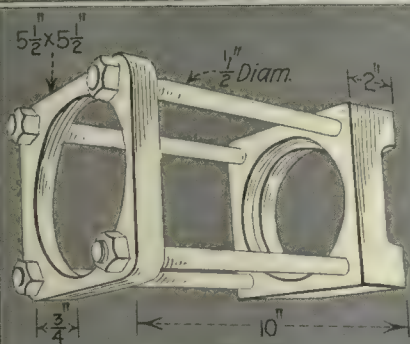


FIG 2-A

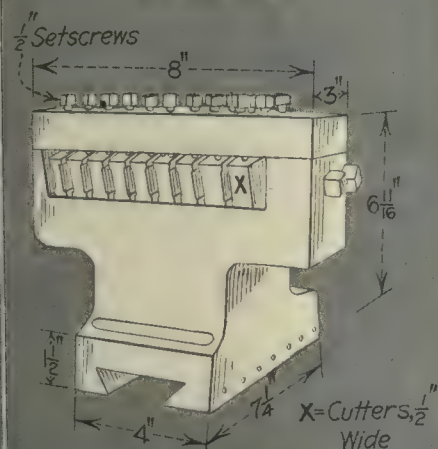


FIG 3-A

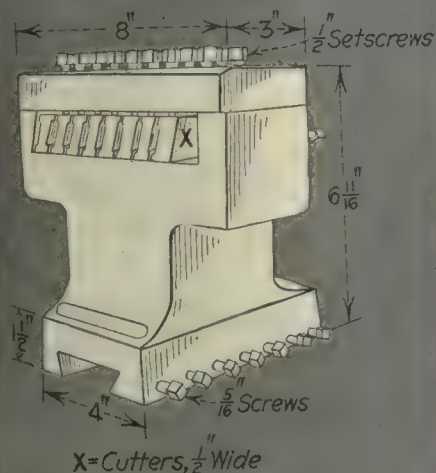


FIG 3-A

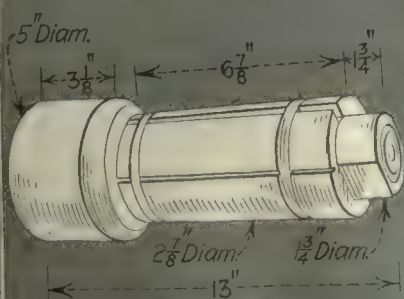
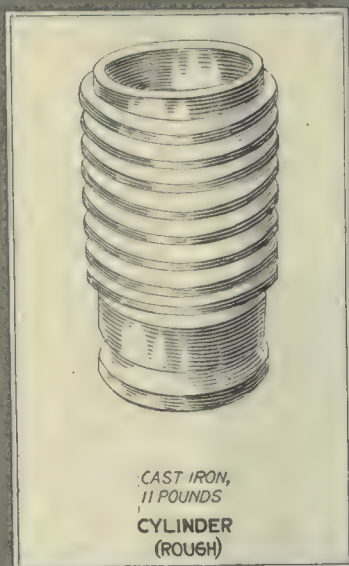


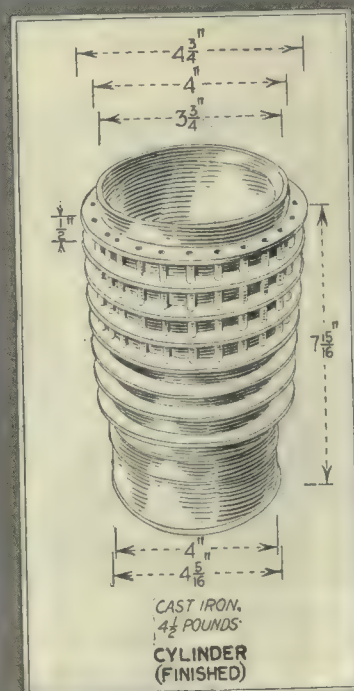
FIG 3-A



CAST IRON,
11 POUNDS
CYLINDER
(ROUGH)

FIG 1

NOTE
ALL BUSHINGS USED FOR
GUIDING TOOLS ARE BLACK-
ENED. ALL JIG AND FIXTURE
BODIES ARE CAST IRON,
STRAPS AND FASTENINGS,
MACHINERY STEEL; GUIDE
BUSHINGS ARE TOOL STEEL,
HARDENED AND GROUND



CAST IRON,
4 1/2 POUNDS
CYLINDER
(FINISHED)

FIG 7

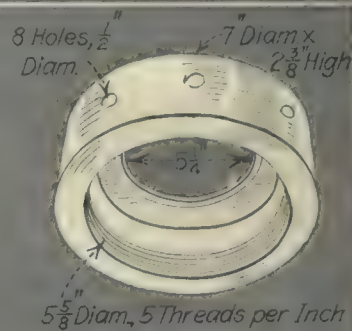


FIG 4-A

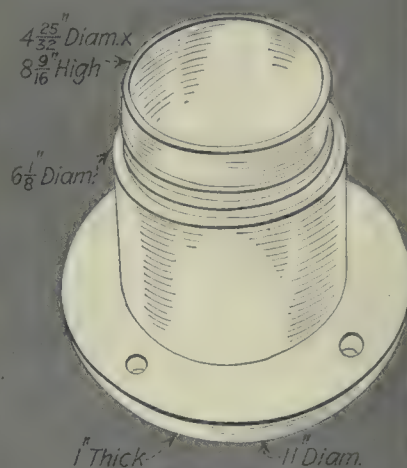


FIG 4-A

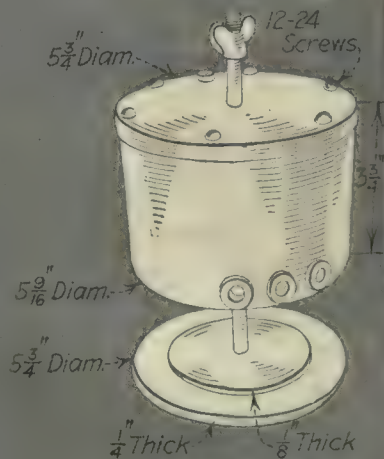


FIG 5-A

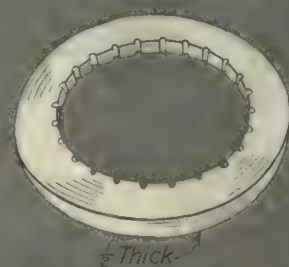
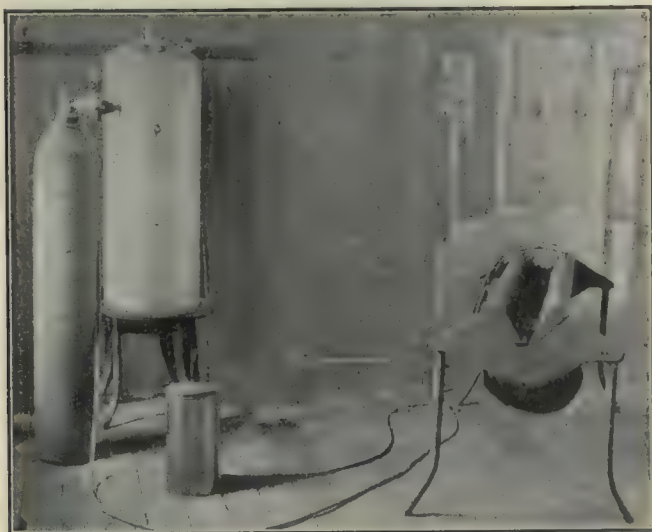


FIG 6-A

Fixture for Welding Thin Sheet-Metal Pipe

BY ETHAN VIALI

The fixture shown at the right in the accompanying illustration is used for holding thin sheet metal while welding the edges together when making pipe of various sizes. It consists of a cast-iron V-trough on legs, having in the bottom a slot sufficiently large to allow the sheet-metal edges to be reached and welded easily. The sheet metal is held securely in place by means of a bar underneath, which is hinged on one end and fitted with a clamping screw at the other. The metal is slipped be-



APPARATUS SET UP FOR WELDING PIPE

tween this clamping bar and the under side of the V. The edges are then adjusted to welding position, and the clamping screw is tightened. The welding proceeds in the usual manner.

This fixture is handy for sheet-metal pipe or box work of any kind. It is in use in the shop of the Thermalene Co., Chicago Heights, Ill. At the left is one of the generating outfits. At the extreme left is an oxygen tank, and next to it is a thermalene generator. The small can in front is one of the "cartridges" from which the thermalene gas is generated.

❧

Cutting Steel Stamps

BY J. F. GREENE

Some few years ago, steel stamps could be profitably made with a vise, a few chisels, a couple of gravers, an emery grinder, a few files and a tempering furnace. Now, however, the uptodate shop requires in addition to the foregoing a horizontal miller, a vertical miller, a drill press and several other tools.

The following method is practiced in the shops of the Pittsburgh Steel Stamp Co., Pittsburgh, Penn. Usually, stamps are made in large lots at a time. The square bars of steel are first cut off to length, after which one end is whitened with stencil paste. After the stencil paste has become dry, a boy imprints the character on the whitened end with a rubber stamp. This is done quickly and accurately by laying the piece of steel in a sort of V-block and pressing it up against the rubber

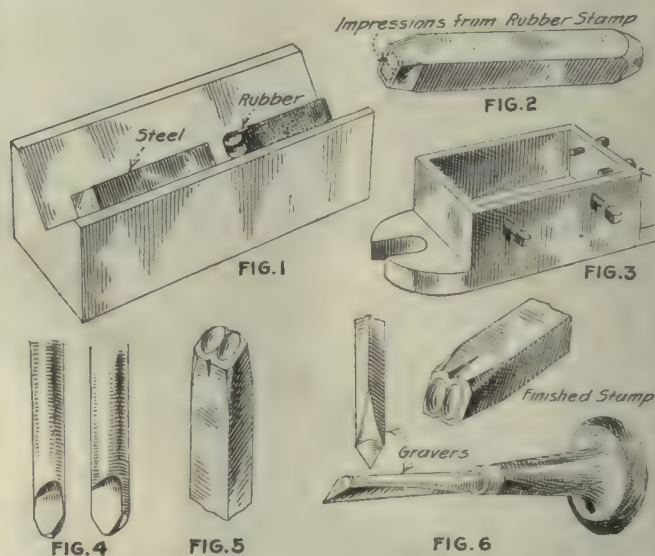
stamp, which is on the end of a piece of steel of the same thickness as the stamp. Fig. 1 shows the operation.

Next, comes the grinding, which is done by boys who become very expert in a short time. The outside is ground at the proper bevel, wherever possible, up to the ink line. In Fig. 2 the dotted lines show the imprint of the rubber stamp and the black border the part to be ground off. The heads of the stamps are also ground in this operation.

At this stage the finisher takes the work. His task is to shape the outside of the character with a file just as it will look when finished. This is a small matter, as the grinder has done most of the work.

The stamps are then placed in a chuck, Fig. 3, and clamped to the bed of the vertical miller. A Becker No. 1 or 2 miller is handy for this work, as it has a foot pedal for lowering and raising the tool. High-speed single-edge cutters, Fig. 4, are used. Here for the first time a skilled operator is required. Through long practice this operator can manipulate the slides of the machine so accurately that all the surplus metal is routed out right up to the outside edge, as in Fig. 5. A $\frac{3}{4}$ -in. letter can be milled out easily in 3 min.

From here the finisher takes charge. With properly shaped chisels he cuts out the corners where the milling



FIGS. 1 TO 6. TOOLS FOR CUTTING STEEL STAMPS

cutter could not reach. He is then ready to sharpen up the lines and smooth out any irregularities, which he proceeds to do with gravers. All lines are brought up to a knife-edge by this process. The next operation is hardening and tempering. It is by far the most important of any and one that requires a great amount of skill.

❧

One Hundred and Forty Million barrels of petroleum was marketed in the United States during the first half of 1916, according to the estimate of the United States Geological Survey. This quantity, which includes a little oil actually produced in 1915 but marketed during 1916, is less than the output during the first half of 1915, though it is greater than one-half the entire quantity marketed last year. The fact that this quantity reflects the results of general activity throughout all oil-producing areas rather than flush production in restricted areas is significant and leads to no other conclusion than that the final statistics of oil marketed in 1916 are destined to establish a new record.

Manufacturing the 1-Lb. High-Explosive Shell--III*

BY ROBERT MAWSON

SYNOPSIS—This article is the concluding installment of this series on the loading of the shell and cartridge case. Final inspection and boxing for shipment are described. The various operations are shown in diagrammatical form, and the times required are also included. The article as a whole provides a complete and valuable treatise on the manufacture of the 1-lb. high-explosive shell.

A detail of a chip wagon that is used to convey the chips from the machine tools to the separators is shown in Fig. 54. It will be observed that the wagon is provided with a cock so that surplus oil may be drained off.

The shell is now ready for loading with the high-explosive black powder. A view of this operation is shown in Fig. 55. The amount of powder placed in the shell is 240 grains or 15.552 grams.

The loading operation is shown in diagrammatic form in Fig. 56. The press used when forcing the primer in

case is loaded with nitro-cellulose averaging 69 to 85 grains, according to the varying explosive charges of powder placed in the shell. The operation is shown in

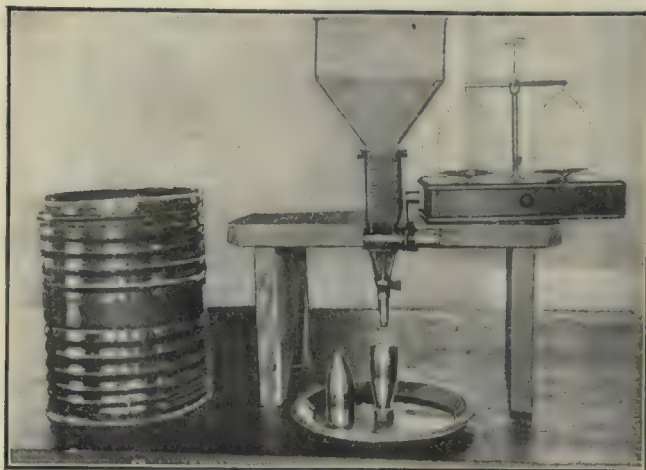


FIG. 55. LOADING SHELL WITH POWDER

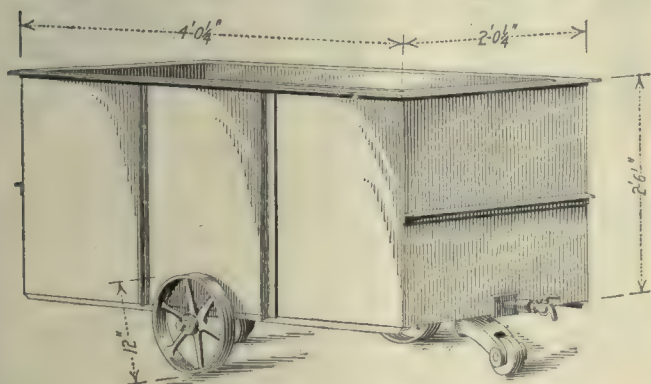


FIG. 54. CHIP WAGON FOR OILY CHIPS

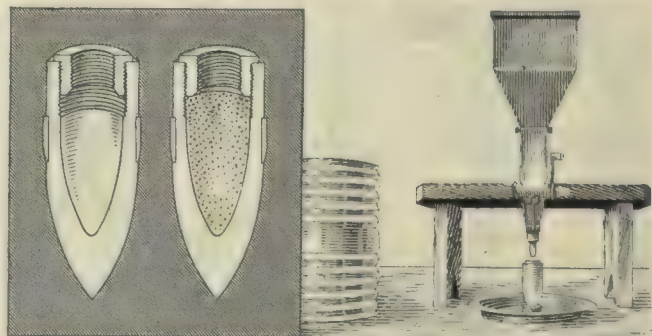


FIG. 56. OPERATION 18: LOADING SHELL WITH POWDER
Machine Used—Ideal Manufacturing Co.'s measuring machine with scales and weights.
Production—1 man can load 420 shells per hr.
Reference—Fig. 55.

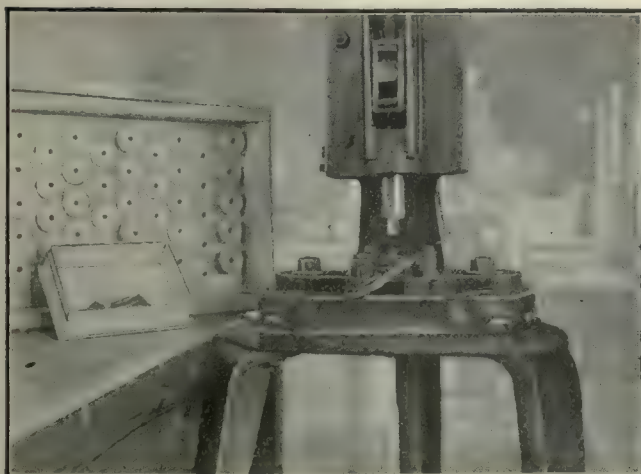


FIG. 57. FORCING PRIMER INTO CASE

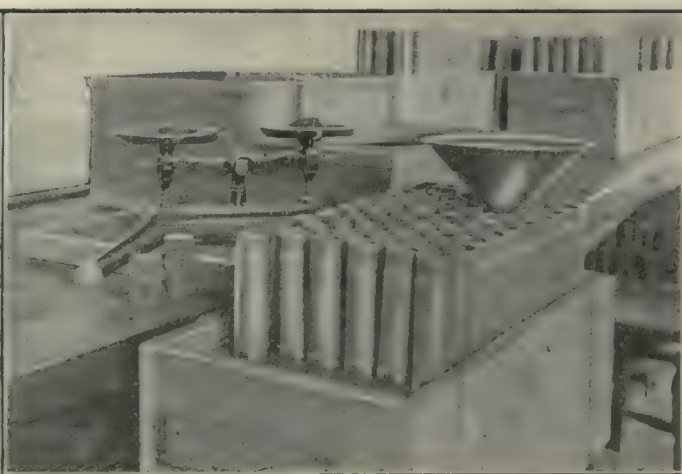


FIG. 59. FILLING CARTRIDGE CASES

the base of the cartridge case is illustrated in Fig. 57, and is also shown in diagrammatic form in Fig. 58. The primer contains 20 grains of powder. The cartridge

Fig. 59, a diagrammatic illustration of the operation being shown in Fig. 60. One of the felt pads shown is placed on top of the nitro-cellulose in the case. This is done for two reasons—to prevent the gases from reach-

with a center to guide the shell when it is being forced into position. The operation is also shown in diagrammatic form in Fig. 64.

The shell is then tested with the gage, Fig. 65. This gage is used as the final check on the machined and assembled projection. The shell does not fit tightly in

projectile. The operation is also shown in diagrammatic form in Fig. 66. The weight of the loaded shell complete, as shown at this stage, is 7,400 grains or approximately 480 grams.

After being inspected the steel part of the projectile is dipped in grease to prevent rust. A detail of the tray

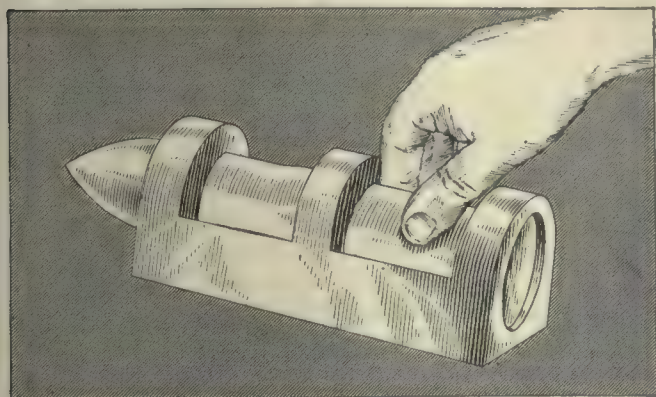


FIG. 66. OPERATION 23: INSPECTING ASSEMBLED PROJECTILE

Production—1 man 500 per hr.
Reference—Fig. 65.

FIG. 66-A. OPERATION 24: GREASING STEEL PART OF PROJECTILE

Production—1 man 500 per hr.

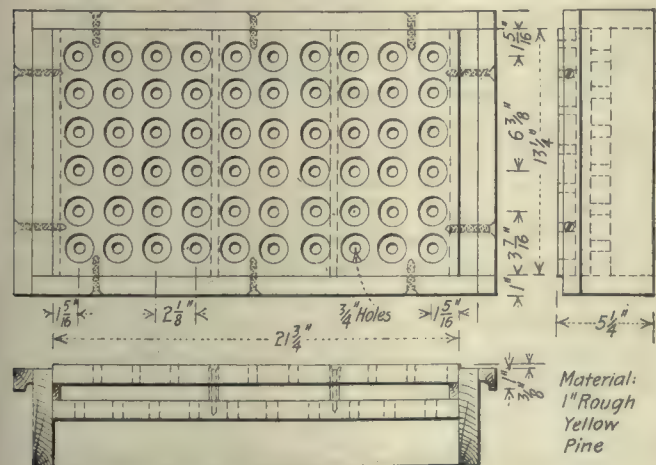


FIG. 67. TRANSPORTATION TRAY USED FOR SHELLS

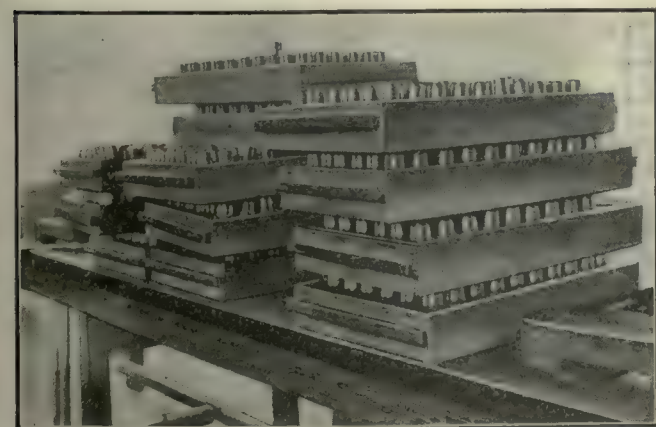
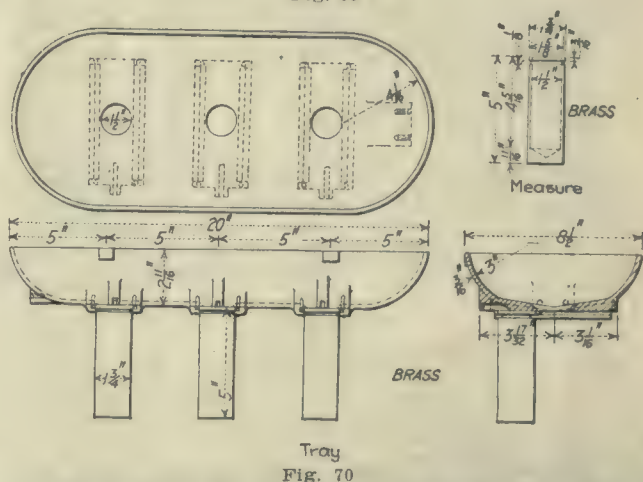
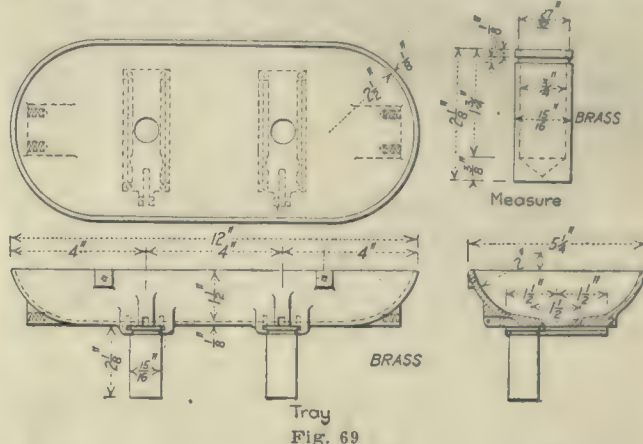


FIG. 68. NUMBER OF LOADED TRAYS

the gage, but slides in as it would into the barrel of the gun. However, should it be found that the inspector could not slide the projectile, or that the steel shell part did not reach to the gage point, it would be evident that some mistake had been made when manufacturing the



FIGS. 69 AND 70. LOADING TRAYS FOR SHELLS

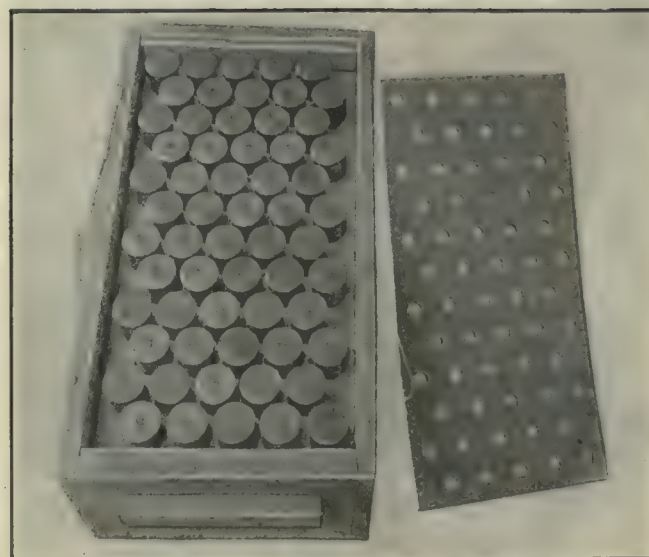


FIG. 71. PACKING CASE FILLED WITH PROJECTILES

used to convey the shells to various locations in the departments as required is shown in Fig. 67. A number of trays loaded with shells are shown in Fig. 68.

In Fig. 69 is shown a tray that is being made for loading the shells. This device is provided with a compart-

ment in which the powder is placed and is covered over with a shield. When it is desired to load, a shell is placed in a holding clamp and a small funnel put in the open end. The slide of the fixture is then slid forward, which brings the measure in position so that it is automatically filled. The slide and measure are then drawn back and when the slide comes against the stop on the pawl the measure is opposite the place cut out on the tray body. The measure may then be pulled out and the powder poured into the shell. It will be observed that when the slide is back the blank part of this part covers up the outlet on the device thus preventing any waste of powder.

A similar arrangement for loading the cartridge case is shown in Fig. 70. The next operation on the shell is packing. A view of one of the cases filled with projectiles is shown in Fig. 71. A detail of the packing case is shown in Fig. 72. After the packing case has been filled

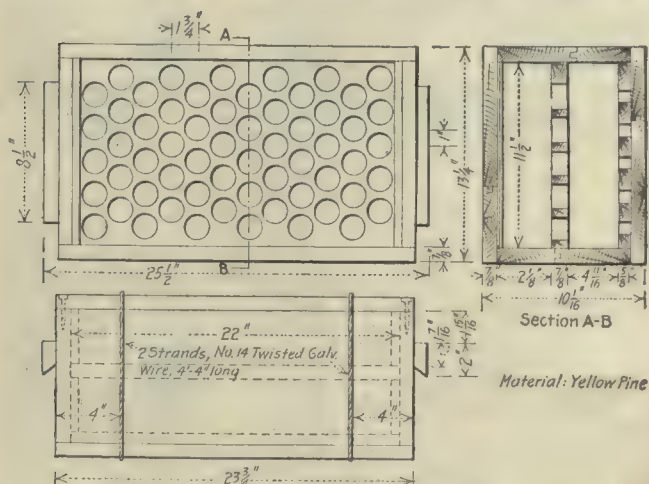


FIG. 72. DETAILS OF SHELL-PACKING CASE

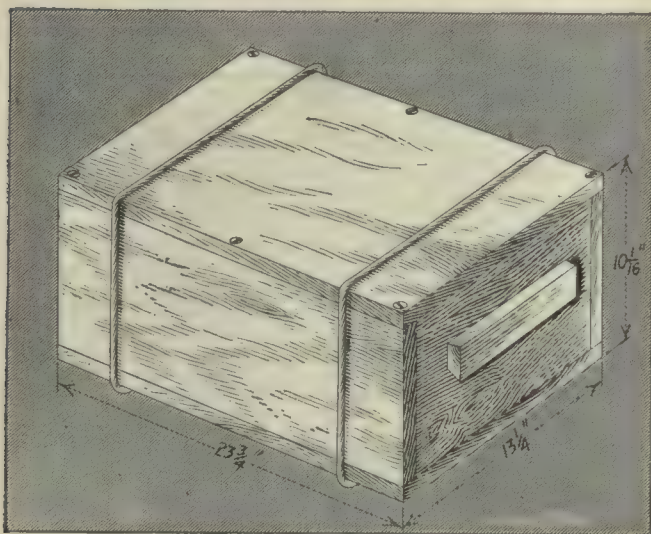


FIG. 73. OPERATION 25: PACKING

Production—1 man 4 cases per hr., or 240 assembled projectiles. References—Figs. 70 and 71.

with the 60 projectiles, and the cardboard cover placed over them, the cover is fastened down with wires and screws and the Government seal placed in a countersunk hole in the cover. The case is then ready for shipment for either land or marine warfare as required. A diagrammatic illustration of the packing operation, showing the reinforcing wires, is given in Fig. 73.

After the shell has been fired from the gun the receiving end of the cartridge case is opened out or forced oversize. In Fig. 74 is shown a device for resizing the end of the case and afterward forcing in the shell. The case is placed in the forming die and the forming plunger forced onto the end of the case with the handwheel oper-

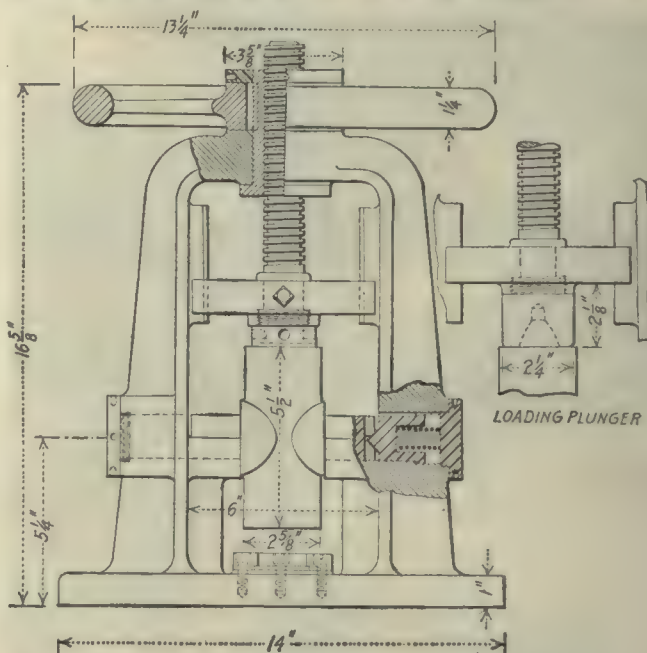


FIG. 74. PRESS FOR RELOADING USED CASES

ating the screw shown. After the plunger has been forced down, thus forming the end of the case to size, the loading plunger is substituted for the forming plunger. In a similar manner the steel shell is then forced into the cartridge case, using the handwheel. This attachment is useful, as it may be taken either to the proving ground or to any other place where it may be found necessary to insert shells into cartridge cases that have already been fired.

❧

Where Are the Good Mechanics?

By J. P. BROPHY*

What are we coming to in these days when we lack skilled workmen? If good mechanics are looking for jobs, where are they? I hope someone will try and explain this situation. In the old days if you wanted a man to run a planer in the machine shop he could do it skillfully; or if you wanted him to handle a miller or lathe you would find him in most cases a capable workman. A greater number of the men in the shop could do almost anything and do it well. If such fellows are still around these days, where are they? We seldom come across such a man, and if we do he is considered a jewel. Now what's the matter? Are we expecting too much? It almost seems so!

During the last ten years we may have hired 100 men at various times when we were busy, and out of this number ten would be a success. In many instances we would hire a man to operate a lathe, as he claimed to be a first-class lathe hand. Before he had worked ten minutes we would discover that there might be a possible chance that he had seen a lathe somewhere some

*Vice-President, Cleveland Automatic Machine Co.

time, but that was about all he knew about it. He had plenty of nerve but no ability. If we should ask one of these would-be lathe hands to take a piece of $\frac{3}{8}$ -in. round stock 3 ft. long, center it and reduce it to $\frac{1}{4}$ in. in diameter, he might possibly be able to center the piece, but the chances are that he would attempt to turn it without a steadyrest. This little, simple illustration shows how far we are away from the old days of skillful men.

A vast number of men when trying to learn their trade fail to apply themselves properly. Thus after they have had all of the opportunity necessary they are still not a success. Their brains do not seem to work right. They fail to realize that serving three or four years learning a trade means much more in acquiring skill and experience than staying at a place of employment for so many hours a day. The whole trouble seems to be that it is in the minds of the workmen a matter of putting in the time, and failing to grasp the real necessity of being skillful.

When hiring help today every man has to be tried out, and valuable time is wasted in order to get into his mind the idea of how to perform his work. It is so much a day of specialization that a man may learn to operate a

mill or a lathe or do vise work and know nothing else. He has little opportunity to become an all around machinist and apparently does not care whether he is one or not. He gets into his mind one thing, knows that fairly well, and there he stops.

It is not much use to complain about these things, but they have come to my attention very forcibly during the last year when business has happened to be good. We have all had to hire and discharge, trying if possible to select men who could do our work. It has been a great and unsatisfactory undertaking. Twenty-five years ago we could have got men without any difficulty. Are we sliding backward mechanically? Perhaps this is not so from a designing standpoint, but it does seem positively true that we are not going forward as far as the development of skilled help is concerned.

Perhaps someone who reads this short article can explain the matter and give us the reason why. It is possible that someone may conclude that a man has less opportunity to learn a trade today than he had years ago. There may be some reason for this conclusion in some instances, but in many cases, where the opportunity has existed, it has not been accepted. So, what's the remedy in a case of this kind?

Methods of Analyzing Motions by Graphical Charts

BY FRANK B. GILBRETH*

SYNOPSIS—The author shows his method of graphically visualizing motions in order to analyze their kind, duration and sequence. Two specimen simultaneous-motion charts are presented—one for loading pig iron on a flat car, the other for chucking a piece in a chucking machine. These methods and charts have been developed in Mr. Gilbreth's intensive study of human motions.

In October, 1915, I presented before a session of the New York Local Section of the American Society of Mechanical Engineers a paper entitled "Motion Study for the Crippled Soldiers." A part of this paper was a brief description of the methods developed and used in my laboratory for studying human motions. One of the illustrations was a simultaneous-cycle motion chart for an assembling operation.

Somewhat to my surprise and regret, this chart and the disclosure of the method of its preparation and use called forth no discussion whatever. It is probable that they were overshadowed by the great importance of the general subject of the paper—the aid that engineers should give to the crippled soldiers of Europe. Because of this situation I am glad to present these same methods, again, illustrated by two other charts, for the benefit of the readers of the *American Machinist*.

In motion study the viewpoint for the method of attack is that work to be done creates a demand for certain human motions and that the worker, whether expert or in training, is a source of supply for those

motions. The primary record or observation of the motion comes from a number of special devices that may be used either in the research laboratory or in a regular place of work. These include the microchronometer, cinematograph and chronocyclegraph apparatus. The observations and graphic records of the first two instruments comprehend the activity of the worker, his surroundings, equipment, tools and the time duration of the motions. The chronocyclegraph apparatus records direction, speeds and paths of the motions. These observations and records form the data from which the simultaneous-cycle motion charts are plotted. These charts, together with three dimensional models of the motions, supply the means for an expert study of the motions themselves, with the purpose of reducing or improving them, and also make it possible for teacher and learner to visualize the desired motions from every viewpoint. They also serve as path guides in case the worker being taught is of the motor type.

The simultaneous motion cycle chart is only one of the products from the micromotion-study films. The same film furnishes elementary time units, time-study data for specific tasks, motion pictures for the education and entertainment of foremen's clubs, inspection of methods which it is proposed to standardize before they are actually standardized, as well as identification of the method on which the worker's pay is based.

Before a simultaneous-cycle motion chart could be plotted, it was necessary to determine the elements of a cycle of human decision and motion. These elements running partly or wholly concurrently with other elements in the same or other cycles are: 1, Search; 2,

*Consulting Management Engineer, Providence, R. I.

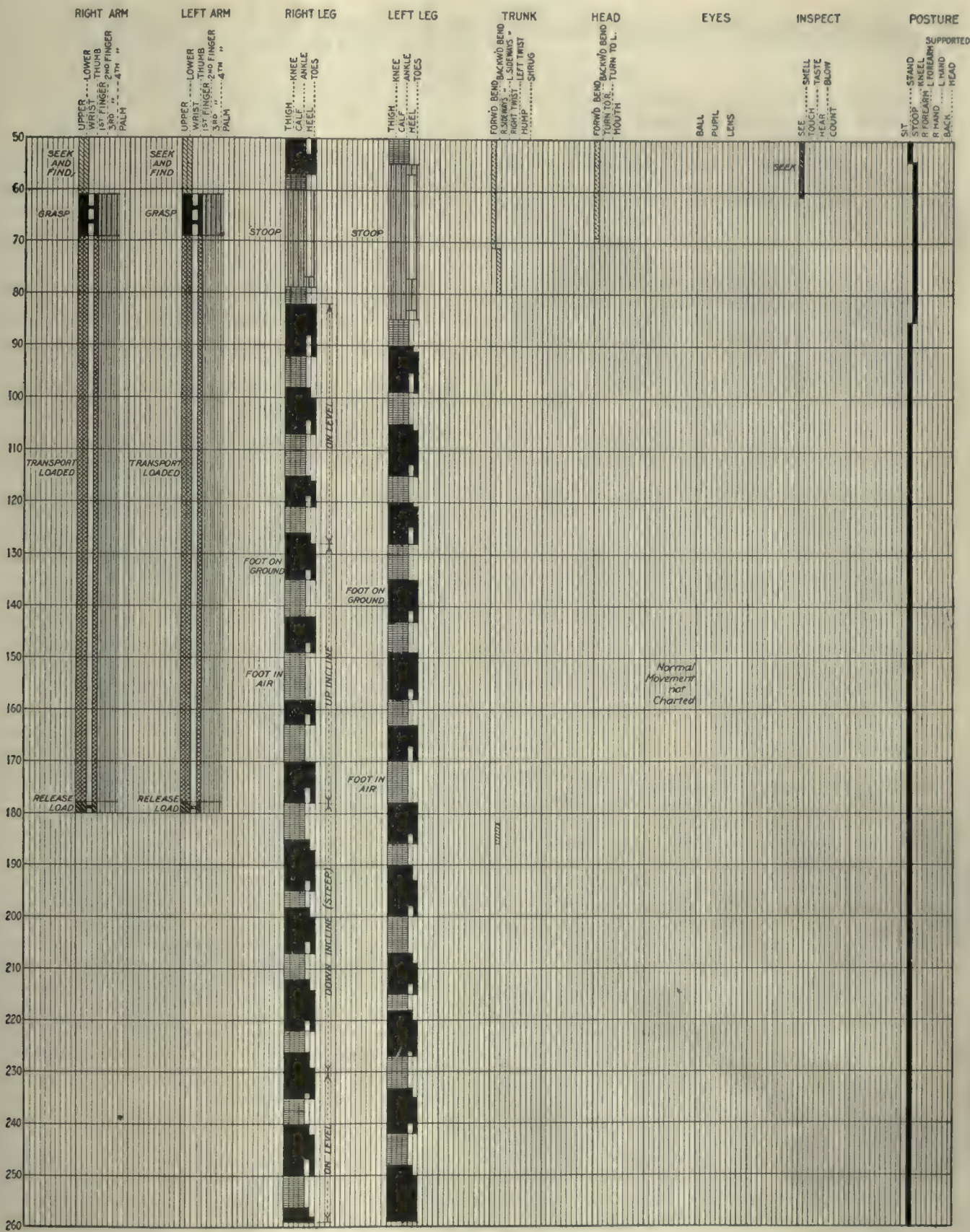


FIG. 2. SIMULTANEOUS MOTION CYCLE CHART OF LOADING PIG IRON ON FLAT CAR

It will be observed that on the chart, Fig. 2, a portion of the movements are not plotted and the legend appears "Normal Movement Not Charted." This shows, what is probably obvious, that only one or a few of the movements of the principal sections of the body need be plotted in detail, provided these are the only ones that require care-

ful study. Mr. Gilbreth reports that such charts have been applied to certain jobs and operations that had previously been intensively studied by other means. The result has been a further reduction of operating time in each case. This would seem to show the superiority of this form of graphical analysis over the other methods.

The "Radical" Automatic

SYNOPSIS—The predominating aims in the design of this four-spindle automatic screw machine have been simplicity and rigidity. Important features of the construction are the "stay-put" cams, the threading mechanism, the provisions for selective tooling, the indexing device and the lubricating system for the cutting tools.

For some three years a multiple-spindle automatic screw machine has been under development by the Fitchburg Automatic Machine Works, Fitchburg, Mass., a firm

"Radical" automatic. As a machine it is a development of the Grant automatic, which was illustrated and described in the *American Machinist*, Vol. 37, p. 795. A comparison of Fig. 1, which shows the front view of the new machine, with the corresponding previously published illustration of the Grant machine will bear out the statement that only one essential feature of design of the prototype has been retained—that of bringing the work to the tools.

The word "radical" is so unusual in machine-shop language that it is in order to comment just a little in regard to its meaning and application. We most often see

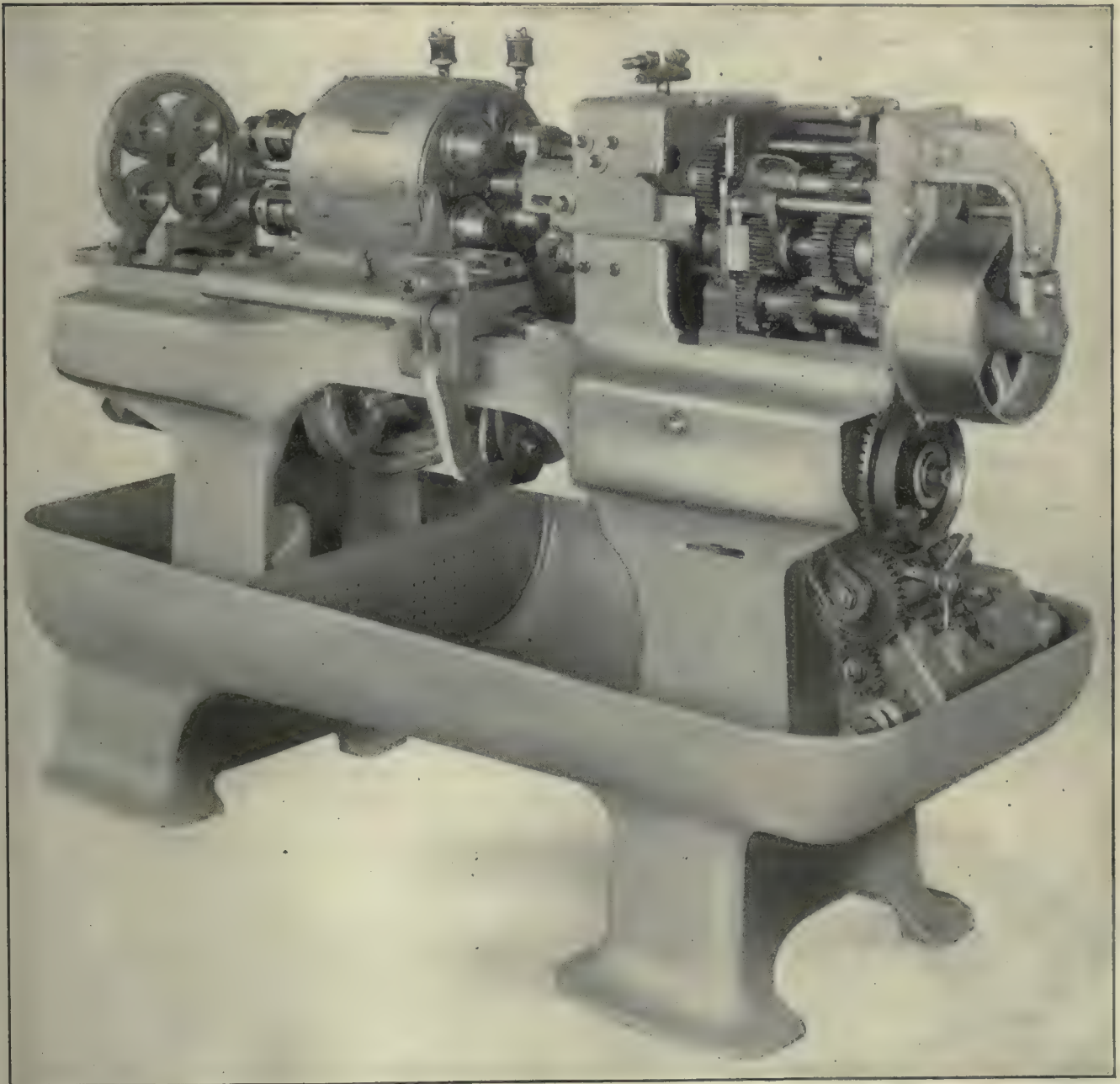


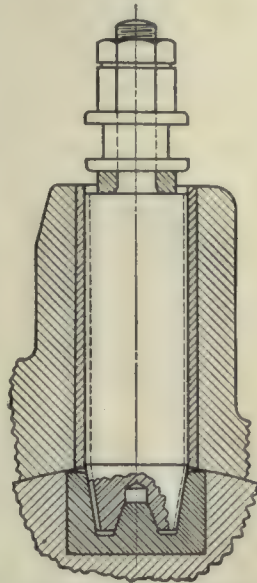
FIG. 1. FRONT VIEW OF THE "RADICAL" AUTOMATIC

that is an outgrowth of the Fitchburg Machine Works of the same city. This latest of the multiple-spindle machines is now ready for the market and is called the

it added to the name of some political party or group that holds extreme views of some kind or another. But this use of the word is comparatively new and does not bring

out the essential meanings, which do apply to machinery and mechanical principles. The word "radical" really means reaching to the center or getting back to the ultimate source, pertaining to the origin of things, affecting vital principles. Close synonyms are "thorough-going"; "fundamental," or that which is essential; "cardinal," or that upon which something turns or hinges; "capital," or that which is of first or chief importance. To compare this word with some of the everyday expressions, we can say that it means the same as "root and branch" and "top to bottom." That is, a radical machine should be one that has been designed root and branch and from top to bottom for the work for which it is intended. Or if we wish to coin an expression with a bit of shop flavor, we might say that the name "Radical" given to an automatic implies that the machine is an automatic from "pan to pulley" (see Fig. 1).

The important feature of bringing the work to the tools has been already mentioned. Others are the single-belt drive, one-piece spindle, the "stay-put" cams, individual stops for each spindle, the indexing mechanism, the cylinder-locking mechanism, the threading device, the speed and the feed boxes, provisions for selective tooling, the simplicity of the lubricating system for the cutting



LOCKING BOLT FOR SPINDLE CARRIAGE

system, which comprises the two sliding and the change gears, provides eight spindle speeds, which are 366, 547, 705, 1,070 r.p.m. in one series and 760, 1,130, 1,470 and 2,220 r.p.m. in the other series. The shift of the sliding gears is made by two handles, each one of which has a simple gravity lock. The handle itself is in two parts, is hinged, and the outer part drops of its own weight into a notch that prevents its shifting unless moved by hand. A detail of the spindle shaft is a pinned joint directly in front of the cylinder. If it becomes necessary to take down the cylinder mechanism, all that is required is to open this joint without disturbing any of the spindle speed-box parts. Similarly, the cylinder mechanism need not be disturbed if it becomes necessary to take down the speed box.

The four spindles are gear driven from a common pinion on the spindle driving shaft. Each spindle is in one piece and has three bearings in addition to the end thrust bearing. The longer journal, or straight, bearing is $4\frac{1}{8}$ in. long. The spindle diameter at this point is $2\frac{1}{4}$ in., giving a length to diameter ratio of nearly two.

The cylinder that carries the spindles is 12 in. in diameter and runs in two bearings, each $2\frac{1}{4}$ in. long. These are at either end of the cylinder housing. The housing is integral with the cylinder carriage, and this carriage in turn carries the cutoff and forming-tool slides. The cylinder is locked in its carriage by means of the locking bolt shown in the cross-sectional drawing, Fig. 2. In the cylinder are four bushings, one for each position, having two taper fits, but of different tapers. The inner taper is a plug and the outer a sleeve, but both are in one piece. The locking pin, which comes up through the bottom of the carriage on a slight angle with the vertical, has an end with two tapers corresponding with the tapers of the bushings. The purpose of this construction is to

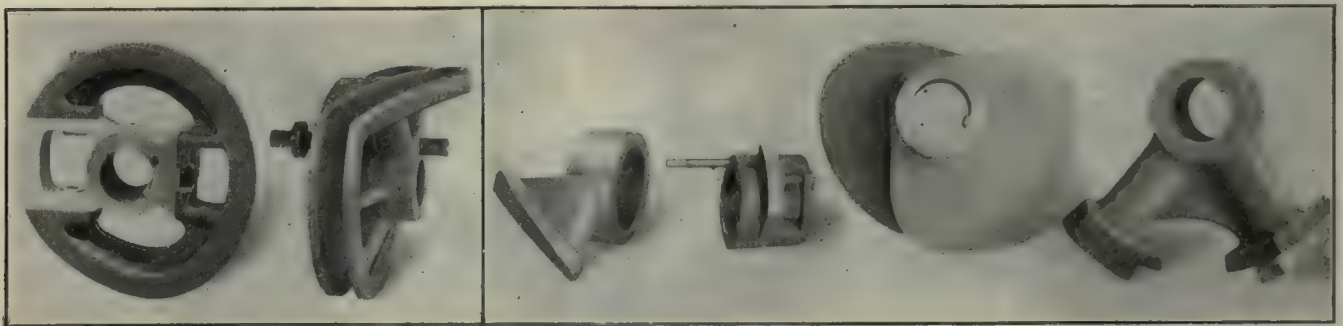


FIG. 3. CAMS OF THE "RADICAL" AUTOMATIC

tools, and the chucks. An adequate description of the machine must take up all these details.

The machine is regularly equipped with a 10x4-in. pulley, which gives spindle speeds from 366 to 2,220 r.p.m., corresponding to surface speeds of from 48 to 225 ft. per min. on stock from $\frac{3}{8}$ to 1 in. in diameter. They also correspond to a "time per piece" range of from 5.12 sec. to 2.5 min. There is room under the arm of the outboard pulley bearing to swing a pulley 12 in. in diameter if slower speeds are needed; it is also possible to put on an 8-in. or 6-in. one if higher speeds are required.

The main-spindle shaft is driven from the pulley shaft through a gear box in the head of the machine, shown uncovered in Fig. 1. The gear train includes eight gears and two change gears just in front of the gear box. This

overcome any inaccuracy in indexing due to wear of the locking-bolt parts. If the outer taper of either bushing or pin should lose its accuracy, the inner tapers are relied upon to give register.

Preparatory to describing the indexing mechanism, it is necessary to go back to the head of the machine and point out the feature of the geared feed box. This can be seen inside of the pan at the right in Fig. 1. This box is driven from the spindle gear box by a chain, a part of which shows in the illustration. From this box the camshaft is driven through a worm and a wormwheel. Ten changes of camshaft speed are provided by this box through a hand shift, producing feeds in linear inches per minute of advance of the cylinder carriage from 1 to $13\frac{21}{64}$. The corresponding speed of the camshaft ranges from 0.18 to 1.3 r.p.m. giving a wide feed range.

The indexing of the cylinder is under the control of the indexing cam, which is permanent and never adjusted. This cam operates an arm, not shown in any of the illustrations, that actuates a sector gear which during the operation of indexing meshes with a pinion on the indexing shaft. The locking pin is controlled by a separate permanent cam on the camshaft. One feature of the indexing is the control of the stock reel. This is revolved in unison with the cylinder by means of a pinion on the indexing shaft meshing with a gear surrounding the reel assuring positive action.

Two of the cams on the camshafts have been mentioned and their uses pointed out. The other cams are the lead cam, which advances and returns the cylinder carriage, thus bringing the stock to the tools; the chucking cam, which operates the chucks; the stock-feed cam, which feeds the stock through the chucks; the threading cam; and the cross-slide cams, which operate the forming slide at the front of the machine and the cutoff slide at the back. All these cams are permanent and do not require adjusting, with the exception of the stock-feed cam and the lead cam. The stock-feed cam is permanent in shape, but can be adjusted lengthwise of the camshaft, to adapt it to feed different lengths of stock. The maximum length that can be fed is 5 in. This cam is adjusted by means of a crank acting on the end of the screw shown in Fig. 3. The lead cam is built up of a hub, which is stationary and permanent on the camshaft, and a rim, or shell, that carries the cam track. Two shells are provided with each machine. These differ only in throw, one controlling the cylinder-carriage movement up to $2\frac{1}{2}$ in.; the other, carriage movements up to 5 in.

One of the most interesting parts of the whole machine is the threading mechanism, shown in detail in Fig. 4. It is called "selective" for the reason that it is possible to thread in either the third or the fourth position, tap in either the third or the fourth position, or thread and tap in either or both positions. It is possible to use spring, button or self-opening dies.

In this threading mechanism are two die spindles, one for the third and the other for the fourth end-tool position. These die spindles are gear driven from the spindle driving shaft in front of the gear box. These spindles and the rest of the threading mechanism are assembled on a slide that may be removed from its dovetailed seat in the side of the spindle gear-box frame, simply by loosening a screw and a pin. Any end tool may then be used in the vacated positions. The die spindles carrying the dies or taps are advanced by a simple dog arrangement. As the thread is finished, another dog changes the speed of the die spindles, thus running the die off from the work. These two dogs are located on the same shaft. There is one shaft for the third position and another for the fourth. Each shaft is graduated for the convenience of the operator in timing the dogs.

The method of holding the tools is arranged for selective tooling—that is, either shank-held tools or turner-

slide type can be used. Either kind of tool can be used in No. 1 or No. 2 position. If the threading attachment is removed, the shank-held type can be used in No. 3 and No. 4 positions. Also, both types of tools can be used at the same time in No. 1 and No. 2 positions.

One feature that shows the result of striving for simplicity in design is the chuck. This is shown in section in Fig. 5. Instead of using master chucks and pads for the various sizes of stock, one three-split master chuck and a series of sleeves, one for each size of stock, are all that is required. An ingenious bit of design on the

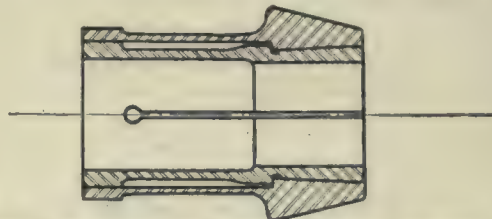


FIG. 5. CROSS-SECTION OF MASTER CHUCK AND STOCK SLEEVE

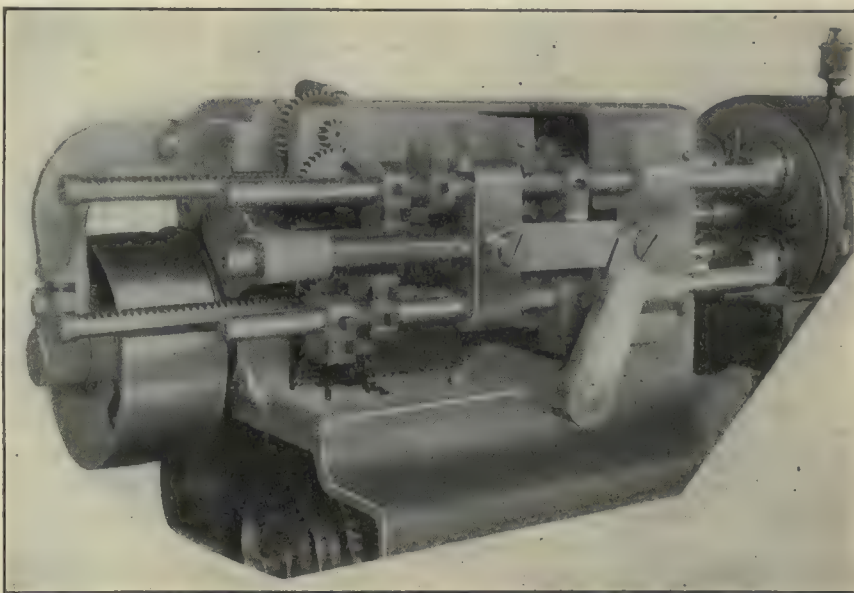


FIG. 4. DETAIL VIEW OF THE THREADING MECHANISM

chuck and sleeve is a slight reversed taper that prevents the sleeve from slipping out of the chuck when no stock is in the sleeve.

SIMPLIFIED SYSTEM FOR HANDLING LUBRICANT FOR CUTTING TOOLS

The system of handling the lubricating oil for the cutting tools also shows the result of the effort toward simplicity. The well in the pan of the machine will hold any quantity of oil up to 25 gal. Into this dips a strainer connected by a flexible tube with a geared pump, which discharges through a short run of pipe to a chamber in the tool head. This arrangement produces a very short piping system. The used oil is strained through two baffles before reaching the well. The strainer can be taken out of the well for the purpose of cleaning or renewing, without disturbing any permanent connection.

A feature that shows the result of the effort to obtain rigidity is the casting of the tool head integral with the bed. This head carries the shank-held tools, turner-type tools and the threading spindles. It also carries

a stock stop located between and below the first and fourth positions—a location that does not interfere with any of the cutting tools. It can be slid back out of the way of the operator to add to the convenience of setting up. It is adjusted by half-inch divisions and locked by a lip on the front of the tool head. A threaded end provides for finer adjustments.

MATERIALS USED FOR VARIOUS PARTS OF THE MACHINE

To take up the matter of materials: The cylinder carriage and some of the cams are of 40 per cent. semisteel. The ways of the bed are of chilled cast iron. The rest of the cams are of steel. With the exception of two, all the gears are of steel, and some of them are heat-treated. All the bearings, with the exception of two, are of Cramp's bearing bronze. All the spindles are made from high-carbon steel forgings. A few features of workmanship are the grinding of all cylindrical bearing surfaces, whether hardened or unhardened, and the use of jigs and special machine tools to insure accuracy of alignment.

The "Radical" automatic is now built in two sizes—1 in. and 1¼ in. Later, three other sizes will be added—1⅞ in., 1½ in. and 2 in.

Light-weight Alloys Used in Zeppelin Construction

Owing to its low specific gravity, aluminum is extensively used in the construction of airships of the Zeppelin type, and some extraordinary stories have been told of the wonderful properties of some of the light alloys used for this purpose.

In this connection the analyses of various alloys of aluminum used in the construction of German Zeppelins are very interesting, as they show there is nothing new about them; that in fact, they are very much inferior to the aluminum alloys used in this country for the construction of automobile engine pistons and for other similar castings. The analyses were made by French chemists and were originally published in the *Revue des Produits Chimiques*. The alloys follow:

For Angle Brackets

	Per Cent.
Aluminum	90.27
Zinc	7.80
Iron	0.45
Silicon	0.37
Copper	0.73
Tin	0.11
Manganese	0.27

For Channel Sections

Aluminum	88.68
Zinc	9.10
Iron	0.43
Silicon	0.49
Copper	0.70
Tin	0.15
Manganese	0.45

For Braces

Aluminum	99.07
Zinc	0.13
Iron	0.38
Silicon	0.36
Copper	0.06

The two first alloys are practically identical and the last is commercial aluminum. In making the alloys a hardener was probably used containing copper, manganese and iron, and after this had been dissolved in proper proportion in the aluminum, zinc was added, the absence of magnesium is not remarkable, considering the fact that these alloys are exposed to trying weather conditions.—*Brass World*.

Arbor for Machining Rollers

By DONALD A. HAMPSON

Several thousand small flanged steel rollers, Fig. 1, had to be resized owing to a change of design of the machines on which they were to be used. The rollers had been made only within screw-machine limits, but the changes required that they should all have the same size of hole and the same outside diameter and that these should be concentric.

The first operation was to make all the drilled holes alike by running a reamer through them. Then an arbor that would be solid and permanent had to be made. It is the gripping feature of this arbor that is worth noticing. The arbor is shown in Fig. 2. It

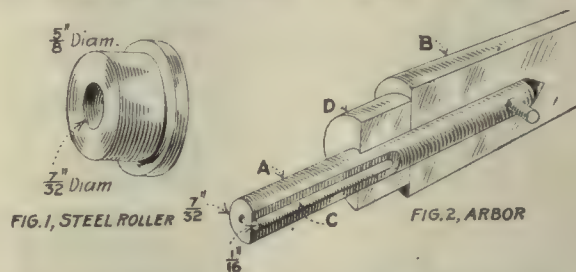


FIG. 1. THE WORK FIG. 2. THE ARBOR USED

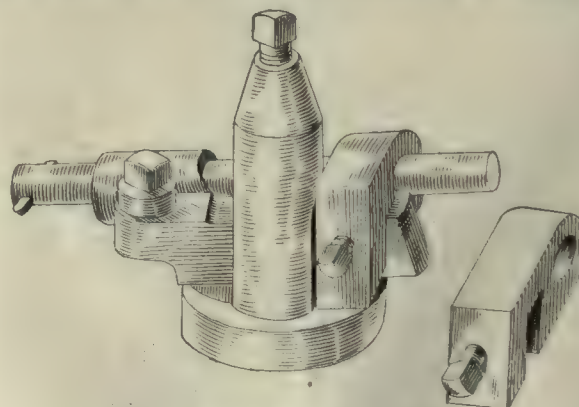
is a hardened and ground piece on which the rollers can be placed one at a time with the fingers, but with no perceptible shake. One end A carries a center hole, and the other is a light drive and pinned in the shank B.

To drive the rollers without further labor, a roller C was supplied to the arbor, working on a flat surface ground before assembling. This roller was made from 1/8-in. tempered drill rod and the flat so measured that the roller in midposition was within the 7/32-in. circle, permitting removal of the work. As the rollers were put on the arbor, they were pushed up against the collar D and given a twist. This movement caused the gripping roller to wedge itself between the flat and the bore.

Boring-Tool Support

By THEODORE KRUSE

The illustration shows an extra support for the rear end of the boring bar for a No. 9 Armstrong boring bar. This I find to be a great improvement, as it makes the



BORING-TOOL SUPPORT

tool more rigid. The hole is a sliding fit for the bar. The rectangular slot fits over the holder and is clamped by the setscrew.

Making Bayonet Scabbards--I*

By ROBERT MAWSON

SYNOPSIS—In this article are shown the various operations and special tools for manufacturing a bayonet scabbard. The problem of making such a part has been attempted by many firms, but often with only indifferent success. The tools and methods here presented are used successfully, and their description should prove both an interesting and a valuable possession to those concerned with munition manufacture.

Since the beginning of the European War quite a number of firms have tackled the problem of manufacturing bayonet scabbards. To most of these firms it seemed such an easy problem that it offered a wide-open door to "get rich quick." After many experiments and at a loss of much money almost all these would-be scabbard makers dropped the work and either went back to their original line of manufacture or took up other branches of munition making.

The Worcester Pressed Steel Co., Worcester, Mass., is a concern, however, that not only solved the problem, but is manufacturing scabbards at an average of 1,000 per day. In Fig. 1 is shown a detail of the scabbard. In Fig. 2 are illustrated samples from each operation up to the completed scabbard. The sequence of operations is given in the accompanying table.

TABLE OF SEQUENCE OF OPERATIONS

Body:	Mouthpiece:
1. Blank	1. Blank
2. First form	2. Pierce slot
3. Bend	Spring:
4. Closing	1. Blank
5. Weld longitudinal seam	2. First form
6. Weld on ball tip	3. Bend
7. Braze on stud	4. Close-in
8. Polish	5. Assemble mouthpiece to
9. Blue	spring, and braze
10. Straighten	6. Size brazed joint
11. Rivet strap on stud	7. Harden spring
12. File end of scabbard	8. Polish mouthpiece
13. Assemble mouthpiece in	9. Draw temper
scabbard	10. Blue mouthpiece
14. Pierce hole through scab-	11. Inspect
bard and spring	
15. Tap	Stud:
16. Fasten spring in scabbard	1. Blank
with screw	
17. Inspect	Washer:
18. Pack for shipping	1. Blank and pierce

The first operation is blanking, and the machine set up for this work is illustrated in Fig. 3. The steel strip for the blanking is cut to the length of the scabbard,

allowing sufficient stock at each end to insure perfect blanks being made. The strip is fed in from the front against the stop shown on the die. The punch, being caused to descend, blanks out the part. The stock is fed forward, the front edge of the blanked opening being

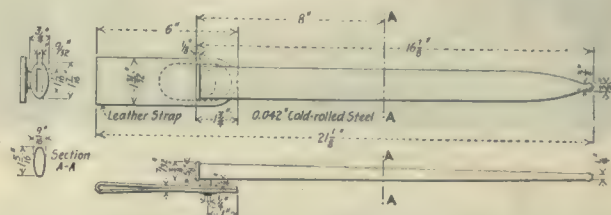


FIG. 1. DETAIL OF SCABBARD

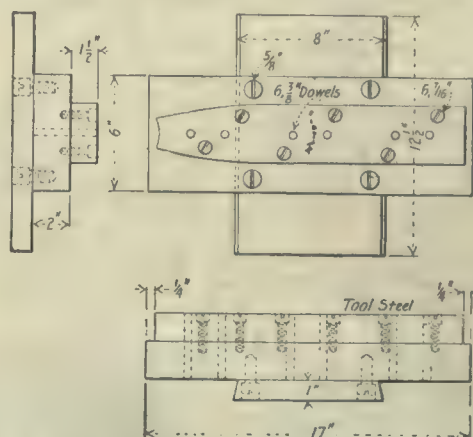
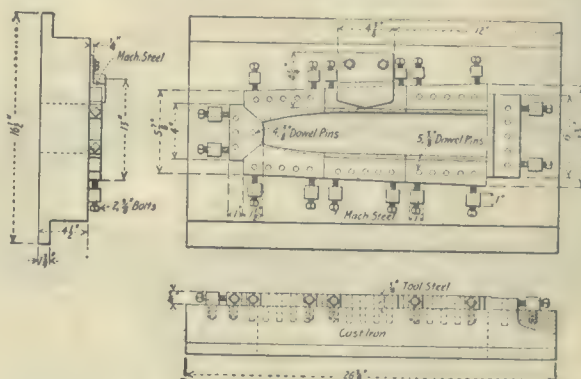


FIG. 4. PUNCH AND DIE FOR BLANKING

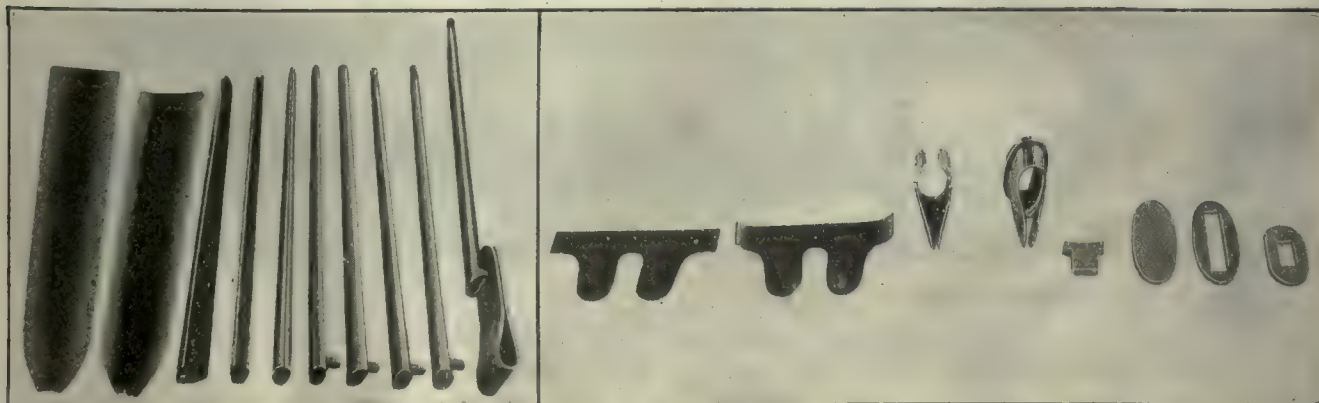


FIG. 2. SAMPLES OF SCABBARD PARTS IN PROCESS FROM BLANK TO FINISHED PIECE

*Copyright, 1916, Hill Publishing Co.



FIG. 3. BLANKING THE BODY



FIG. 6. FIRST-FORMING THE BODY

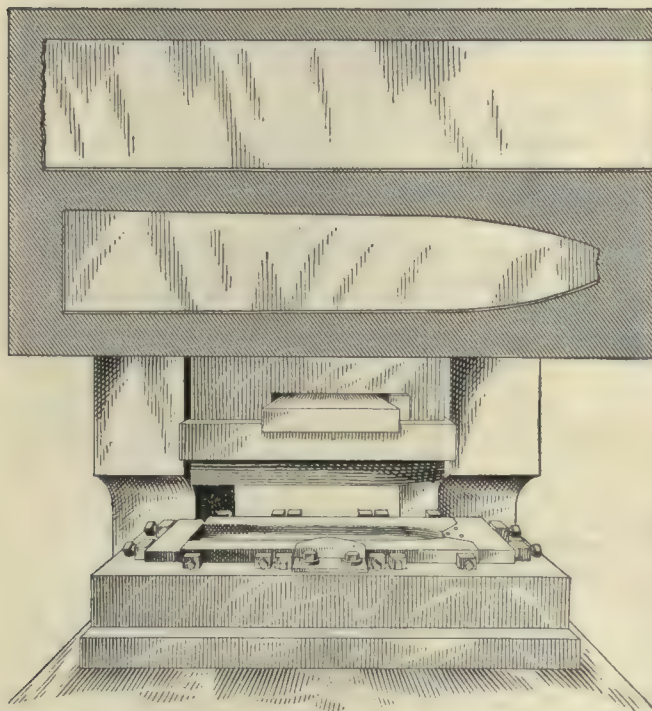


FIG. 5. OPERATION 1: BLANKING BODY
Machine Used—First blanking, Toledo 2½-in. stroke press.
Production—1,000 per hr.
References—Figs. 3 and 4.

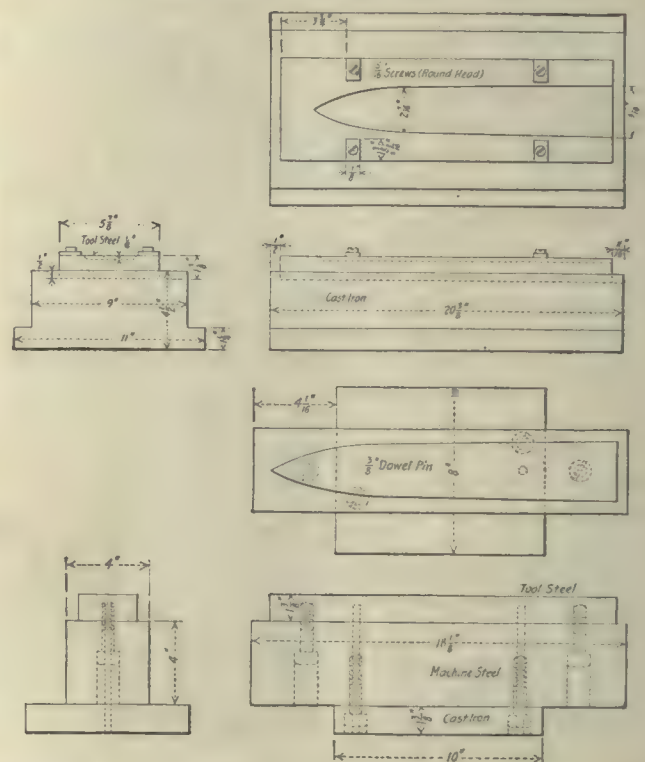


FIG. 7. PUNCH AND DIE FOR FIRST FORMING

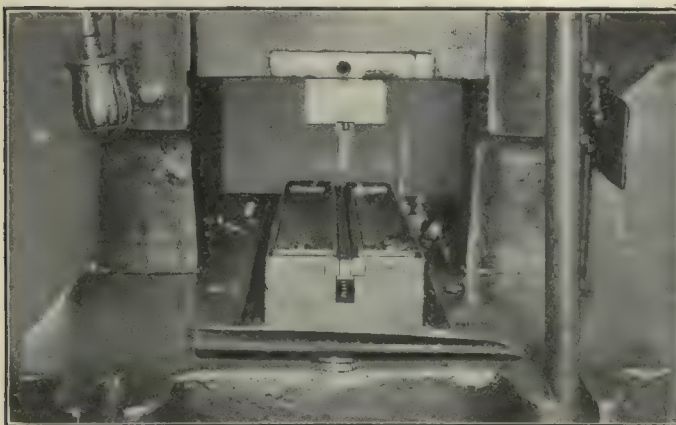


FIG. 9. BENDING THE BODY

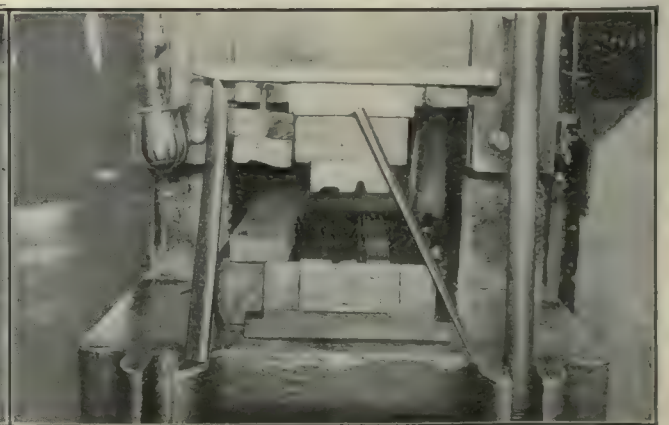


FIG. 12. CLOSING THE JOINT

brought against the locating stop mentioned. The sheet is then ready for the next blanking. The punch and die, Fig. 4, are the tools for blanking. The operation is also indicated in its diagrammatical form in Fig. 5.

The next operation is first-forming. The press performing this work is seen in Fig. 6. The punch and die for this operation are given in detail in Fig. 7. The operation is also shown diagrammatically in Fig. 8. The

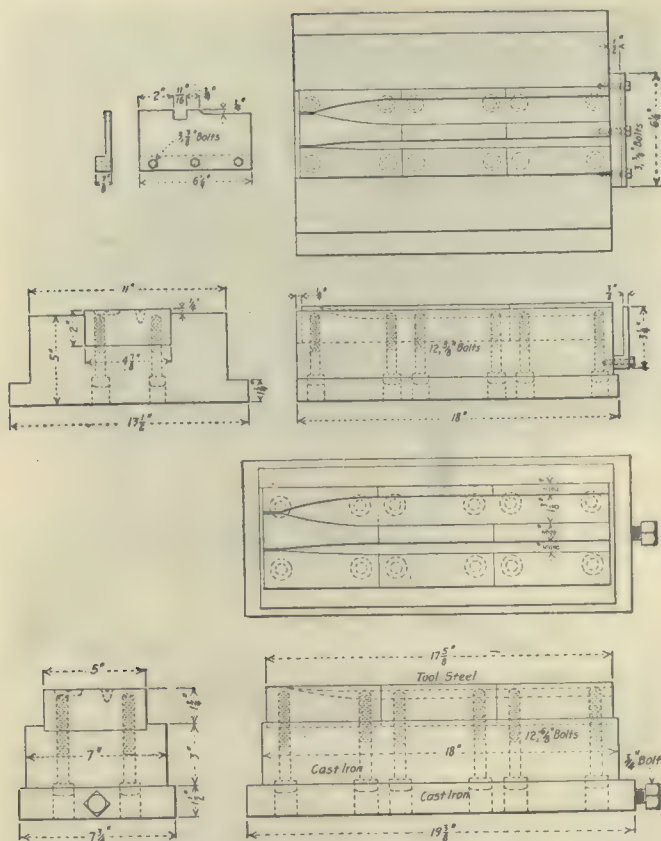


FIG. 15. TOOLS USED FOR FINAL CLOSING OPERATION

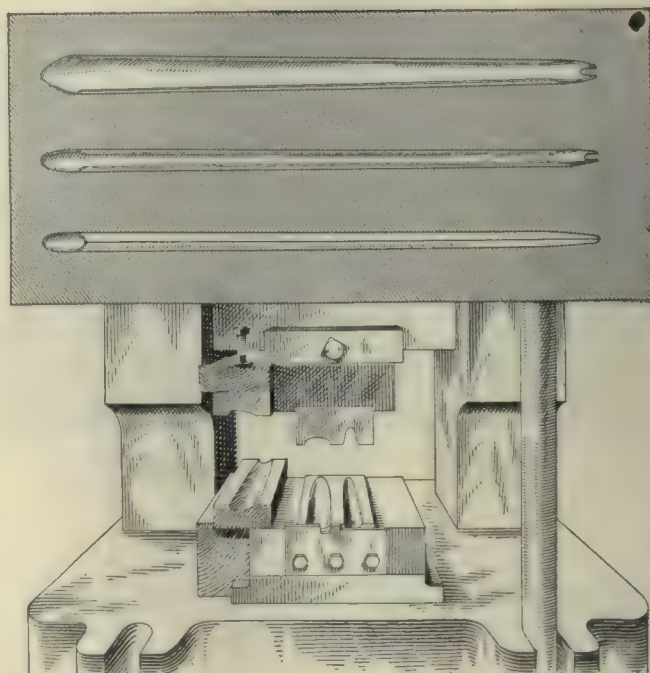


FIG. 16. OPERATION 4: CLOSING JOINT
Machine Used—Bliss 6-in. stroke press.
Production—1,000 per hr. for suboperation 1, 210 per hr. each for suboperations 2 and 3.
References—Figs. 12, 13, 14 and 15.

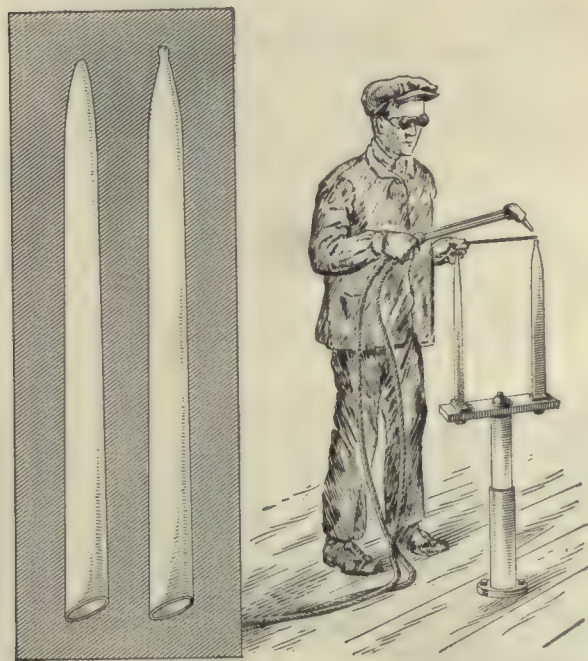


FIG. 20. OPERATION 6: WELDING BALL TIP
Machine Used—Davis-Bournonville torch.
Production—800 per hr.
Reference—Fig. 19.

The next operation is welding the seam. In Fig. 17 is shown one of the scabbards in position in the fixture ready for this welding operation, which is also given in diagrammatical form in Fig. 18. The ball tip is welded at the end of the scabbard as the next operation. The scabbard is held on the fixture seen in Fig. 19 and the ball, which is made with a shank to fit into the hole at the end of the scabbard, is welded in position. A dia-

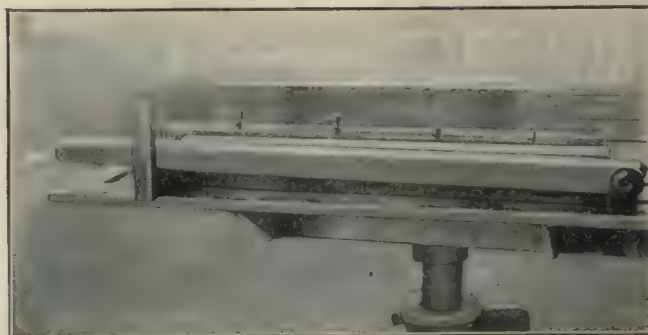


FIG. 17. FIXTURE USED IN WELDING THE SEAM

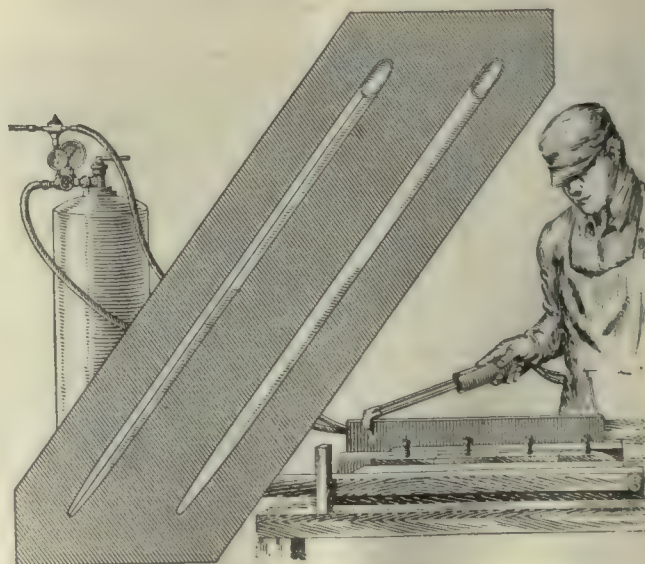
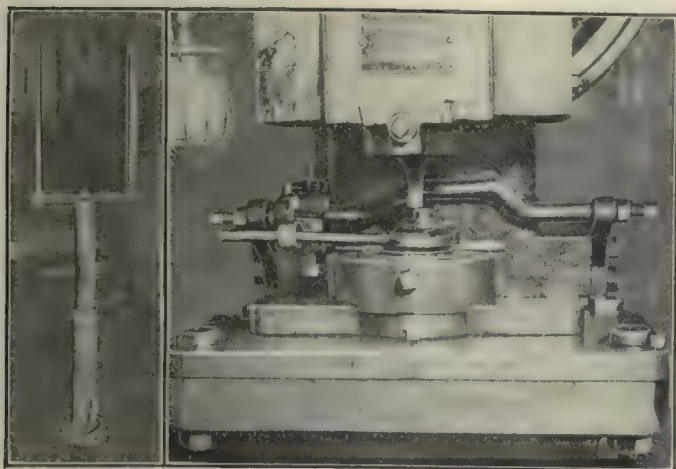


FIG. 18. OPERATION 5: WELDING THE SEAM
Machine Used—Davis-Bournonville torch.
Production—30 per hr.
Reference—Fig. 17.



FIGS. 19 AND 21. WELDING ON TIPS AND PUNCHING
THE SCABBARD STUD

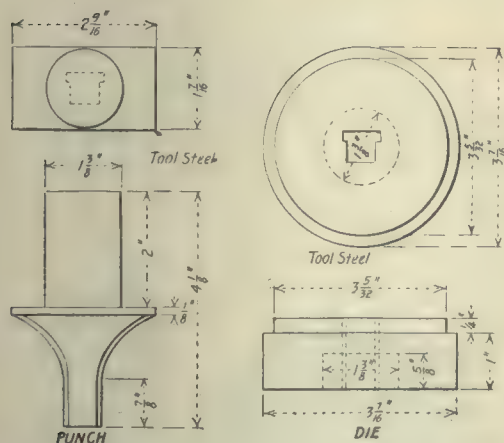


FIG. 22. PUNCH AND DIE FOR MAKING STUDS

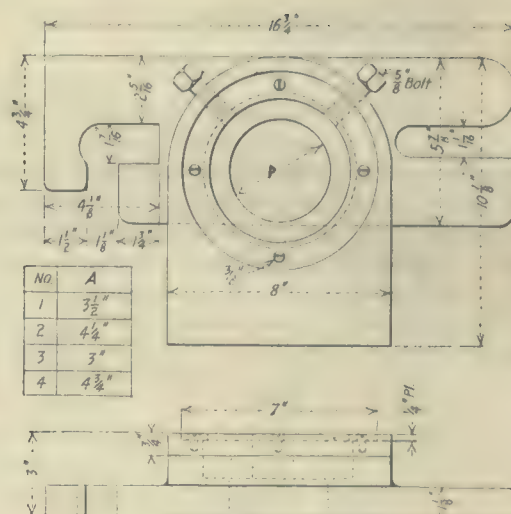


FIG. 23. DETAIL OF BOLSTER

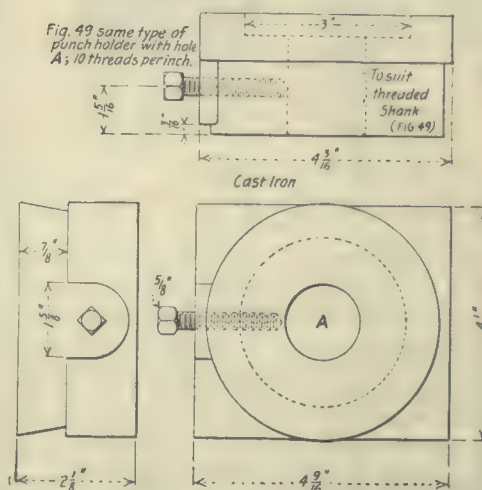


FIG. 24. DETAIL OF PUNCH HOLDER



FIG. 26. BRAZING ON THE STUD



FIG. 28. BELT GRINDER FOR SCABBARDS

grammatical illustration of the operation is given by Fig. 20, which shows clearly the details of the work.

The next operation to be mentioned is the making of the scabbard stud. The punch press, with the tools for making the stud, is illustrated in Fig. 21. The punch and die are shown in detail in Fig. 22. The die fits into the bolster, Fig. 23, and the punch is secured to the machine with the holder, Fig. 24. The operation is also seen in diagrammatical form in Fig. 25.

The stud is brazed to the side of the scabbard, using the fixture illustrated in Fig. 26. For this work, the

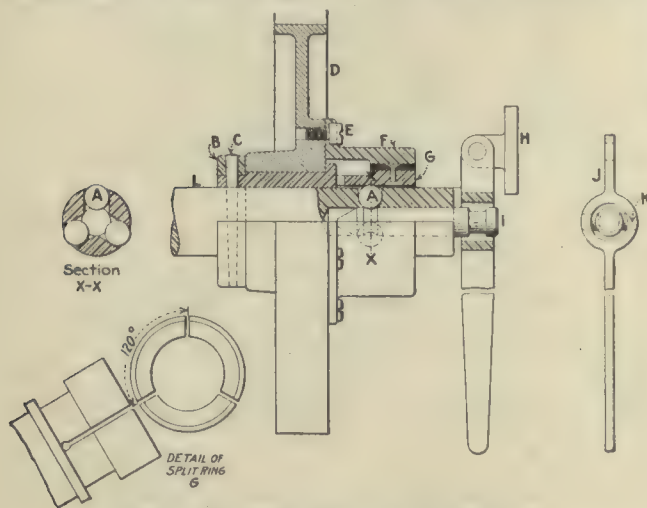
welding torch is employed to melt the brazing spelter, as shown in the diagrammatical illustration, Fig. 27, this operation being facilitated by the fixture used. The scabbard is then taken to the polishing department and ground all over the outside on a wheel. The surface is polished on the belt grinder, Fig. 28. The operation is also given diagrammatically in Fig. 29. The scabbard is transferred to the annealing shop for the bluing operation. This and the subsequent operations will be described in the next section of the article.

(To be continued)

An Expansion Clutch

By A. T. APPLGATE

Herewith is shown the design for an expansion friction clutch for comparatively light work, such as auxiliary drives for machine tools. The arrangement of parts is such that it can be used only at or near the end of a shaft. The drive in this design is through the shaft *L* and spur gear *D*. The driving member of the clutch is a split steel ring *G* that expands against the drum *F* when the three balls *A* are forced outward by the cone-shaped end of the plunger *I*. In this particular case



BALL AND CONE EXPANSION CLUTCH

the ring *G* was faced with a "brake lining," but it could be used metal to metal. The drum *F* is bolted to the gear by the screws *E*. The gear is retained in place by means of the collar *B* that is secured with the taper pin *C*. The bracket *H* to which the shifting lever *J* is fastened is located on a solid part of the machine. The pins *K* should be hardened. There is spring enough in the segments of the split ring so that the balls can be raised over the high part of the plunger and into the retaining groove.

✽

Brush and T-Slot Scraper

By DAVID MAJOR

Realizing the value of combining tools that are used in connection with one another, I contrived the device



COMBINATION BRUSH AND T-SLOT SCRAPER

shown in the illustration. It consists of a machine T-slot scraper and a brush. Chips can readily be removed from blocked and crowded slots with the scraper, which

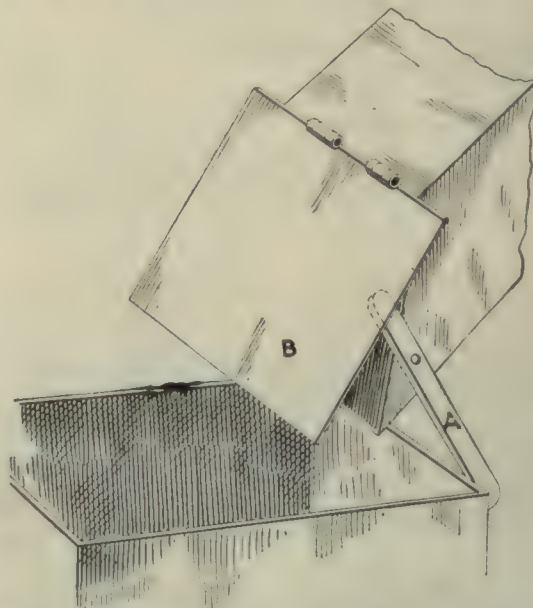
is made of cold-rolled steel and screwed into the back end of the brush. Then when the chips are freed, the brush is brought into play to remove them and clean up the table. It is evident that time is saved by such a contrivance in place of two separate articles.

✽

Self-Closing Chute Door

By E. G. BAGGER

The drawing shows an extremely simple and inexpensive attachment that may be put on any wood or metal chute to prevent small machined parts from spilling on the floor while the receptacle under the machine is being removed or emptied. It is not necessary to stop the machine with this attachment. When the receptacle is pushed in under the machine, it strikes the U-shaped piece *A*, bolted on the chute. The upper end of *A* forces open the gate *B*. When the receptacle is pulled away,



SELF-CLOSING CHUTE FOR WORK CONTAINERS

the weight of the gate *B* forces it shut, preventing parts from dropping out for some time unless they are very heavy. Even so, they may be kept in by adding to the weight of the gate.

This attachment has been applied successfully to presses for making metallic shells for cartridges. It may be adapted to many other styles of machines equally well. The parts are made of ordinary sheet steel.

✽

Properties of Beryllium

Beryllium is a lustrous, soft, white, tough metal something like aluminum but of lower specific gravity. In the form of ribbon or powder it burns in the air like magnesium.

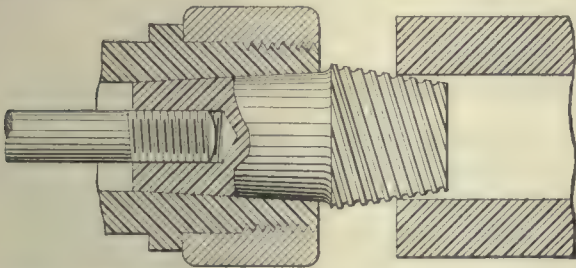
The metal alloys easily with copper, forming a white metal when the proportions, 90 per cent. copper and 10 per cent. beryllium are used, and a yellow alloy when 95 per cent. copper and 5 per cent. beryllium are alloyed. The metal could be obtained without great difficulty but the small quantity of beryllium oxide available makes it unlikely the metal will ever become more than a curiosity.—*Brass World*.

Letters from Practical Men

Driving Center for Rough-Turning 18-Lb. Shells

Of the many methods of drawing the work in the rough-turning operation on British 18-lb. high-explosive shells the following surpasses them all.

The drawing shows a plug center with about a 20-deg. inclusive angle turned with quadruple grooves made to fit the spindle of the lathe. These grooves have a sharp edge to grip the shell, and the greater the cut



DRIVING CENTER FOR ROUGH-TURNING SHELLS

the better it will hold. The shell is loosened by a grip wrench. As soon as the cut is started, the tail center must be tightened. A tool post, holding two tools, is used, the roughing tool being about an inch in advance of the finishing tool. This combination runs for hours without resetting, as the finishing tool has only a small amount of work to do.

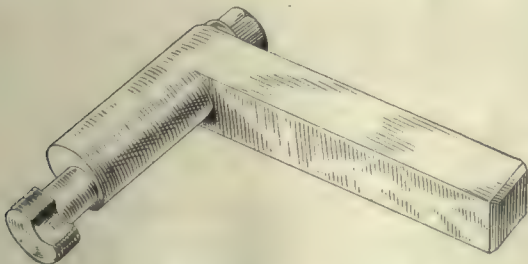
JOHN HOMEWOOD.

Medicine Hat, Canada.

✕

Internal Chaser Holder for Threading

The illustration shows a form of chaser holder that we have found useful in conjunction with circular chasers of the type shown for cutting internal threads. The shank of the chaser is made with a very slow taper and when pulled up by the nut is locked securely in the holder, the taper hole in which is bored eccentric, as shown. This



INTERNAL CHASER HOLDER

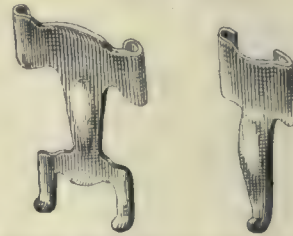
allows the holder to enter the hole being threaded, so that the chaser need project only a small amount from the holder. This makes a stiff job.

F. G. SMITH.

Coventry, England.

Convenient Clips for Rules and Rule Covers

The readers of *American Machinist* may possibly be able to make use of two ideas of mine, not patented, which are shown herewith. One is a clip for a 6-in. flexible rule cover. This clip is so constructed that the tongues bear on the steel binding of the cover, permitting the rule to be withdrawn readily without pulling the case from the pocket. The other clip is for the 1/2-in. width



POCKET CLIPS FOR STEEL RULE AND CASE

6-in. flexible rule and has also a depth gage—the lip projecting at right angles to the clip.

These two safety clips have been extremely useful to me. I am never obliged to look around for my rules, as they do not fall from my pocket when I lean over.

Rutherford, N. J.

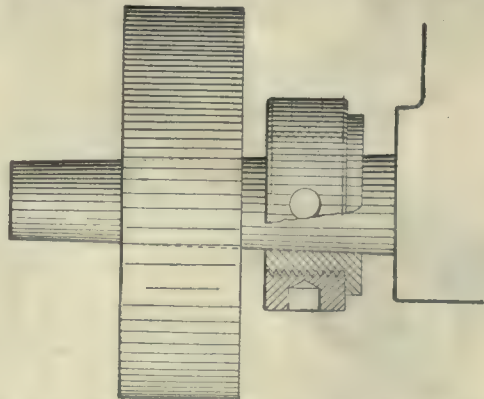
GEORGE F. KUHNE.

✕

Removing Polishing Wheels from Taper Spindles

Polishing wheels are usually removed from taper spindles by driving them off with a hammer.

The sleeve and nut shown do the work with less effort and do not harm the wheel or spindle. Both are made of cast iron and vary in size according to the size of



JACK NUT FOR REMOVING POLISHING WHEELS

spindle. The sleeve fits the spindle close to the jack and about 1/4 in. from the face of the wheel. A spanner wrench is used to operate the nut. On a double polishing jack the threads are made right- and left-hand and are used on their respective sides.

Chicopee Falls, Mass.

EDMUND S. MALE.

Recessing Attachment for Automatics

The attachment shown in the illustration was designed to machine the recesses in the bushing *A*, and it is used on automatic machines in which the spindles revolve and carry the tools. The work is held in the chuck and fed up to the spindles. This attachment can, however, be used with equal facility in the screw-machine lathe or the drilling machine.

The body *B* is held in the spindle of the machine, and the sliding member *C* carries the striking block *D* and the recessing tool *E*. The machine feeds forward



RECESSING ATTACHMENT FOR AUTOMATICS

the chuck jaws carrying the work. The face of the chuck jaws comes to the striking block, causing the sliding member to travel on the arms of the body, which are set at an angle of $7\frac{1}{2}$ deg. The recessing tool is thereby forced outward from the center and cuts the recess.

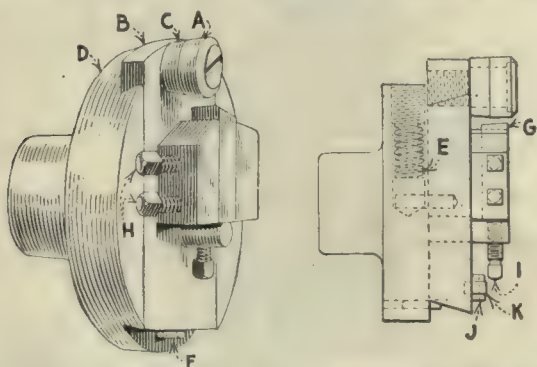
When the work has arrived at the end of the forward stroke and starts on the return, the spring *F* between the body and the sliding member, which has been compressed on the forward stroke, keeps the striking block against the face of the chuck jaws. The recessing tool recedes toward the center and is kept there until stopped by the head of the screw which regulates the amount of travel in that direction.

JAMES H. LILLER.

Berwyn, Penn.

Boring and Chamfering Tubular Work

The difficulty of getting a concentric bored hole or a chamfered portion on tubing or thin tubular parts, has been successfully overcome in our shop by several sizes of the type of tool herewith illustrated and de-



BORING AND CHAMFERING TUBULAR WORK

scribed. It is used for boring thin brass and other seamless tubing, in one instance removing $\frac{1}{16}$ in. of metal from a tube originally $\frac{3}{32}$ in. thick in the wall, in another case removing $\frac{5}{64}$ in. $\frac{3}{4}$ in. deep in steel. In this operation the lug *J* holding the roller *K* was made to act as a stop.

Another job, a second operation on a Brown & Sharpe automatic using a magazine feed, was done with a tool of this kind. There have been various other applications, as turning short lengths when pieces have been bored which require accurate concentricity. In this case the position of the guide roll *A* and the cutting tool *G* was reversed from that shown. The rounded and beveled guide roller *A* is held to the block *B* by the stud *C*. The roll is a running fit on the stud. The dovetailed block *B* is a good sliding fit in the holder *D*. The helical spring *E* keeps the roll and slide *B* in position when in contact on the work and against the stop pin *F* when out of contact with the work. The cutting tool *G* is held in the block *B* and secured by the setscrews *H*. The adjusting of the tool is by the screw *I*.

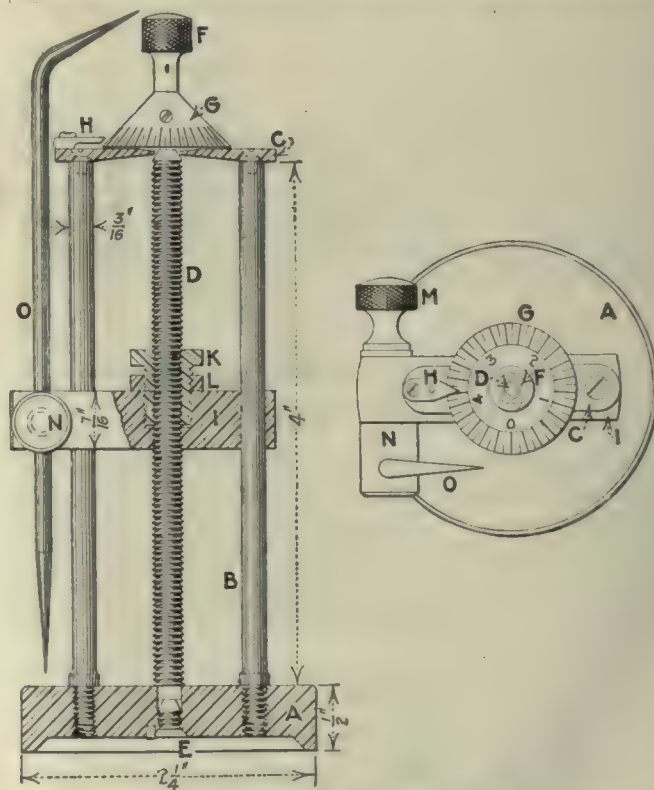
The cost of these tools has been saved many times over in simplifying operations and in producing accurate and concentric work.

J. A. BOUDREAU.

Lowell, Mass.

Micrometer Surface Gage

The illustration shows a tool for scribing off parallel lines at varying distances. The scriber consists of a base *A*, which is tapped for $\frac{3}{16}$ -in. posts *B*, with shoulders at the top and bottom, as shown. They are connected at the top by a steel plate *C*. The plate is screwed against



A MICROMETER SURFACE GAGE

the shoulders of the posts by countersunk screws. It is filed out in the center to a trifle under $\frac{1}{2}$ in., the rounding on both sides making it springy. From the base and extending with a turned-down end through the plate is a $\frac{1}{4}$ -in. screw *D*, 20 threads to the inch. It rests on the adjusting screw *E* in the base and at the other end is pressed against the plate *C*. This is made possible by means of the small cone turned on the screw between the threaded and the thinner portions. The screw *E* is

turned till there is plenty of spring in the plate, thus causing sufficient friction to prevent the screw from accidental turning. Then the screw *E* is pinned down to the base.

The turned-down upper end of the screw *D* is provided with a knurled knob and a cone divided in 50 equal parts, both fastened to the screw by means of a pin and set-screw. A small indicator *H* is screwed on top of the left post, next to the cone. As the screw is 20 to the inch and the cone is divided into 50 divisions, turning the screw one division makes block *I* move 0.001 in. A bushing *K* threaded on the outside to fit the tap in the block and threaded on the inside to fit the screw can be turned a small part of a revolution to take up the slack that might be between the screw and the block. The locknut *L* keeps the bushing in position after proper adjustment. The swivel *N*, with the knob *M* and the scriber *O* at the end of the sliding block, can be clamped in any position, height or angle, thus giving the instrument a very wide range of action.

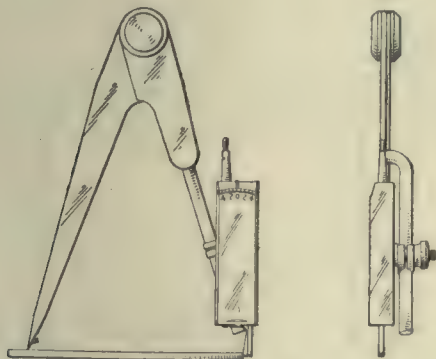
Brooklyn, N. Y.

JAN SPAANDER.

An Indicator on a Caliper

The accompanying sketch shows a caliper that has proved very efficient in producing gages and templates in our toolroom. Having work that required accuracy as to radius and angles, we were forced to seek other ways than depending on the layout lines.

We cut one leg from a pair of hermaphrodite calipers and drilled a small hole in the side near the cut. In this we brazed a piece of drill rod (size No. 2 gage, which



PUTTING AN INDICATOR ON A CALIPER

corresponds to the rod in a small-surface gage) with just enough offset to bring the contact point of the test indicator in line with the other point of the hermaphrodite calipers. With this tool we were able to file to a limit of 0.001 in. from our original layout point. It is also very useful in finding the exact center of a bore when a piece requires further laying out.

Schenectady, N. Y.

A. J. DAVIGNON.

A Handy Drawing-Room Drawer

The illustration (Fig. 1) shows a useful and handy drawer for the drawing office. A sliding cover *A* and rollers *B* were used. This puts pressure on the paper and at the same time a straight cutting edge is obtained. The joint was made as shown at *C*. For a roller axle a piece of wood about $\frac{3}{4}$ in. in diameter squared at the ends, with two washers clamped by cotters, enabled the keeping of the paper in place. By making the drawer

wider a similar arrangement was used for tracing cloth and is shown in Fig. 2. By removing the wooden core inserted in the cloth it can be dealt with in the same manner as the paper.

It will be found easier, however, to insert a wood screw at each end and use a bearing, as shown at *A*. If

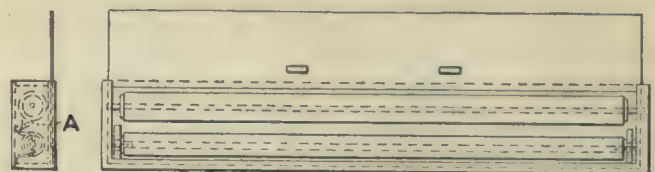
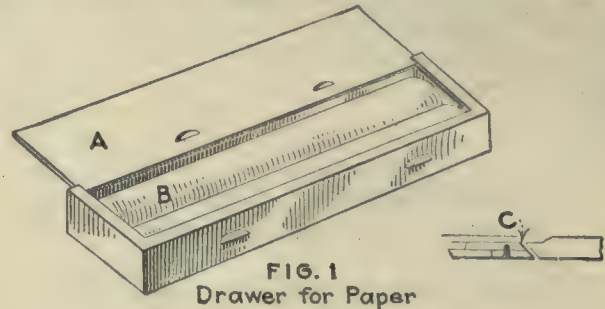


FIG. 2 Draw. for Tracing Cloth

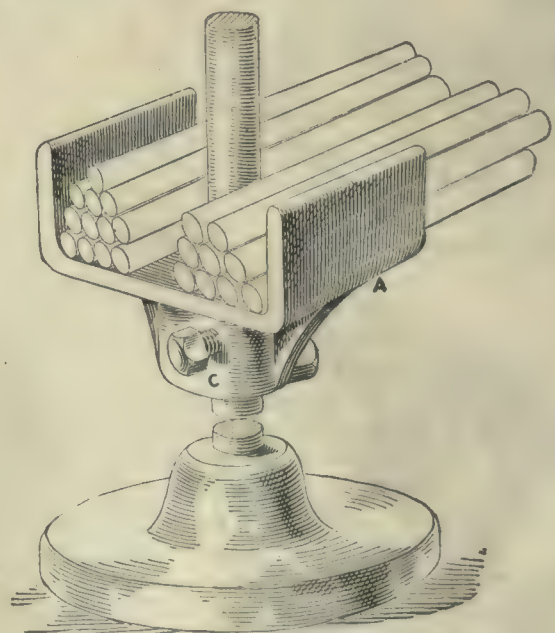
this arrangement is put at the back of a wide drawer graduated on the side, paper can be measured without the use of a rule.

ANDREW SMITH.

Philadelphia, Penn.

Storing Screw-Machine Stock

I have noticed that in many shops the bar stock for the automatic screw machines is brought to the machine in quantity and stacked on the floor. Besides taking up a great deal of room, this also interferes with trucking.



RACK FOR BAR STEEL STOCK

An arrangement for storing the stock in racks that keep it off the floor and at the same time occupy space that would not otherwise be used, is shown in the illustration. The casting *A* can be made as shown, or, as in the case

of small-diameter stock, it can be made double-deck and secured to the vertical member of the conventional support by setscrews or pins.

These racks can be made very cheaply, as on the one shown the only machining was the drilling and tapping of the holes for setscrews. It was not necessary to bore the casting. In some cases, if the boss *C* is made large enough in diameter, the casting can be bored out to suit various sizes of shafts, thereby saving the expense of making patterns for different sizes. P. G. LITTLE.

Kenosha, Wis.

Making Copper Rifling Rings for 3-In. Shells

Cutting off copper rings to gage and without loss of time fooling with setting the tools, etc., is a rather tedious job on the automatic screw machine. A better and more accurate way is first to cut them off on the auto-

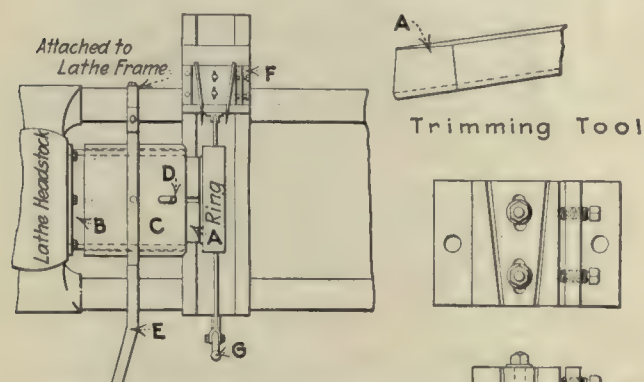


FIG. 1 TRIMMING LATHE

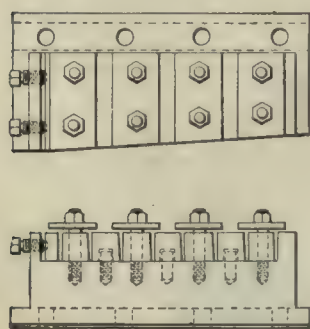


FIG. 2 CUTTING-OFF TOOL AND HOLDER

matic and then trim them in a specially equipped lathe, as illustrated in Fig. 1.

When placing the ring on the chuck, the sleeve *C* is first moved forward by the handle *E* until it is stopped by the pin *D*. This sleeve acts as a stop for placing the ring on the chuck. The tool holder *F* is moved forward by a rod attached to a handle *G*, which is in turn fastened to the bed of the lathe. A stop for the tool holder is attached to the cross-slide. The chuck and air cylinder are of the type manufactured by the Manufacturers Equipment Co., of Chicago, Ill.

Fig. 2 shows a tool holder used on the automatic screw machine for cutting off seven rings in one operation. The cutting tool is a piece of "Blue Chip" steel, ground as shown at *A*. The construction of the tool holder can readily be seen from the illustration.

This lathe is used for trimming the rings. The internal collet chuck *A* is operated by a rod passing through the hollow lathe spindle to a piston and air cylinder fastened at the rear of the lathe spindle. The air cylinder is operated by a foot lever. The casting *B* is fastened to the lathe headstock, and on this the sleeve *C* slides. A pin *D* is fastened in *B* with a slot in the sleeve *C*.

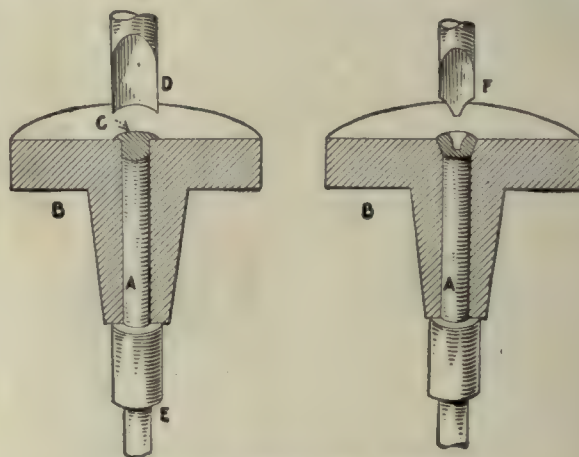
Fig. 3 illustrates the tool holder and cutting tool used for trimming the rings. It will be noticed that the tools can be adjusted to width with this holder. The tools are placed in the holder with the cutting edge down. This holder can be used for trimming rings with both straight and beveled sides by grinding the tools accordingly. Four thousand 3-in. rings can easily be trimmed in a 10-hr. day with this equipment. J. A. JONES.

New York City.

A Riveting Stunt

Having a quantity of 1/4-in. diameter brass tenons *A* to rivet into round castings *B*, we attempted to secure a head *C* with a 1/8-in. capacity riveter hammer *D*. The hammer was of the common type used in small riveters and revolved slowly in addition to its rapid vertical motion. We not only did not secure a good head at *C*, on account of the small size of the machine, but succeeded in injuring the shoulder at *E*.

It finally occurred to me to cut the tenon shorter and drill a hole in the end. After making a hammer point



THE TWO METHODS OF RIVETING

F and countersinking the hole in the casting at *G*, we were surprised at the ease and quickness with which we were able to do the work; and there was no damage to the shoulder at *E*. The time consumed in drilling the tenon and countersinking the hole in the casting was insignificant compared with the saving in riveting time.

Springfield, Mass.

G. F. HARTER.

The great need today in standardizing the trades is for coöperation. In other times all excellent methods or means were held as "trade secrets," sometimes lost to the world for generations until rediscovered. The day for this is past. Thinkers of today recognize that the work to be done is so great that, given all that every one has accomplished and is accomplishing, there is room and to spare for every worker who cares to enter the field.

FRANK B. GILBRETH.

Discussion of Previous Question

Welded High-Speed Tools

The recent articles in the *American Machinist* describing the welding of high-speed steel cutting edges or points on carbon- or machinery-steel shanks is especially interesting and valuable at this time when the price of high-speed steel is increasing so rapidly.

Undoubtedly the welding on of high-speed steel cutting ends is entirely practicable, and with a proper method is inexpensive. I have developed a method of utilizing short lengths of high-speed steel, as clearly indicated in the illustration, which is offered as a contribution to the literature on this subject. This photograph shows two tools made of $\frac{3}{4} \times 1\frac{1}{2}$ -in. stock with carbon-steel



WELDED CUTTING TOOLS

shanks and high-speed steel cutting ends. The white chalk line on the tool indicates the location of the weld. In the actual tools the joint of the weld is just perceptible. The photograph also shows two tools $\frac{1}{2} \times 1$ in., made up of 0.40 per cent. carbon-steel shanks and high-speed ends which have been bent hot as an indication of the strength of the weld.

The advantage of the method here shown is that the work can be done in an ordinary smith's forge without any special equipment and at a cost not materially in excess of welding any soft steel. AXEL STROMFORS.

Holyoke, Mass.

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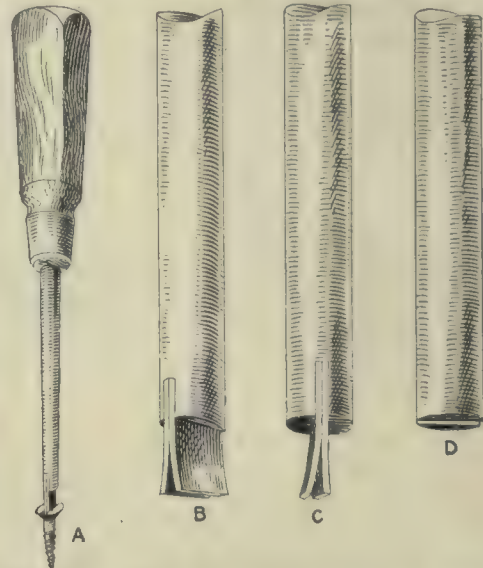
Magnetic Screwdriver

Why try to use a magnetic screwdriver as shown on page 729, Vol. 44, and elsewhere? I have had a couple of years experience in which the screwdriver was one of my main working tools and I have found that there are just as many brass as steel screws used in a good many shops. So if a person has a magnetic screwdriver, either permanent or electro-magnetic, he cannot secure any benefit where brass screws are used.

The illustration shows a tool used and which fellow workers swear by. I know the idea is not new, but we

have been using it for several years, and for starting a screw in close quarters or any place where you might use a magnetic screwdriver, it is O. K. It will start brass as well as steel screws.

The view shows the slotted drill rod at A, while B and C show the two leaves of spring steel inserted. The



SCREWDRIVER THAT HOLDS SCREWS FOR STARTING

points are not sprung apart as far as shown at B. These are closed and inserted in the screw as at D and hold the screw, making it easy to start. The job can be finished with a solid screwdriver if it requires more pressure than this can give readily. Different sizes can easily be made and will be found very useful.

Connellsville, Penn.

W. R. HAMMER.

✱

Metric System and Its Critics

In discussing the English and metric systems on page 1089, Vol. 44, George G. Little considers the subject from a point of view which, I believe, does not give just consideration. At first he told us that he never used the metric system, and then he tries to show that the oral expression in millimeters is troublesome. I have worked with the metric system for about ten years. For the same length of time I have been working with the English system. I must say that one expression is just as easy to make or comprehend as is the other. If the metric system is established and universally known, less time will be lost by saying "eleven" or "twelve-seven" (12.7) than in saying "one-half of an inch." The millimeter "unit" need not to be expressed, since it is understood. No dimension, then, needs such lengthy expression as "sixty-two and a half" (0.0625 in., using Mr. Little's own example).

I admit that while the change from one system to the other was in progress, there would be a little inconvenience for some people. But it is the same as when we move from an old, unmodern dwelling to a new one.

The packing, moving and new arrangements cause expenses and discomfort. Once we are settled, we wish "we'd done it long ago."

To establish the metric system does not mean the adaptation of something "just as good." It rather means to adopt a simpler and more convenient system. Mr Little gives upright and Spencerian writing as an example, concluding that the last is the prettier. On discussing the metric and English systems, it is not a matter of how much one is attached to a "good old method." Nor is it a question of æsthetics. It is a question of how much effort, energy and time is spent while working with one or the other system. My own experience (in the shop as well as in the drafting room) taught me that the metric system has its advantages. If we compare the two systems with the old Roman system of figuring (as MMDCCCXLVIII) and the Arabian now in use (as 2,848), I believe we come nearer to the reality. A hundred years ago we might have gotten along "just as good" with the old Roman system, which is cumbersome and lengthy.

We hear again and again that the English system is easily computable. True enough, but nevertheless there is still a pilgrimage to some corner in the shop, where the table of decimal equivalents is shining. Our micrometers are still decorated with decimal equivalents on both sides, and I have seen cases where the owner had to consult his "mike" about a dozen times daily.

A SCENE FROM REAL SHOP LIFE

In all our industries of a light and medium nature no one, from the tool maker down to the machinist apprentice, can get along without a number of tables that the metric man would ignore entirely. Here is a little conversation which actually took place and which shows characteristically where the English system is of advantage to a modern industry:

Scene—in a medium-sized shop.

Jim (who came from the other end of the floor): "Say, Fred, what size drill must I take for a $\frac{19}{64}$ -in. reamed hole?" Fred, a little surprised: "Why, ain't ye have yer drill gage!"

After pausing a while Fred continued: "Oh, I see; $\frac{19}{64}$ in. is larger than a quarter, and No. 1 drill is the largest in the gage. Well, how much is $\frac{19}{64}$ in.?"

Jim took his "mike" out of the apron. Looking at it, he gave the equivalent, 0.2968. "Oh, well," he added, "let's make it 0.297."

Fred was well pleased with the change in decimals, because he instantly exclaimed, "That's better." He crossed out the first figure and wrote the second down. "Let me see," Fred continued after a while, "I think a drill in the neighborhood of about 0.288 to 0.29 in. will be right."

"Ain't ye smart?" shouted Jim again. "I know all that myself. What I want to know is the number or letter of such a drill."

"I ain't have no table; we'll have to ask Lang," replied Fred.

Both repeated the story to me. While I took out my "American Machinist's Handbook" and looked up index and page for letter-size drills, Jim, Fred and Gus, who "butted in" to see what the argument was, had a little conference. The question came up whether a $\frac{3}{32}$ -in. drill was not big enough. Jim assured them that $\frac{1}{64}$ was

too much to ream and that he had to make fifty pieces in a hurry. In the meantime I found that letter "L" drill is 0.290 in.

Here is a case where four men spent about fifteen minutes. The "Old Man" did not know that Jim had to get special information for the hurry job. Neither did the efficiency man know that an hour's time was wasted and that such time is lost daily. Otherwise he might have introduced some new, efficient system—namely, the metric system.

If the man in the metric shop has to ream a 7.5-mm. hole (about $\frac{19}{64}$ in.), he knows instantly that 7.4 and 7.3 drills are the nearest smaller sizes he can use. Suppose the same man has to make some special screws, say 5-mm. thread and 10.5 head. At once he knows that his two diameters have to be the same as given. On the other hand, if the man with the English standard has to make similar screws, say 10-32 with $\frac{1}{2}$ -in. head, the first thing he has to do is to "look up" what diameter No. 10 is and then get the decimal equivalent of $\frac{1}{2}$ in.

We cannot get away from the fact that, whether calculations are made on the drafting table, in the raw material department or in the shop, there is always a necessity of converting fractions into decimals and vice versa. These conversions alone have caused many a job to be "junked," and a "firing" followed, not to mention the confusing mass of data of different wire gages, sheet-metal gages and other standards that cause endless trouble and waste of thousands of hours daily.

The metric system, with uniform standards running in arithmetical progression, is certainly of advantage to modern industries. Its establishment is easy, and our mechanics would adopt it quickly. However, there is a serious question—and I believe the only question—that confronts us: "How much will our industries suffer and lose by abandoning machines, measuring appliances and tools?"

The question is worthy of discussion.

Chicago, Ill.

ADOLF LANGSNER.



Metric System and Its Critics

I have noticed with disgust the comments on the metric system, in the *American Machinist*; I consider the arguments against it very poor and cheap.

Surely, I hardly expect anything else from English-speaking people, who have a limited knowledge of or are in total ignorance regarding the metric system. Therefore they can easily criticize it and find many sympathizers.

F. P. Terry, on page 78, is so well acquainted with the metric system and inch measurement that, with all his contempt for the metric system, he is unable to point out a single advantage of the inch system over the metric. His only reason is that he does not want his mind disturbed. He is used to thinking in inches and does not want to think about anything else.

The contention that "The man who designs a crowbar about 5 ft. long and then thinks it out in millimeters does not benefit by the system" makes me think that, undoubtedly, when a man designs a crowbar or an anvil, he must figure them out in thousandths or probably in millionths of an inch.

The clumsiness of the English system of measuring is evident to everybody, even to the critics of the metric

system. They reluctantly admit that it is a better and simpler system, but somehow they brace up courage enough to stand up and oppose its coming.

It "eventually will come, but we are not yet prepared for so radical a change." This is the main opposition. The other leading contention is "the millions of dollars' worth of tools that must be scrapped." If the acceptance of the metric system now will entail the loss of millions, what will be the loss fifty or a hundred years from now, when "eventually it will come," as its critics aver? Can we disregard the future entirely?

Probably, even if it is only for the sake of dollars, the American manufacturers will have to adopt the metric system if they want to be able to increase their foreign export with countries using that system. I can easily predict that the recognized English stubbornness will never compel those countries using the metric system to accept a clumsy system instead of the metric system.

Nobody will be so radical as to advocate the destruction of all the tools based on the present system, simply because the lawmakers may decide to prescribe the metric system; but as other countries have made the change gradually, so we could, by constructing every new machine and tool on the new system. By so doing, before we realize it, we will acquire the system with all its undisputable advantages.

One of the great advantages is that children will not have to study a considerable length of time more—more than they should—in order to get acquainted with the present clumsy system, with all its different units and how they are subdivided, but never corresponding with another, as in the metric system. Moreover, we shall not need a set of tables with us all the time, to recollect all these different units, their subdivisions, their relations one with another, their decimal equivalents and many other inconveniences caused by the present system.

A former critic thought he found in a report of a commission that investigated the result of the adoption of the system in Argentina a justification for not following the metric system. The report greatly exaggerates actual conditions, and this I know by years of personal residence in various parts of that republic.

It is only natural for any people to retain for a certain time and for certain purposes old ways, even realizing occasionally that the new method is better. But it is a fact that everything bought and sold in Argentina is in kilograms, its multiples or decimals; the meter is used for measuring anything above a foot or two, the regular rules being meters, with inches on one side. Liquids are measured by liters. What more can I say?

While farmers, ten or fifteen years ago, used to rent the land by quadras or parts of a legua, now it is all in hectares and everybody (generally speaking) is better acquainted with the meter than with the old measurements.

It is our right, as Mr. Terry claims, to use our system, and probably nobody from outside will ever attempt to deprive us of it. It is also our right to go and live in jungles or caves as our forefathers did, but evidently for some mysterious reason most of us prefer to live in a comfortable place. Other people dispensed with their old systems for better ones; why not we? Some day we shall accept the metric system, and we shall wonder why we waited so long before taking this step forward.

This is no time for sentimental or radical objection, but it is a matter of accepting what the critics themselves declare to be "a better and simpler system."

Do not let us be too proud of our old relics. If we recognize something better, why not favor it instead of opposing it with the admission that eventually it will come?

JOEL TESSITORE.

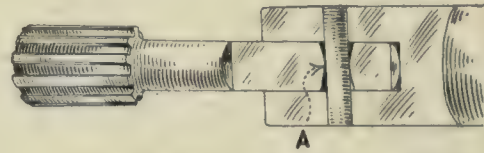
Hyde Park, Mass.

✱

Compound Float for Reamers

Without being too critical, it seems to me that Mr. Murphy has gone to considerable trouble in making a reamer with a "compound float," as shown on page 866, Vol. 44. It would be simpler to use the scheme illustrated in the accompanying sketch.

Mr. Murphy shows in Fig. 1 the usual type of floating reamer, with a crosspin through a straight hole in the shank. In the sketch shown here the hole is reamed



COMPOUND FLOAT FOR REAMERS

from each side with a taper reamer, so the thrust is taken at the point A. With this style of floating reamer there is no chance for it to "cramp" against the driving pin, as Mr. Murphy mentions.

I use this style of reamer quite extensively in a large cast-iron chucking department and find it satisfactory.

Greenfield, Mass.

HERBERT M. DARLING.

✱

The Suggestion System

I have read with interest the letters by J. H. Davis (page 561, Vol. 44) and others on the suggestion system, and entirely agree that coupled with a commonsense method of reward it should be helpful in all shops. I have noticed a remarkable improvement in shops where a bonus or piece-work system prevails. I will cite two instances that occurred during my journeyman experience as a fitter and turner.

The first was in a shop of good repute that did a high-class engine trade. It worked under a "successful bonus system" and paid good wages. The job consisted of inserting some small locating pegs in double piston rings. They were previously made by hand-filing from the wire and the head riveted over inside the ring with a small hammer. Any one who has tried to head a rivet in a 3-in. hole will quite understand the difficulty of making a sound job without breaking the ring, which was of cast iron.

After doing a few gross sets, I discovered a small power press that was not in use, and when time permitted I made a set of dies that pressed up the head complete, riveting the outside end as usual, and made a nice little job.

When the manager next visited the shop I was working busily on the job. On being questioned, I explained the plan and was relieved when, after timing me, he remarked: "Young man, that is the sort of thing we want here. As long as you are engaged on this job the price

will not be cut, and I will give instructions that this job is to be sent to you first." This meant a raise of 50 per cent. in my wages and a good saving to the firm by their bonus system, and besides, it relieved me of a rather disagreeable job.

Some time later, I joined one of our real "uptodate" shops. On the shop door hung a "Suggestion" box that stated among other things that the president would pay for useful information.

After settling down to work, I stumbled on a job on the vertical miller, using the radial table to form a face parallel to a central hole. In spite of the newness of the machine, a persistent error would make its appearance in the true radius of the arc, and caused some of the work to be scrapped. I therefore drew out a former of correct shape, hardened and ground on its edge, and put a hardened collar between two cutters of similar diameter, so as to bear on the former.

The job cost me two of my spare evenings and some little trouble. The suggestion was duly posted and a week later I was informed by a letter from the president that the suggestion would receive attention. Not long after, an office messenger came to me and said that the president desired to see me.

Being young, I had all sorts of visions as to what might happen. The president after making a speech to the assembled managers, superintendent and my humble self, presented me with an order on the cashier to pay me the magnificent sum of 2/6 (60c.), and instructed the rate fixer to see that the time was carefully checked and altered, to conform to the time taken with the new device. My feelings can better be imagined than described, especially as the job saved about 5/ (\$1.20) on each piece, besides insuring that the work would be turned out correctly.

There are you see, other sponges that only absorb, besides the one mentioned by John R. Godfrey, page 459, Vol. 44.

T. STONE.

Durham, England.

✱

Calipering Running Work

I have read with interest the advice on calipering running work, by M. Jacker, page 992, Vol. 44. It recalls an interesting experience of my own, thirty-odd years ago, and the story contains an excellent "kink" to prevent calipers from catching on the work, not given by Mr. Jacker.

I was a youngster then, being initiated into the art of turning and calipering. Old Wullie was on the next lathe, and I very soon found out that my calipers had a nasty habit of catching on the work, while nothing of the sort ever happened to Wullie. I approached him on the matter and was told that he had a secret hardening process for the points, all his own, and he would impart it to me for a dollar down, with a positive guarantee against further trouble in this direction. He would hand me his calipers to try to make them catch. While I found them far less apt to bite than my own, I still had a suspicion of a catch of another sort and that he had a notion that youngsters should not learn everything for nothing, as such information was likely to be easily forgotten.

One day I saw Old Wullie getting ready to file up a job. While he cleaned down a bit, I made my way up

to the attic and was very soon at full length on the floor, with one eye on a hole that gave a good view of Wullie's operations. I saw him deliberately lift his drip pan, put some of the suds in and then, after setting his calipers, rest them inside his pan with the points in the suds. Somehow it dawned upon me that, whenever he gave me his calipers to try, he always lifted them from the drip pan.

I did not lose any time. I returned to my lathe and began experiments. Very soon Old Wullie's secret was gone forever. Just wet the points with any "old wet" hanging around, and it matters very little at what angle you hold them, they will not catch.

It only remains for me to add that after I discovered my invention I gave it to the whole shop, much to the discomfort of Old Wullie, as the credit was all mine. They would not believe he knew all about it years ago, because he never told anyone, and I did.

Belfast, Ireland.

F. P. TERRY.

✱

Financial Literary Rewards

In Vol. 44, on page 977, R. D. Gatewood has touched on a subject that, to my mind, is one of the fundamentals of progression, not for the technical writer so much as for the machinist, the man for whom such literature is primarily intended. Dismissing for the moment the technical writer's grievances, I think it is generally understood among machinists that uptodate literature is fairly high priced. Now, one can say these works are good investments, their cost being divided over their life; but what is their life? That depends on the progress after their publication on the subject treated.

Individual knowledge, and with individual knowledge individual efficiency, would be more readily obtained if prices were lower. I am quite aware that I stand on somewhat ticklish ground and am likely to be assailed, the argument probably put forward being that good men demand good money for their writings. Cutting down payment would not ease the situation, as the standard of books would gradually fall. What is the solution?

A solution that suggests itself seems to lie along the path of making advertisements pay for publications to a much greater extent in technical works than they do at present.

In England there are striking examples of the successful handling of this idea, but they are comparatively few. The principle seems good. The whole idea is to bring down the technical food from the engineer's office and feed it to the individual machinist.

Bristol, England.

WALTER R. RICHARDS.

✱

Filing a Round Hole

On page 30, James McIntyre describes a method of filing holes, by grinding away part of the cutting sides of the file. I suggest that in order to eliminate the grinding and to leave the file useful for all other work he try enlarging holes by the following method: Chuck a round file in the lathe, revolving it backward, and feed the work onto the file. This prevents the work from running up on the spiral out of the file.

By this method holes may be readily reamed larger, or elongated sufficiently to obtain the desired clearance.

Rutherford, N. J.

GEORGE F. KUHN.

Editorials

Pennsylvania--The Leader

The State of Pennsylvania has recently put into effect a code for the artificial lighting of factories, mills, and other work places. It is effective through its adoption by the Industrial Board of the Department of Labor and Industry, of which John Price Jackson is chairman. Through this act, Pennsylvania becomes the leading state as regards its provisions for requiring adequate standards of illumination in its industries. To be sure, other states have done something along this line, notably Wisconsin, but nothing as comprehensive as this code of Pennsylvania has heretofore gone into effect.

The requirements adopted follow very closely the provisions of the Lighting Code as originally worked out by the Illuminating Engineering Society, and the Society is to be congratulated on this success of its earnest efforts. The code first developed by the Society was presented in the *American Machinist*, Vol. 37, p. 547. It was discussed and supported by editorial comment in the same issue on page 566. In March of the present year it was brought up for general discussion at a joint meeting held in New York City by the Illuminating Engineering Society and the American Society of Mechanical Engineers. The trend of the discussion was favorable, although a few points were questioned and some suggestions made for modifications. Following that meeting, the code was taken under reconsideration by the Illuminating Engineering Society, and the result submitted to the states of Pennsylvania and New Jersey. The first has acted. The provisions of the code as adopted by its Industrial Board are as follows:

Rule I. General Requirement—Working or traversed spaces in buildings or grounds shall be supplied during the time of use with artificial light in accordance with the following rules whenever natural light falls below the intensities specified in Rule II.

Rule II. Intensity Required—The desirable illumination intensity to be provided and the minimum intensity which shall be maintained are shown in the following table:¹

	Minimum Ft. Candles	At the Work. Ordinary Acceptable Practice Ft. Candles
1. Roadways and yard thoroughfares...	0.05	0.05- 0.25
2. Stairways, passageways, aisles, storage spaces	0.25	0.25- 0.50
3. Rough manufacturing operations, such as foundry work, rough machining, rough assembling, rough bench work	1.25	1.25- 2.50
4. Fine manufacturing operations, such as fine lathe work, pattern and tool making, light-colored textiles, tobacco manufacture	3.50	3.50- 6.00
5. Special cases of fine work, such as watch making, engraving, drafting, dark-colored textiles	5.00	10.00-15.00

Uncertain cases and intermediate requirements are to be left to the judgment of the State Industrial Board.

Rule III. Shading of Lamps—Glare either from the lamps or unduly bright surfaces produces eye strain and increases accident hazard.

Exposed bare lamps shall not be used except when they are out of the ordinary line of vision; lamps should be suitably fitted to minimize glare.

¹This rule is intended to provide adequate illumination at the work. For purposes of measurement a horizontal reference plane 30 in. above the floor is to be taken, and a properly standardized portable photometer or illuminometer used. For purposes of very rough estimate it may be stated that with a good overhead system of lighting 1 cp. (spherical) per square foot of floor area should produce an illumination intensity of about 3-ft. candles.

Rule IV. Distribution of Light on the Work—Lamps shall be so arranged as to secure a good distribution of light on the work, avoiding objectionable shadows and sharp contrasts of intensity.

Rule V. Emergency Lighting—Emergency lighting shall be provided in all work spaces, aisles, stairways, passageways and exits; such lights shall be so arranged as to insure their reliable operation when through accident or other cause the regular lighting is extinguished.

Rule VI. Switching and Controlling Apparatus—Switching or controlling apparatus shall be so placed that at least pilot or night lights may be turned on at the main point of entrance.

A study of the preceding provisions will show that the code is short and simply phrased. Nothing is said about daylight illumination. A number of the provisions of the code framed by the Illuminating Engineering Society are omitted. This course has undoubtedly been dictated by wisdom, for an innovation of this kind to be successful must not be too drastic or complicated.

The Society's original code provided for four classes of intensity which are those numbered from 2 to 5 of the code as adopted in Pennsylvania. The Industrial Board added the first item, "Roadways and yard thoroughfares." It also added a minimum requirement in the fifth class; namely, 5-ft. candles.

Pennsylvania's code has been carefully considered and wisely planned. If it is enforced with the same degree of good judgment, the Keystone State is to be congratulated indeed. The *American Machinist* bespeaks the cordial support of all the machine-shop executives in Pennsylvania for these progressive regulations.

What state will be next?

✱

Standardizing Aeroplane Construction

The standardization of aeroplanes and motors, similar to the manner in which automobile parts have been and are being standardized, is being undertaken by the S. A. E. These initials, it may be explained, now stand for the Society of Automobile Engineers, but may, if present proposals are carried out, be translated into the near future into the Society of Automotive Engineers. Such action would enlarge the scope of the society to include the automobile, aeronautic, marine, tractor and gas-engine fields and so tie together the problems of self-propelling vehicles or mechanisms of these four great services of the internal-combustion motor.

It is quite possible that some of the standards adopted by motor-car builders can be used equally well in aeroplane work. But many of the problems are so different that new standards must be decided upon. Spark plugs, for example, will require a special set of specifications, owing to different and more difficult conditions.

Propeller hubs are among the first elements to be considered, the present feeling being that the standard adopted by the French will be selected for this purpose. Some standard is absolutely essential for economical and satisfactory manufacture.

Another matter for early consideration will be the nomenclature of the aeroplane, the first point being the question of right- or left-hand motor, particularly as applied to the twin-motored machines. The committee is disposed to advise the use of the terms "clockwise" and "counter-clockwise," as in electrical engineering, the observer standing facing the end of the power-delivery shaft.

It is rather unfortunate that this definition should be just opposite that used in machine-shop practice regarding milling cutters, although it is probably the more logical. It has always been difficult to see why a right-handed milling cutter or drill should turn to the left, when looked at from its cutting end. Uniformity of definition is highly desirable; but as the electrical and aeronautic usage is evidently logical, there is little likelihood of a change to meet our shop practice.

Dr. S. W. Stratton has announced that the Bureau of Standards will establish an investigation department for disseminating the knowledge that is being acquired in the numerous laboratories in various parts of the country. With interest really aroused in the standardization of aeroplane construction, there is sure to be made rapid progress that will be of great value in its development.

Limiting Shop Improvements To Increase Profits

Improvements in the machine shop and in machine-shop operations and tools are usually held to be highly desirable, and one who can make them is considered a valuable man to have in the plant. This is undoubtedly true, but it must be qualified by the fact that improvements, like anything else, can be overdone. When this happens, they no longer continue to be improvements, but drawbacks from a financial standpoint.

It may be well to seek out a definition as to what constitutes an improvement in the machine shop. There are so many ways of doing the same thing that a change in method is sometimes taken to be an improvement, especially where this change brings with it an increased production and a reduced cost. The point is sometimes lost sight of that the old method may not have had justice done it. Possibly, with proper thought and direction the old method could have been made to beat the new one and also to reduce costs and increase production.

As a starting point, therefore, let us assume that before an improvement in a method is to be approached, we are sure that the former method is being worked to its limit and as intelligently operated as is possible. The insistence on this thought will in itself eliminate some 50 per cent. of the changes that now take place in many shops under the name of improvements.

The second mental step in approaching a change of process is to make sure that it is worth while, granted that it is an improvement. Everyone who has had close experience with machine-shop life has seen changes of method which were possibly slight improvements, but which have been forced into existence as a matter of satisfying the personal pride of the originator. Sometimes the ingenuity of the method casts an unnatural light upon it, which blinds one to the actual merit of the idea. A wooden box used as a jig under certain conditions is a more meritorious device than would be the most elaborate example of a tool maker's art under

similar conditions. But there is no glamour about the ugly wooden contraption that saves 100 times its cost each week, whereas there is considerable attraction in the highly polished and elaborate metal device that possibly may earn its keep after a year or two.

There are some men whose minds are creative and whose thoughts change from object to object with great flexibility, who are able to devise improvements faster than a mechanic can carry them out. Very few jigs are built without some possible improvement being found before they have been completed. Sometimes these improvements might even be considered worth while, considered from the standpoint of what they would save. And yet there is a limiting condition here also. It does not pay to change methods too often, even when there is the strong excuse of considerable saving. One may readily imagine a condition in which changes would be made so frequently that nothing could be produced, and no benefit would be obtained under such conditions from the possible saving due to the changes, however great these might be.

ESTABLISHING A MINIMUM PERIOD OF SERVICE FOR JIGS AND FIXTURES

These considerations point to the desirability of insisting on a minimum length of operation of each piece of equipment that has proved worthy of operating at all. What this period shall be is a question that may be determined individually and cannot be settled in these columns for the varying conditions existing in different shops. The factors to consider are the average length of time required in the shop to put through paying lots of the piece that is to be machined in the jig or fixture in question; and the average length of time required to accustom an operator to a change of method.

On all proposed changes it is well to insist that an estimate be made up before the change is authorized, showing the amount of money that may be saved by the improvement and comparing this with the cost of throwing out the old equipment. In shops where the depreciation on jigs and fixtures is based on a life of one year there is no loss, as far as this point is concerned, in discarding the method and device at the termination of that year. The other factors, however, must be considered in addition to the cost of equipment in order to size the problem up properly. These were mentioned above and are the average length of time required to put a paying lot of the parts through the shop, and the time needed to accustom an operator to the change in method.

STICKING TO THE MAIN PURPOSE AS A CHARACTERISTIC FOR TOOL DESIGNERS

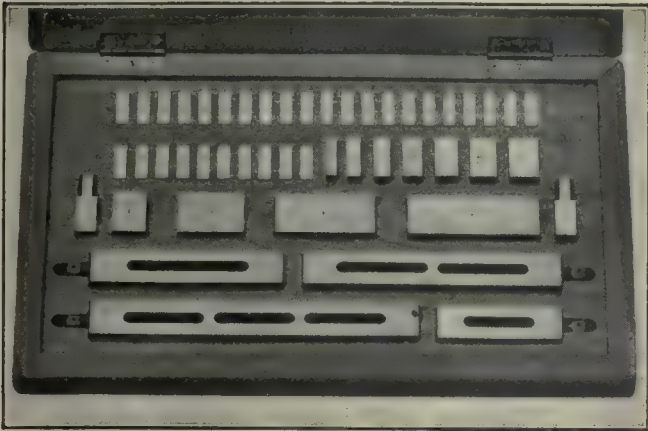
Noah learned something while he built the ark. Doubtless after he had the frame completed, he could see a much better way to make it; and if he had had the instincts of some machine-shop tool designers, he would have scrapped the whole thing and started over again. Possibly, before the roof was put upon the cabin he had conceived the advantages of a submarine for similar purposes, but notwithstanding this he kept the main object in view, which was to get the ship built before it rained; and according to all accounts he finished with a few hours to spare. His example is a profitable one for tool designers to study.

Shop Equipment News

Block Gages

The illustration shows one of a number of sets of block gages manufactured by Wismach & Co., 1513 Richard St., Milwaukee, Wis.

The blocks have parallel lapped opposite sides. They vary in thickness by specific increments given in fractions of inches or millimeters, and two or more of them can be wrung together to obtain what is practically a solid gage of a given size. Holders are provided for the blocks



BLOCK GAGES

when they are used for external measuring or for measuring holes with the two half-round members furnished for this purpose.

✱

Opportunities We Have Missed

BY A. L. HAAS

It is true of research work no less than of many processes that the byproducts may prove even more valuable than the direct outcome of investigation or manufacture. This is why the scientific, technical mind displays so much interest in what seems the merely curious, irrespective of its immediate value. Attention is focused when new ground is broken. It is difficult to see where the clew may ultimately lead, or what end may result from the pursuit of the elusive.

The distinction between science and commerce can be said to consist in the fact that the former seeks no gain, while the latter finds no interest in the novel and curious. To some extent this serves to explain the coolness with which the inventor is met when he seeks to exploit a new device. Unless he can prove that his novelty has an immediate cash value, his reception is apt to be far from cordial.

A difficulty cropping up in the course of the day's work is an obstacle to be overcome. The graver the matter the more likely is it to lead to results of value, to an adaptation worth all the trouble of patient investigation. To take full advantage of opportunity afforded needs trained imagination, but the average individual blessed with patience may fall across something worth while.

Two pertinent instances of missed opportunity serve to add point to the question. Both of these concern the testing of hardness.

It will be within the recollection of many that in the 1890's, with the development of the bicycle in its earlier stages, crushing bicycle balls in a testing machine became a favorite pastime. In common with other students taking an experimental course I must have destroyed at least a gross, the results obtained varying in a most erratic manner.

The cause of such variation was rightly attributed in part to the hardened plates used. It proved impossible to apply the pressure in a simple point as desired. Hardened plates of every known brand of steel quenched in every possible way were tried, but the ball always left a permanent depression in the plate. Attention was focused on the test, not on its results to the plates, although any student might have realized the importance of the indentation and its application. When, however, the Brinnell machine was marketed, the opportunity we had missed became apparent.

THE SCLEROSCOPE PRINCIPLE

The second instance concerns the scleroscope. Long before this was ever marketed, forgers in the Sheffield cutlery industry utilized the same underlying principle. A competent man knew by instinct and the rebound of his hammer on a blade across the anvil whether the steel was properly hardened or tempered.

At least five years before the instrument was marketed an old Sheffield forger demonstrated his methods to me after I had gained the old man's confidence. A matter of fifty years' experience lay behind the demonstration, and it should have provoked more lasting interest than it actually did.

Taking a dead-soft blade, he made me feel the impact and rebound of the hammer. After heating and quenching, the lesson was repeated, and again after drawing to color. Unless the blade felt right under the hammer, it was re-treated, and the old man had a reputation second to none in that particular firm.

Realization of a principle does not show us how to reduce it to practice, and the merits and ingenuity of the Brinnell and the scleroscope methods are not even questioned. The point is that the underlying principles of both methods of test were in existence for exploitation by any acute mind. Thousands of trained men had seen bicycle balls tested and found the impediment of the indentations, but never realized their application to a practical issue.

The cutlery forger's test was less known, as the trade was secretive. Unless confidential relations had been established, it is more than probable that I would not have been shown the inner mysteries of the old man's craft. Still, the test must have been known to numbers who never thought of calibrating the rebound as a means of comparing hardness.

Drafting-Room Practice in a Departmentalized Shop

Five distinctive features individualize the drafting room of the Wellman-Seaver-Morgan Co., Cleveland, Ohio. They prove that success in the drafting department is by no means incompatible with free departure from conventional methods to fit special needs of the business or personalities.

Leading features are: (1) Departmentalization of the drafting room to match the departments of the engineering organization; (2) functionalized control, in which the engineering direction and administration are separated; (3) cost recording applied to the single drawing, with a card file for all drawings; (4) a system for limiting house-account jobs; (5) use of cut sheets.

The company builds a large range of structures and machines, and its engineering work covers at least two broad classes of structural steel and three classes of mechanical-engineering construction. This condition is met by a complete departmentalization of the engineering branch, in fact of the whole company except the shop. In many concerns where this is the case, the drafting room is a single unit, technically and administratively, but here the drafting room also is departmentalized. Long use of this plan of operation proves its success.

The six departments, each headed by an engineer, are: Coal and Ore Handling, Hydraulic Turbine, Mine Hoist, Crane (charging machines and coke-oven equipment), Furnace and Estimating. The drafting force is divided into corresponding groups, and each group is headed by a foreman. Including an extra group, for billing and orders (3 stenographers and 3 clerks), the whole force comprises normally 90 men. The 44-hr. week is used.

Administrative control of the drafting force is in the hands of the Engineer of Construction, who employs, disciplines and manages. For technical instructions, however, the group foremen are directly under orders of the department engineers. There is no one corresponding to the Chief Draftsman of the usual type of organization. Finished drawings are checked by the

group foreman and are countersigned by the department engineer.

This division of functions is not merely formal but is applied consistently. Thus, space limitations made it necessary to locate two groups of the drafting force away from the main drafting room—in fact directly under the eye of the respective department heads. These groups nevertheless are under the same administrative control as the force in the main room.

In this organization good disciplinary control is secured without a time clock. The group foremen are



FIG. 2. DRAFTING TABLE OF ORIGINAL DESIGN

responsible for their men to the Engineer of Construction. They are accountable for both regularity and order, in addition to efficiency.

RECORD FORMS AND FILE CARDS

To obtain a permanent record of drawings and a reliable basis for estimates of drafting costs an unusually careful system of recording the drafting-room operations was devised. It is based on the draftsman's time card (Fig. 3), which states not merely the job number but also the operation (designing, detailing, tracing) and the drawing number. The group foreman countersigns and turns in the time cards of all his men. The original goes to the paymaster; a duplicate is filed in the drafting room.

On completion of a drawing, it is turned in to the Engineer of Construction, accompanied by a report card (Fig. 5) giving all pertinent data that describe the sheet, except the time spent on it. This report card is filed as a permanent record of new drawings made on a given order.

A cost card for the drawing is made up from the time slips, posted up each day, and totaled when the report card announces its completion. This card (Fig. 6) gives the total time and cost, and an analysis of this time by men and by dates. An analysis by operations can be deduced, when needed, from the rates of pay shown on the card.

Regular (contract) jobs are started by a group foreman on receiving from the Engineer of Construction a duplicate of the order made out by the contracting agent or engineer. This order is returned after completion of all the drawings of the job.



FIG. 1. CORNER OF DRAFTING ROOM

DAILY TIME CARD.		DRAFTING DEPARTMENT.
THE WELLMAN-SEEVER-MORGAN CO.		
NAME _____		TIMEKEEPER'S CHECK _____
DATE _____		
CHARGE NO.	OPERATION.	HOURS
APPROVED _____		TOTAL TIME _____

44 11—15 50M

FIG. 3. TIME SLIP GIVES OPERATION AND SHEET NUMBER

House-account jobs, or what might be called non-producing work in the drafting room, are initiated by a special order made out on a numbered-series card issued by the Engineer of Construction. This card, besides tending to limit the amount of such work, helps to insure proper locating of the charge in the accounting department. The latter result is secured by sending a duplicate of the card to the accounting department when the job is initiated, and giving on this card a sufficient description of the proposed work that the latter department is enabled to place the charge against the proper one of several standing accounts authorized by the management of the company. Fig. 7 shows the card and its duplicate. The back of the duplicate is ruled for the daily time and cost figures from the time slips, the time-slip entries being identified by the number taken from the special-order card.

THE WELLMAN-SEAEVER-MORGAN CO.	
CONTRACT NO.	PROPOSAL No.
SUBJECT	
DRAWN BY	DATE
CHECKED BY	
APPROVED BY	
TRACED FROM	
FOR	
197-8-15 ZM	SCALE

FIG. 5. REPORT CARD FOR INDIVIDUAL DRAWING

[illegible]

FIG. 6. COST-RECORD CARD IS FILED FOR EACH SHEET

The arrangement of the room is determined partly by the space layout and the window lighting. The room is about 40x100 ft., and 15 ft. high; about three-fourths of the wall space has windows. With narrow piers, and windows extending to the ceiling, the side light easily allows of placing two tables in line from the wall. As the column arrangement makes an 8-ft. aisle down the middle of the room, the row of two tables on either side just fills the available space. In the other direction the tables are spaced about 4 ft. 8 in., or three per 14-ft. bay.

Present practice as to equipment is of relatively recent date. Up to eight years ago the room was fitted with upright drawing boards mounted on easel brackets set on top of office-type desks. Fig. 4 sketches roughly the desk and board, and its lamp fitting. The brackets could be adjusted to different angles, the board (about 32x40 in.) could be shifted up and down on the brackets and could even be slid down to rest on the draftsman's knees, and a parallel-ruler working in slots of the rails served in place of the T-square. The lower stile had a projecting tray to hold pencils and tools. A pipe support over the top carried a baby Nernst lamp whose hook could be slid along the pipe rail to any position.

The horizontal-board plan is now used exclusively. Many of the old desks were adapted for this by putting 6-in. legs under them; two desks with a filing case between give enough table length for two draftsmen. The rest of the room is equipped with large tables designed and built by the company. Fig. 2 shows one of these quite clearly. There are two drawers for tools and books, and two large ones for drawings. The top is 34x84 in., it has an oak border and a soft-pine filling. This is rarely or never used for pinning down drawings, but a drawing-board on taper rails is placed on it.

Several large boards are used in the Hydraulic Department. These range from 4x6 to 5x10 ft., and have a steel edge for the T-square. For other departments the regular table serves satisfactorily.—*Engineering News*.

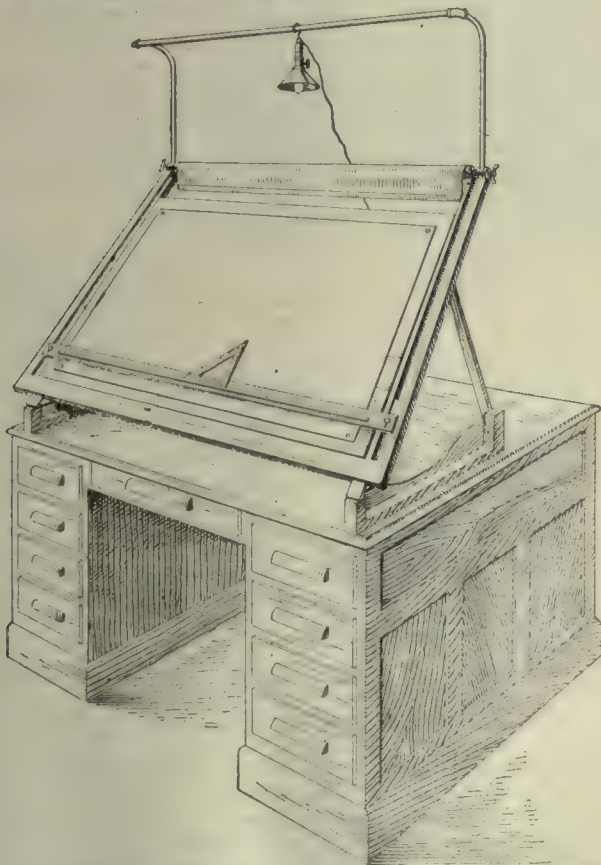


FIG. 4. SKETCH OF UPRIGHT BOARD AND LAMP MOUNTING AS FORMERLY USED

Now abandoned for horizontal tables and ceiling drops

There are a few drafting machines, but most of the tables are equipped with T-squares. Triangles and other tools are furnished by the men. Special tools such as pantograph, beam compasses and special curve and radius templates are furnished by the company.

The present lighting system has one 360-watt drop fixture in each bay (14x16 and 8x14 ft.). The fixture has six 60-watt tungsten lamps placed under a 39-in. General Electric "diffuser," and inclosed below by a pearl-glass shade, all hung about 6 ft. from the ceiling (9 ft. from the floor). The illumination is said to be entirely adequate. Ceiling and walls, painted buff in oil, are important factors in the lighting.

FIG. 7. DRAFTING-ROOM ORDER CARDS FOR HOUSE-ACCOUNT JOBS

Cards 3x5. Lower, white, goes to drafting-squad foreman as his order. Upper, buff, goes to auditor, and is ruled on back for time and amount.

Most of the work is done on cut sheets. Buff drawing paper is used for pencil layout and detailing, and this as well as the tracing cloth and blueprint paper is bought in sheets. The tracing cloth is bought with border and company stamp (lower right corner) printed on.

The reason for using blueprint sheets is that the two machines—imported vertical machines, among the first made—take sheets only.

There are four standard sizes of drawing sheet; only in turbine work and other special cases is it necessary to depart from these. They are:

Over All	Inside Inner Border Line
26 x 36 in.	23 $\frac{3}{4}$ x 33 $\frac{3}{4}$ in.
18 x 26 in.	16 x 23 $\frac{1}{2}$ in.
13 x 16 in.	10 $\frac{1}{4}$ x 14 in.
9 $\frac{1}{2}$ x 12 in.	7 $\frac{1}{4}$ x 10 $\frac{1}{2}$ in.

The sheet sizes are selected by the group foreman in planning out the work on a particular job. The smallest size is used for drawings that are likely to be wanted in letter size for filing with correspondence and notes.

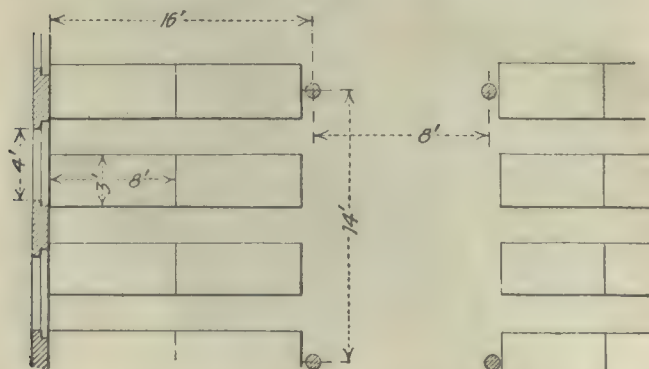


FIG. 8. PART PLAN SHOWING TABLE ARRANGEMENT

Japanese Copper Production and Exports

Usually Japan exports considerable copper to China each year, but during the past year not only have there been no exportations of the metal to that country, but Japanese merchants have been scouring the markets of China for copper, and Chinese statements have been made that Japanese dealers purchased Chinese copper coins and shipped them to Japan to be melted down.

In 1909 the production of copper in Japan was given as 46,000 tons; during the past year the production increased to 72,000 tons. One-half of the exports of last year went to Russia, one-fourth to Great Britain, and the remainder to France and the United States.—*Brass World*.

NEW PUBLICATIONS

MECHANICAL TECHNOLOGY—By G. F. Charnock. Six hundred and twenty 8 $\frac{1}{2}$ x 5 $\frac{1}{2}$ -in. pages; 503 illustrations; indexed; cloth bound. The D. Van Nostrand Co., New York City. Price \$3.

In this volume the author has brought together a connected and systematic account of the chief operations followed in mechanical trades. The various metals and alloys used and the machines and processes employed in the manufacture and refining are described at some length in the first part of the volume. Foundry practice is discussed in the second part; troubles that often occur in this department are analyzed, and methods of avoiding them are outlined. Not only hand molding, but molding with machines is treated in detail in this section.

The third part takes up forging and stamping, general smithwork and also special machines for manufacturing parts from metals possessing malleability and ductility. Wire drawing and wire-drawing machinery, also the manufacture of tubes and the processes followed for manipulating sheet metals by flanging, diskling, drawing, embossing and coining are considered.

The work will be found to be comprehensive and thorough. The various details in both machines and methods are presented with particular care, so that the book should be of value to the engineer, the student or the machinist.

PERSONALS

J. Sigfried Edstrom, general manager of the Swedish General Electric Co., sailed on Wednesday, July 26, for Stockholm, Sweden.

Capt. N. Wallenius, general manager of the Nordiska Kullager Aktiebolaget, of Gothenburg, sailed on Thursday, July 20, for Gothenburg, Sweden, on the S.S. "Hellig Olav."

Hiram Walker, until recently assistant engineer with the Enger Motor Car Co., Cincinnati, Ohio, has become associated with the Chandler Motor Car Co., Cleveland, Ohio, in the same capacity.

Charles G. Williams, engineer in the automobile and aviation line, has resigned from the Mason Motor Co. to accept his appointment authorized by the Secretary of War as inspector of United States Army aeroplanes and aeroplane motors. His first duties call him to the Curtiss Aeroplane and Motor Corporation, Hammondsport, N. Y.

CATALOGS WANTED

The Sheffield Machine and Tool Co., 35 S. St. Clair St., Dayton, Ohio, would like to receive catalogs from manufacturers of equipment used in making dies, jigs, fixtures, etc.

A Belgian Manufacturer of bicycles would like catalogs of tube bending machines to bend seamless steel tubing in sizes of $\frac{3}{8}$ or 7x14 or 16-in. gage, to be used especially for bending bicycle handlebars. These catalogs should be addressed to A. Van Haver, East Alton, Ill.

Manufacturing Operations at the Gleason Works

By E. A. SUVERKROP

SYNOPSIS—The building of efficient gear-cutting machinery demands a high degree of accuracy, because these machines are practically in the same class as dividing engines. Methods that insure accuracy of related components in these precision machines are here described.

Inaccuracies in work from a gear-cutting machine are visually detected more readily than they are in the work from any other machine, with the exception of the grinder. For example, take a spur gear 24 in. in diameter, 8 diametral pitch, with a 3-in. hole in its center. The hole could be $\frac{1}{8}$ in. out of center or the rim $\frac{1}{8}$ in. out of round without attracting attention; but should the spacing be out so little that a tooth is 0.002 in. thicker or thinner than those next to it, the difference is appreciable at a glance. Accuracy is of vital importance in a machine that is to produce exact gears; but accuracy is expensive, and any methods that assure it without excessively increasing the cost should interest all mechanics.

In Fig. 1 is shown a milling fixture, or more properly a special miller, that not only does more accurate work, but also reduces the cost as compared with the results obtained with a fixture formerly in use.

The work *A* is the main frame of a 24-in. Gleason gear planer. The milling fixture *B* is provided with a central stem that fits the finished bearings in the center of the frame. The circular feed is at *C* and is driven by the shaft *D*, which is splined to accommodate different sizes of frames. Change gears at *C* provide for various gradations of feeds. A crank *E* permits rapid swinging of the fixture *B* by hand.

The entire mechanism is driven by the motor. The gear guards over the reducing gears *G* were purposely displaced to show the mechanism. A vertical shaft concentric with the axis of the fixture transmits motion to the feed gears through a pair of bevel gears at *H*. The horizontal shaft *I* transmits motion to the milling cutter arbor *J*. The shaft *I* is splined so that the cutter arbor

can be adjusted to or from the axis of the fixture. Vertical adjustment of the cutter arbor is also provided, as well as an outboard support *K*, which may be moved toward or from the center of the fixture and up and down on the arm *L*. When undercutting such parts as the flange *M*, a shoe secured in the member *N*, but sliding on the planed upper surface of the flange *M*, holds the cutter to its work and prevents deflection of the member *N*, which is otherwise supported in the center bearings only of the frame. Micrometer adjustment of the milling head is obtained through a screw and a graduated dial

at *O*. Years ago, about 20, the frames of the Gleason gear-cutting machines had two cored T-slots on top of the flange. Underneath the flange was a seat for a circular rack. These T-slots, the periphery of the flange and the seat for the circular rack were machined by a hand-operated fixture with a single-pointed tool mounted on a slide rest. I am told by one who used to pull the bar around by hand that it took a week to do the small

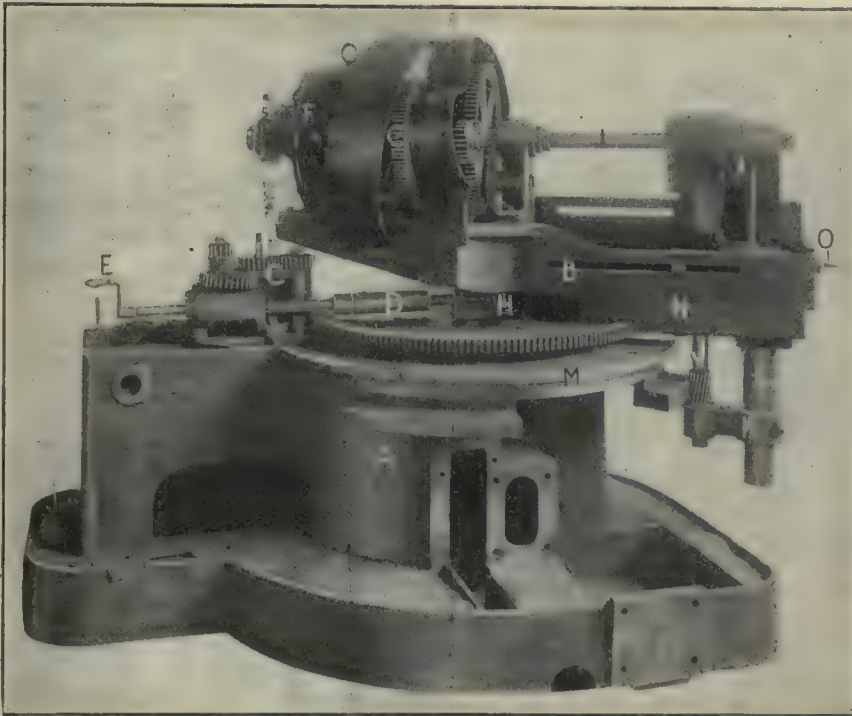


FIG. 1. ARC MILLING FIXTURE FOR FRAMES

amount of work on the old frame. With the fixture shown, the frame of a 24-in. gear planer is accurately machined in 18 hr.

One often sees "parallels" used to support and space pieces of work vertically, but not so often does one see them used to space horizontally. The castings shown in Fig. 2 are columns for spiral-type gear cutters, the ways *A* of which have been planed in a previous operation. In this operation they are set up to plane the pads *B*, which must be square with the ways. The first one is set square on the planer table in the usual way and clamped. Then a parallel *C* is set on the planer table against the finished face of the flange *A*. The next casting is laid on the table, and the back of its flange *A* is brought up against the other edge of the parallel *C* and so on till the table is filled. These parallels are rectangular cast-iron frames with diagonal braces from opposite corners. Assuming that they are parallel and that the flanges of the ways are also parallel, the accuracy of the pads *B* depends merely on setting the first casting square and being sure there is no dirt between the parallels and the flanges of the work.

In Fig. 3 is shown an 88-in. King boring mill fitted with reversing gear similar to that usually found on planers. The work *A* on the table is the frame of a curved tooth gear roughing machine.

The work has already been planed on the bottom, where it rests on the boring-mill table, and on the top, where the indicator is lying. The slide, which is covered by the setting jig *B*, has also been planed. The setting jig fits the slide, has an angular member that bolts to the pad *C* and reaches down and touches the pad *D*, which has been finished on the planer. The slide locates the hole in the jig in one direction, and the pad *D* locates it in the other.

The dial indicator is held in the boring bar, and the work is trued up. The planed upper surface is also trued. The casting shown on the table was adjusted while the writer watched, and one side was packed up with a cigarette paper 0.001 in. thick. This will give an idea of the accuracy required. No limit of accuracy is stipulated on this work, but the majority of the machines are set within

trolled, and it is necessary to set the dogs *E* to only approximate position. A lever on the electrical device advances or retards by small increments the reverse of the table.

Reversal takes place within a space of about $\frac{1}{16}$ in., so that one can almost work to a line. A pin will be noticed



FIG. 2. PLANING PADS SQUARE WITH WAYS

0.0005 in. for boring. The average time necessary for setting up, rough- and finish-boring is 2 hr. On the upper surface there is an annular groove surrounding the bore. This groove is termed the "dirt ring," and its duty is to trap any dirt and prevent it from working into the bore. This ring is turned in 15 min. The bar is then changed and the lower bearing of the bore machined. This also takes about 15 min. The flange at the top is a little over 26 in. in diameter and occupies about two-thirds of a circle. The edge of the flange is finished $27\frac{7}{16}$ in. in diameter, and the flange is undercut for 2 in. back from the edge. Turning and undercutting this segment are done in about 2 hr.

The latter part of the job is somewhat interesting. At the start of the cut where the circular flange joins the rectangular part of the base the usual clearance for the tool has to be made. As every mechanic knows, clearance in work of this character is usually made with hammer and chisel. The operator of this boring mill "shapes" it out with a tool set horizontally in one of the bars. The cutting edge of the tool is set horizontally, and the ram is operated by hand with the traverse screw.

The control of the oscillating movement of the table is practically the same as that used on planers. The two dogs *E*, Fig. 4, are adjustable in the T-slot, which runs around the table. The reverse is also electrically con-

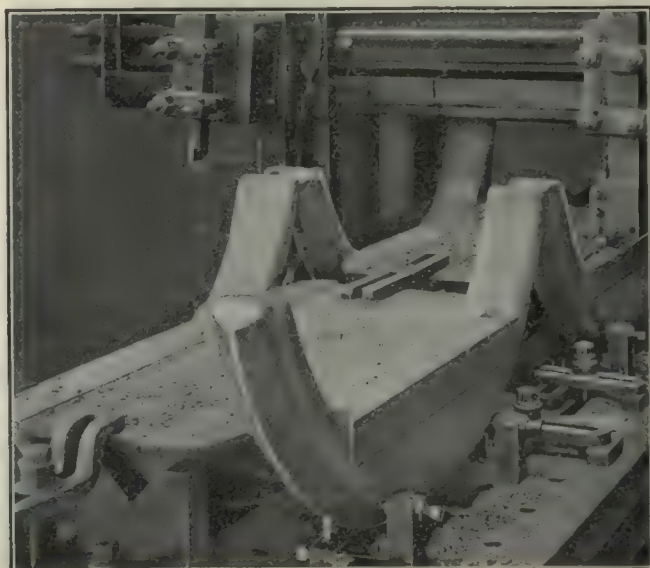


FIG. 3. PLANING THE CRADLES

at *G*. This is a "safety" devised by the operator of the mill. When the trip is in "central," not operating position, the pin *G* can be pushed into a hole in the bed, lock-

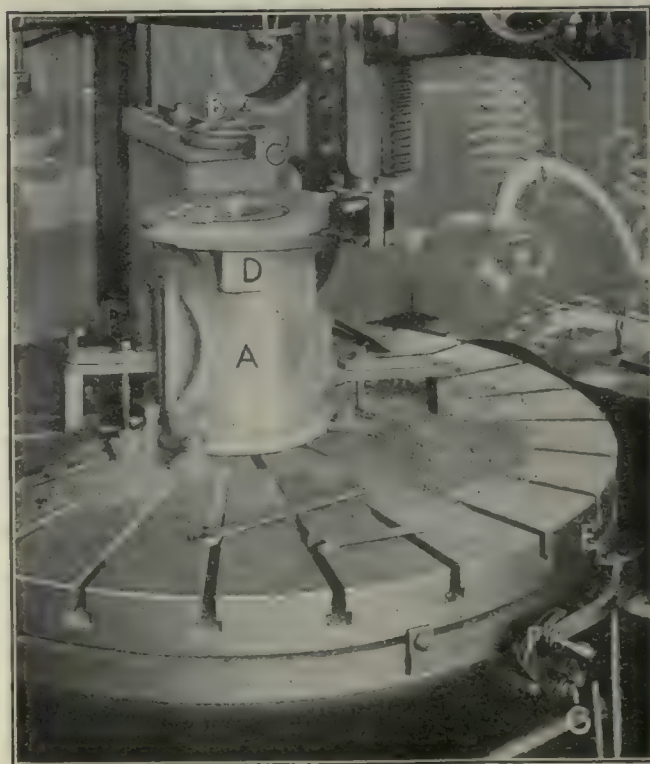


FIG. 4. KING BORING MILL WITH CIRCULAR AND OSCILLATING MOTIONS

ing the trip and preventing the machine from being accidentally started. This is a handy device on a machine of this description, making it safe while the operator is setting work and foolproof when he is called away from it.

In Fig. 3 is illustrated the planing operation on the cradles for the spiral-type generator. The set-up shown was used before a planer jig was made. A T-slot is cut from the solid metal on one side. The tool is shown making the slot for this. At each end there is a cored

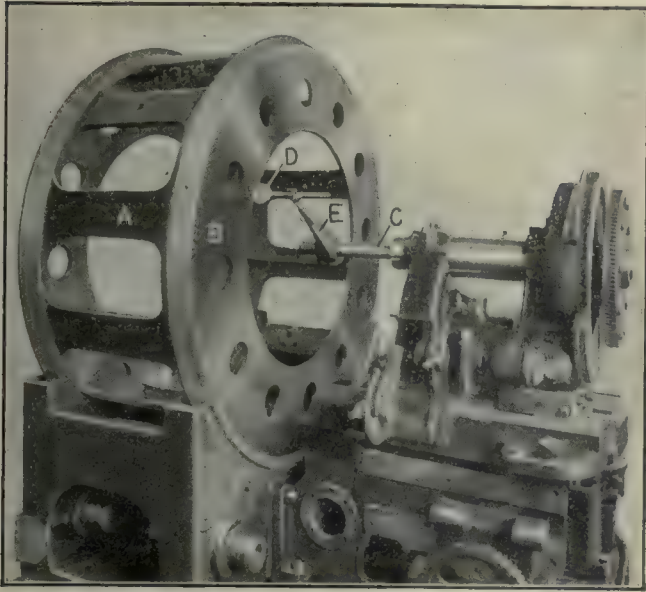


FIG. 5. SCRAPING IN V'S FOR CRADLE

pocket for the tool to run into. The final operation on the T-slot, cleaning out for the head, is done with a T-slot cutter in the miller.

In Fig. 5 is seen an exceptionally interesting operation, the scraping of the V's for the cradle of a curved tooth

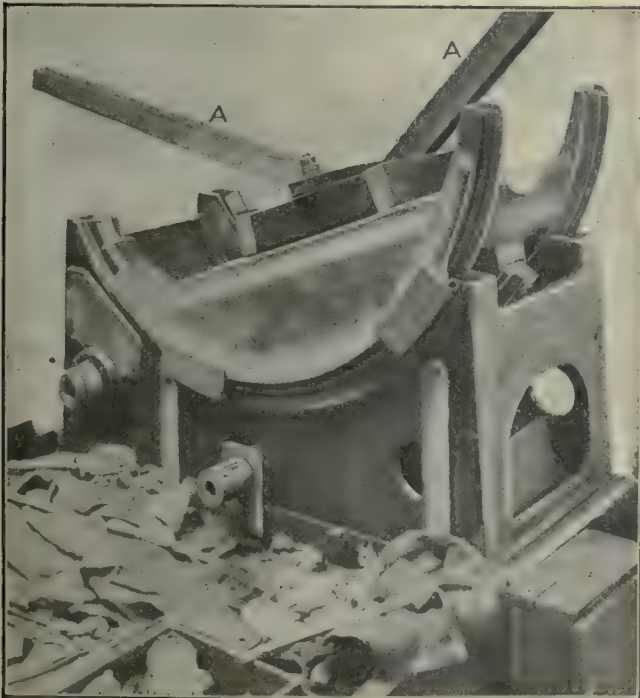


FIG. 6. SCRAPING CRADLE TO THE FRAME

gear cutter. The part *A* may be termed a circular surface plate to which the V's for the cradle are scraped. This surface plate is a little over 4 ft. in diameter. It was turned on a boring mill. The casting, while light for its size, is well braced. After being rough-turned on all surfaces to be finished, the surface plate was accurately measured

and allowed to season for two months before finish-turning. On being set up for finish-turning, it was found that it had warped about $\frac{3}{16}$ in. out of round. The finishing was done on the boring mill with the greatest care, as there was no means of improving on the work from this machine.

The V's are scraped to the surface plate *A* so that its end *B* indicates absolutely square with the spindle *C*. An indicator *D* on the arm *E* must show no variation on a circle about 30 in. in diameter. The time necessary for scraping the ways is dependent on a number of variables—accuracy of the machine work, hardness of the material, skill of the scraper hand, etc. From one to two days is usually sufficient time to finish this part of the work. Each time the surface plate is dropped into the V's the indicator is swung to the top, bottom and sides and its reading noted. The work goes on till the readings of the indicator at all points in the circle are the same.

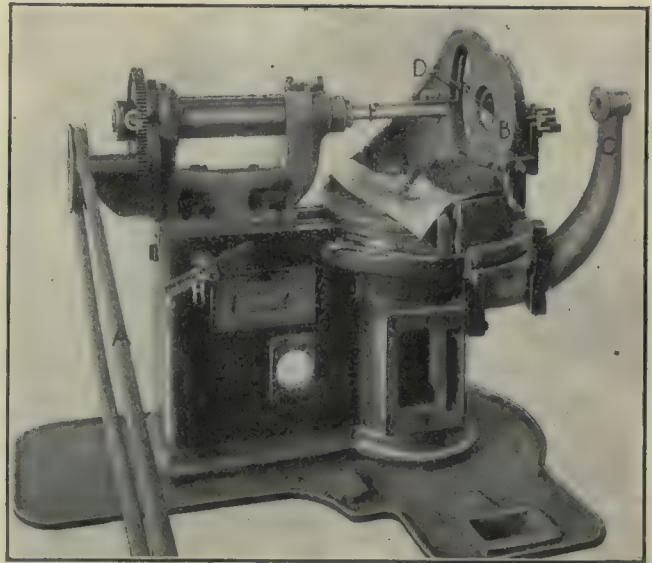


FIG. 7. BORING THE BRACKET

In other words, the cradle must be as nearly square with the work spindle of the machine as it is possible to get it.

In Fig. 6 is shown the scraping of the cradle. Two wooden bars *A* are provided for rocking or sliding the cradle in the V's. In this job, as in the one preceding, only one member is scraped—in this case the cradle. Thus the accuracy of the scraping on the V's of the frame is not impaired. It takes from 6 to 12 hr., depending on the conditions previously indicated to scrape in a cradle.

In Fig. 7 is illustrated the testing, which follows an interesting precision boring operation. The rope *A* has no place in the testing operation, as the spindle is turned by hand for this work, but is merely to show the drive for the cutter bar in the boring operation. Power for boring is obtained from an electric motor mounted on a truck so that it can be moved from machine to machine as they reach this stage of completion.

When setting up to bore the hole in the members *B* and *C*, a boring bar and dial indicator *D* are used to set the member *B* and the boring-bar bearing square and in line with the boring bar. The test bar *F* and the indicator *D* are first used to set the face of *B* square with the spindle axis. The boring bar is then substituted for the test bar. The bearing *E* for the outboard support of the bar is adjusted till the indicator, which has been secured

to the boring bar, shows that the bar is square with the face of *B*. As previously stated, the drive for the bar is from a motor through the rope *A* and the gears *G*. The traverse of the bar and head is by hand with the crank *H*. A single-pointed cutter is used. The time necessary to set up and bore this job is about 3 hr.

In Fig. 8 is shown the testing of the spindle of a curved-tooth generator. This operation precedes the scraping of the cradle base, Fig. 5. The test bar is 15 in. long, and it must be level within 0.001 in. throughout the length of the bar.

In Fig. 9 is seen the testing of the spindle for concentricity with the fulcrum from which it is swung. The

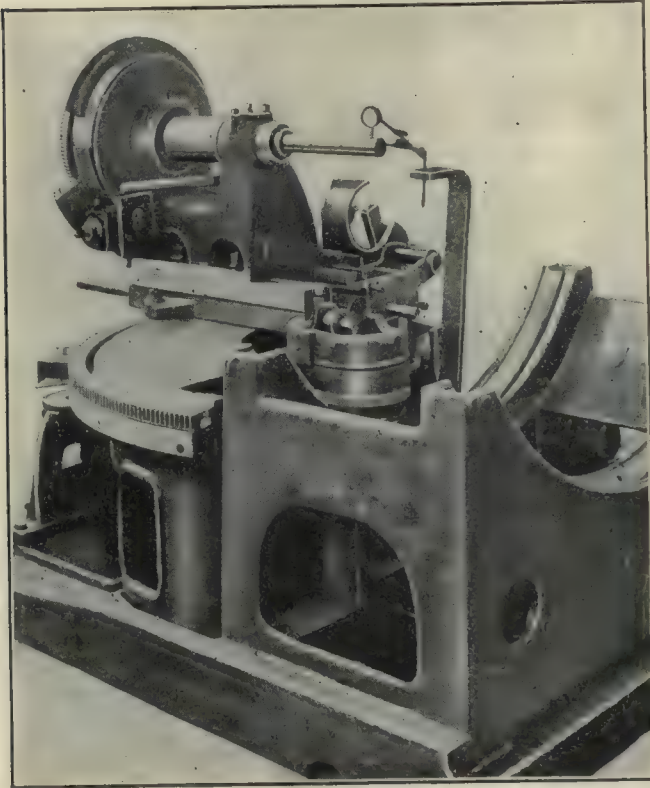


FIG. 8. TESTING ALIGNMENT OF SPINDLE WITH FRAME

testing arbor *A* has a spherical, or rather hemispherical, end. It has a taper shank that fits the tapered hole in the spindle. For this test the head is swung on its fulcrum, and the allowable variation from truth is 0.0005 in. only.

In Figs. 10 and 11 are shown the final hobbing and testing of the index wheel. The index wheels are made in two parts, held together by fitted bolts. The preliminary hobbing is done on a hobbing machine, with the index wheel in place on its spindle, as it is practically impossible to fit a separately cut index wheel accurately to a spindle. The spindle and the index wheel are then fitted to the head, and the latter is then ready to have the index wheel finish-hobbed in the manner to be described. After they have been assembled in the machine, the entire head, the spindle and the index wheel are removed to the hobbing stand, Fig. 10. The worm is removed, and the hob *A* is mounted on the wormshaft in its place. The drive for the hob is by rope over the rope pulley *B* and reducing gears *C*. Mounted on the spindle is a split drum *D*. Wound around this is the rope *E*, which is led over a pulley and has a weight attached to the other end. The weight is sufficiently heavy to carry the spindle and index gear around so that

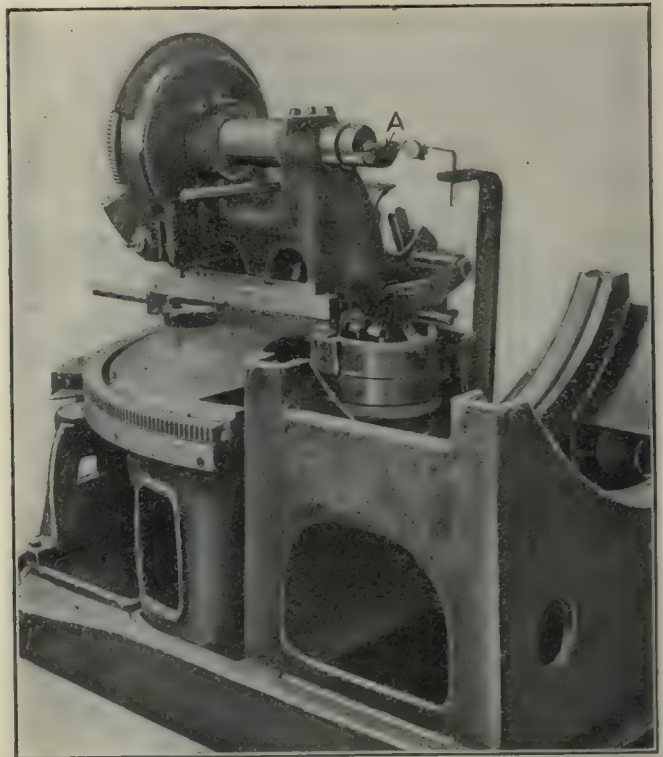


FIG. 9. TESTING HEAD FOR CONCENTRICITY

the hob merely cuts the teeth, but does not have to pull it around.

The index gear, as previously stated, is made up of two parts—the main part *F*, which is a force fit on the

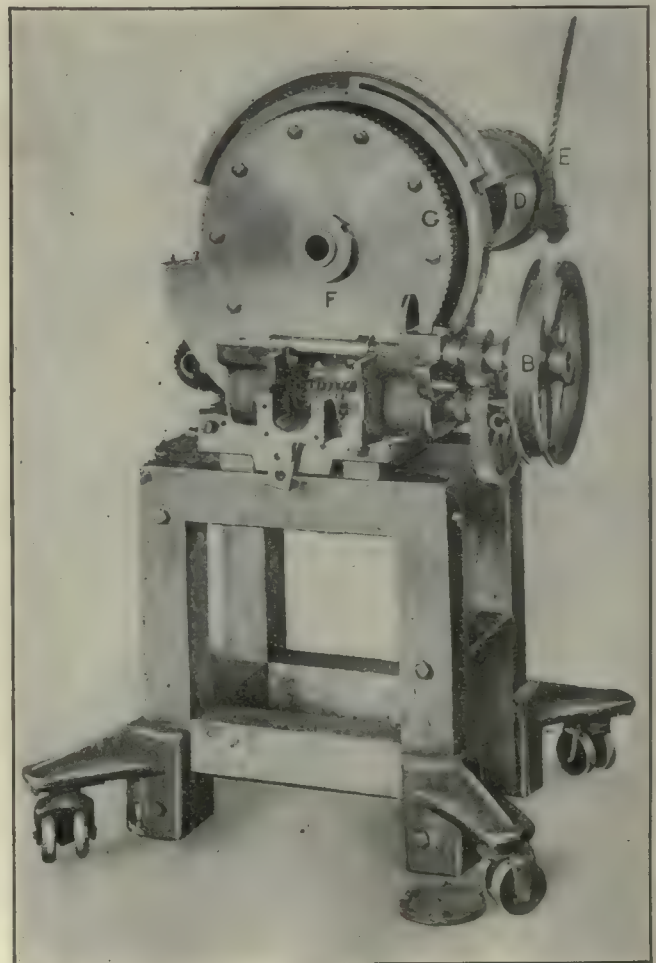


FIG. 10. FINISH-HOBGING THE INDEX WHEEL

spindle, and the ring *G* secured to *F* by accurately spaced and fitted bolts. Before starting to finish-hob, the ring *G* is removed and given a half-turn on *F*. After finish-hobbing has proceeded as far as it should according to the operator's judgment, the hob and hobbing gear are taken off and are replaced by the worm. It must be borne in mind that the whole indexing unit has been removed bodily from the gear-cutting machine.

The testing outfit consists of a dial indicator, *A*, Fig. 11, a crank *B*, a stop pin *C* and a pawl *D*. The operator lifts the pawl *D* out of engagement with the stop pin *C* and turns the crank *B* clockwise till the stop pin *C* engages the slot in the pawl *D*. The reading of the dial

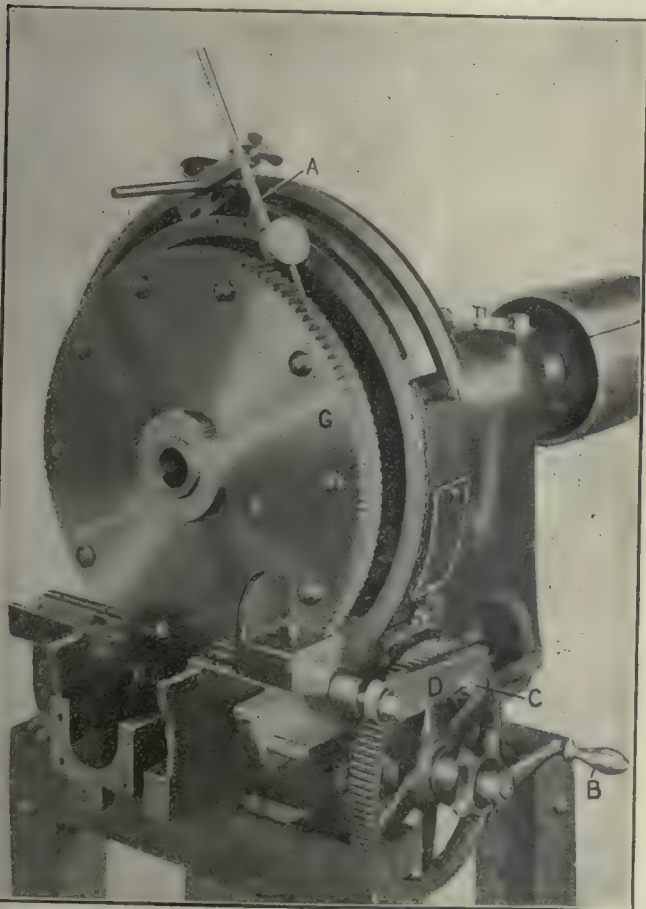


FIG. 11. TESTING THE ACCURACY OF THE SPACING OF THE TEETH OF THE INDEX WHEEL

indicator is then taken and the operation repeats tooth by tooth until a complete rotation of the index gear has been made. No rules are applicable to the work of justifying an index; experience is absolutely necessary. Each index gear is different. The justifier, assisted by his experience with previous index gears, hobs and tests, and hobs and tests till the gear is within the required limit of accuracy. The ring half *G* of the index gear *F*, Figs. 10 and 11, is shifted from position to position in search of the most advantageous location for it on *F*. The greatest allowable cumulative error is 0.0015 in. The majority of the index gears come within 0.0005 in. Occasionally an index gear is encountered which is found impossible of correction, generally because of hard spots. Such gears are forced off the spindle, scrapped and a new one fitted.

No time limit can be placed on work of this character. To finish-hob and test an index wheel requires from 3½ to 7 hr.

Young Men of Today--A Criticism

By J. P. BROPHY*

In looking around for shop apprentices I find that most of the young men of today are aspiring for nothing but dollars—and they want them right now. They seem to have no thought for their future. In our own shop we have increased the amount paid to such young men, aiming, if possible, to obtain the very best class of help. But in many instances it seems that the wages we can pay such youths is not great enough to attract them into our employ. These young men will not take the time to learn a trade or business, but would rather drive a wagon or do some other common, unskilled work. They can obtain a little more money at some such job, so they prefer the temporary advantage instead of trying to do things and achieve final success in a way similar to that followed by men who have worked and struggled for what they now have. To sum up the situation, it almost seems that these young men are lacking in just ordinary commonsense.

In many cases it seems as if the parents have lost control over their own children—at least that is the way it appears to me. A few years ago, if you wanted a young man to settle down for a three- or four-years' apprenticeship and learn a trade or business, you and his parents could control the situation. But today this is not so. One disturbing thing seems to be the many places of amusements, some even supported by municipalities, which take young people away from home during the time they should be preparing themselves for the future. These many opportunities for pleasure make it difficult to control young men after they leave the public school, and also make it hard for them to settle down and learn some kind of skilled work that will be to their advantage in later years. I am satisfied that a vast number of employees will agree with what I am saying.

Is it possible that too much book education is destroying the thinking power of our young men and preventing them from understanding life as it really is? In any event, a high-school education and a \$1.50 per day job seem to be entirely satisfactory to a great number. Apparently they do not care what may happen later on in life.

Turning again to the matter of amusements and sports, these tend to make our young men wish to be away from home too much. Some pleasure is all right, but an important thing that should never be forgotten is that sacrifices at the right time fortify us for the years to come. Nowadays, on almost any evening, you can find numbers of young people in the dance halls. Probably they would congregate there every night in the week if they had the opportunity. But they are there at times when they should be at home preparing for the next day's work, or learning things to make life easier as they grow older. It sometimes seems as if the wholesome amusements of the past are absolutely forgotten.

To get right down and consider a very simple job, that of office boy offers an excellent chance for an ambitious youth, as there are many opportunities for advancement. But in spite of the fact that this work may lead to a future excellent position, it is now a rare thing to have an application for an office boy's job, whereas in the years gone by such requests were numerous.

*Vice-president, Cleveland Automatic Machine Co.

Machining Small Lathe Parts

BY ROBERT MAWSON

SYNOPSIS—In this article are shown jigs used in drilling the apron-feed rod stand, head driving-pulley guard stand, back-arm bar bushing, countershaft-carriage stop bracket, two-speed head front-pulley shaft cap and the spindle driving-gear nut. The jigs are shown in detail, and the average drilling time given.

On page 1007, Vol. 44, was described a turret lathe manufactured for Reed-Prentice by the Blake & Knowles Steam Pump Works, East Cambridge, Mass.

The jig for the feed-rod stand employs a turned plug

that fits into the previously bored hole as the locating medium. In drilling the pulley-guard stand the tool is designed merely to hold the part, the holes being located in the center of the bosses and then drilled. The jig is provided with an indexing pin so that the two sets of holes will be drilled radially.

A simple plate jig provided with a locating plug is employed for drilling the bar bushing. The tool used in drilling the carriage stop bracket employs a steel groove into which fits the machined tongue as the locating means. Two simpler types of jigs are used in drilling the other two elements. In one, hook bolts hold the part in position, and in the other a thumb-screw tightens the casting.

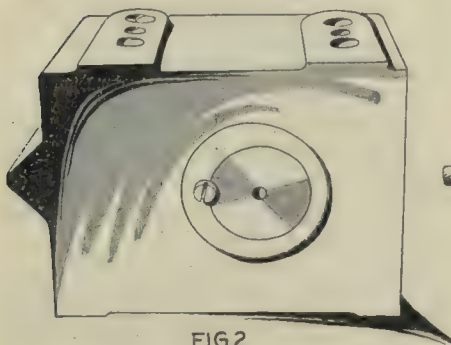


FIG. 2

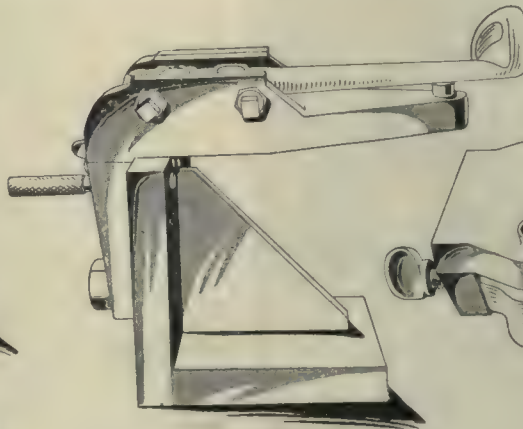


FIG. 4

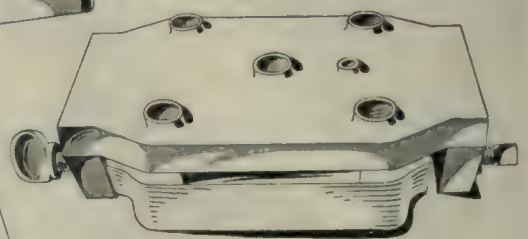


FIG. 10

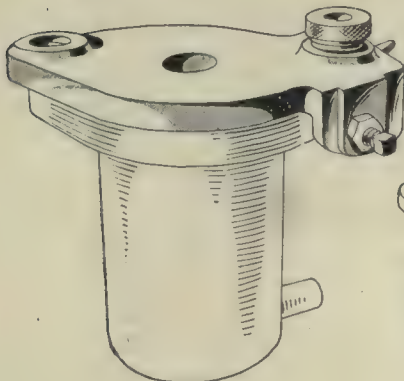


FIG. 6

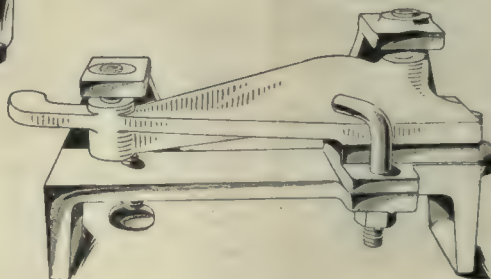


FIG. 8

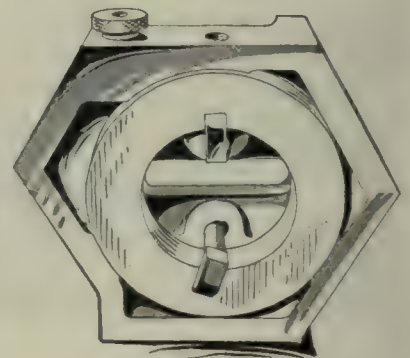


FIG. 12

JIGS USED IN DRILLING TURRET-LATHE PARTS

FIGS. 2 AND 2-A

Operation—Drilling apron-feed rod stand, Fig. 1. The bored and milled casting is located by a plug and finished pads. A washer and a thumb nut hold it in position.

Holes Machined—Four $\frac{1}{8}$ -in. and two $\frac{3}{8}$ -in. drilled.

FIGS. 4 AND 4-A

Operation—Drilling head driving-pulley guard stand, Fig. 3. The casting is located against a stop pin at the end and rests against another pin at the front end. Screws are tightened against the casting to force it against adjustable pads and thus hold it. Two holes are drilled with the index pin, as shown. The swinging element of the jig is then placed in the second position, being located again by the indexing pin, and the second drilling is performed.

Holes Machined—Four $\frac{3}{8}$ -in. drilled.

FIGS. 6 AND 6-A

Operation—Drilling back-arm bar bushing, Fig. 5. The jig is placed on the casting to be drilled, being located by a plug that fits into a $\frac{3}{8}$ -in. hole previously bored. A thumb-screw forces the flange around against a locating setscrew.

Holes Machined—Two $\frac{3}{8}$ -in. drilled.

FIGS. 8 AND 8-A

Operation—Drilling countershaft-carriage stop bracket, Fig. 7. The machined casting is located by a recess into which a milled tongue fits. The part is then slid along the jig against a locating pin. The hook bolt shown holds it in position.

Holes Machined—One $\frac{1}{4}$ -in. and one $\frac{3}{8}$ -in. drilled.

FIGS. 10 AND 10-A

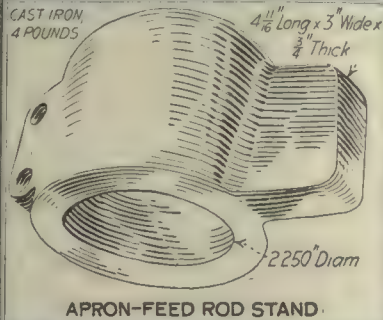
Operation—Drilling two-speed head front-pulley shaft cap, Fig. 9. The milled casting is located by two steel tongues that fit outside the recess on the lap. The part is then forced against an adjustable setscrew by a thumb-screw.

Holes Machined—Four $\frac{1}{8}$ -in. and one F drilled and one hole drilled to suit an oil cup.

FIGS. 12 AND 12-A

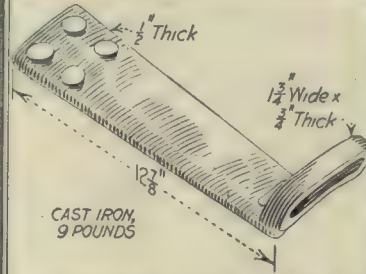
Operation—Drilling the head-spindle driving-gear nut, Fig. 11. The finish-turned and threaded nut is located by the outside in the jig and held in position by the two hook bolts, as shown.

Holes Machined—Three $\frac{3}{8}$ -in. and one $\frac{1}{8}$ -in. drilled. The latter hole is then counterbored to $\frac{1}{4}$ in. for a depth of $\frac{3}{8}$ in.



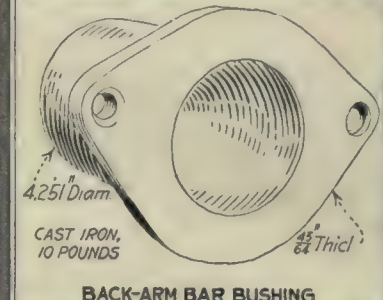
APRON-FEED ROD STAND

FIG 1



DRIVING-PULLEY GUARD STAND

FIG 3



BACK-ARM BAR BUSHING

FIG 5

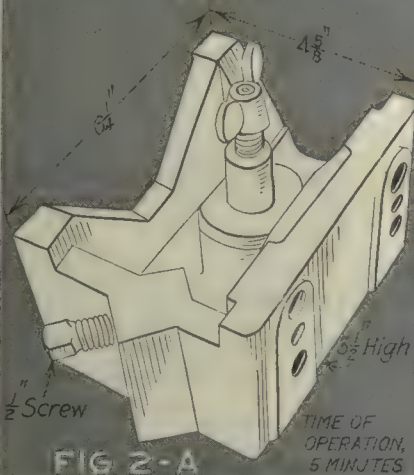


FIG 2-A

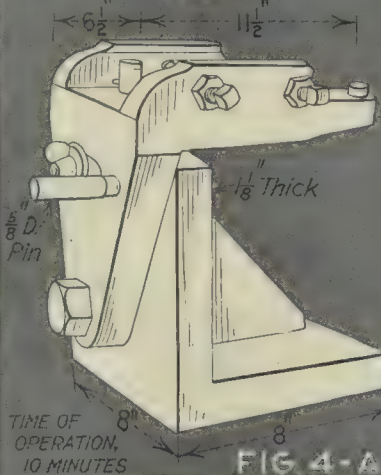


FIG 4-A

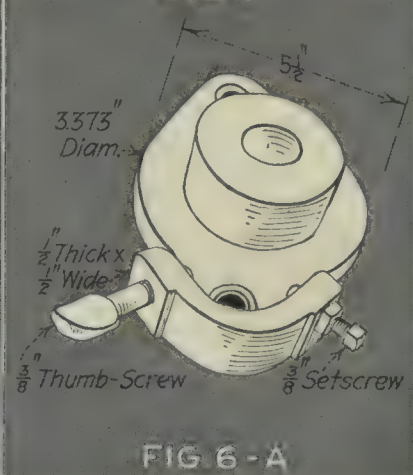
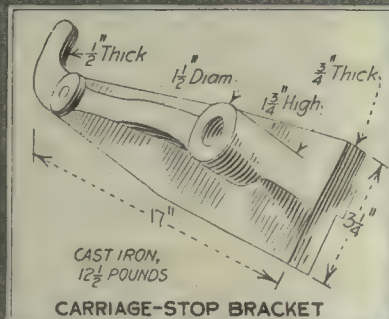


FIG 6-A



CARRIAGE-STOP BRACKET

FIG 7

TIME OF OPERATION, 30 MINUTES

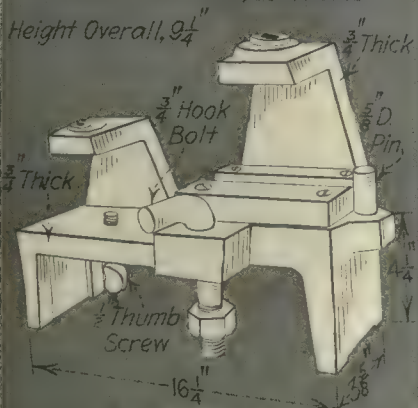
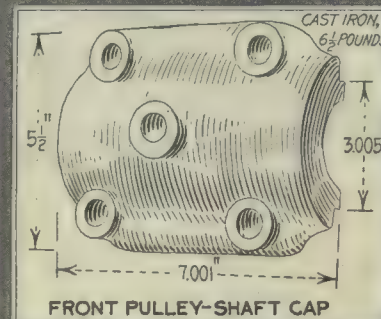
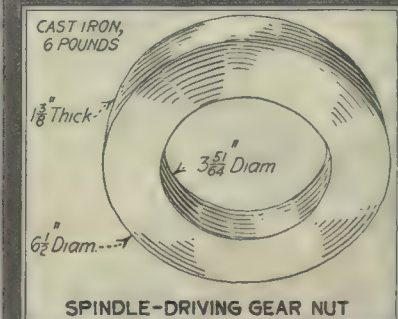


FIG 8-A



FRONT PULLEY-SHAFT CAP

FIG 9



SPINDLE-DRIVING GEAR NUT

FIG 11

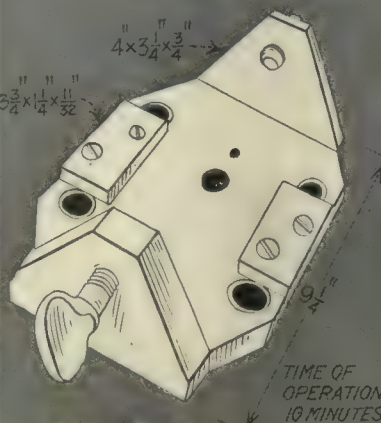


FIG 10-A



FIG 12-A

ALL BUSHINGS USED FOR GUIDING TOOLS ARE BLACKENED. ALL JIG AND FIXTURE BODIES ARE CAST IRON, STRAPS AND FASTENINGS, MACHINERY STEEL; GUIDE BUSHINGS ARE TOOL STEEL, HARDENED AND GROUND

A Lathe Milling Fixture of Wide Range

By C. O. PARKHURST

Next after the lathe the miller is probably the most flexible machine tool, capable of doing a large variety of work.

There are plenty of milling attachments for the lathe, to be had for the buying, but generally they are limited in their capacity to small or special work for which they are designed and have not a great range.

The attachment shown in the illustration is a regular "hand" miller so modified as to be readily placed on the back end of the lathe bed. This fixture can be driven by a heavy rod toggled to the live spindle of the miller, the

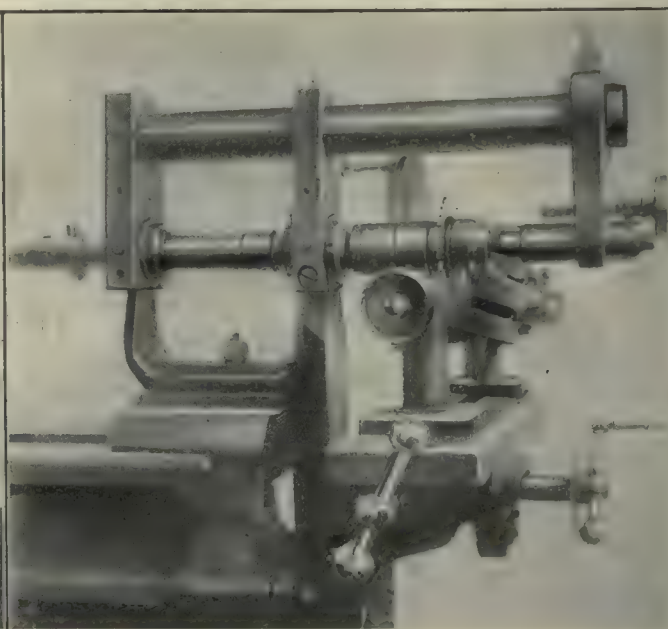
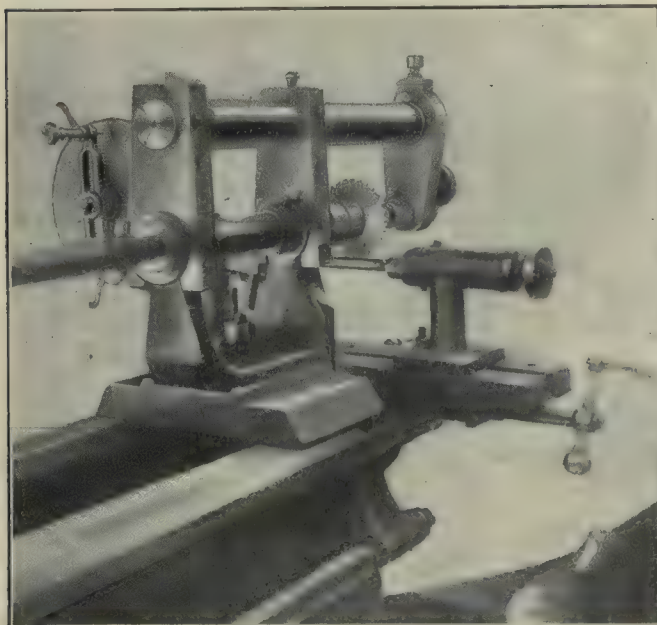
miller, can be used here for holding work, and as true and dependable a product can be secured as on any regular miller, the limit being only the size of the machine. Worm gears have been cut, small pinions down to $\frac{1}{8}$ in. in diameter have been made, and pretty nearly all kinds of work except rack cutting have been done with this fixture.

■

Soldering Iron with Removable Copper Point

By P. GAMES

The illustration shows a soldering iron made from a piece of standard copper tubing swaged down to a point at one end in the way shown in the accompanying detail.



FIGS. 1 AND 2. A MILLING FIXTURE THAT WORKS IN PARTNERSHIP WITH THE LATHE

other end being held in a chuck on the live spindle of the lathe, the tailstock of the lathe having been removed.

The original of this machine was made and used as a regular miller. Seeing it in operation and realizing what could be done with it as a lathe attachment, I borrowed the patterns and built the lathe attachment. As originally designed, it had no overhead bar for the outer cutter of the milling arbor. This was put on later to stiffen the machine.

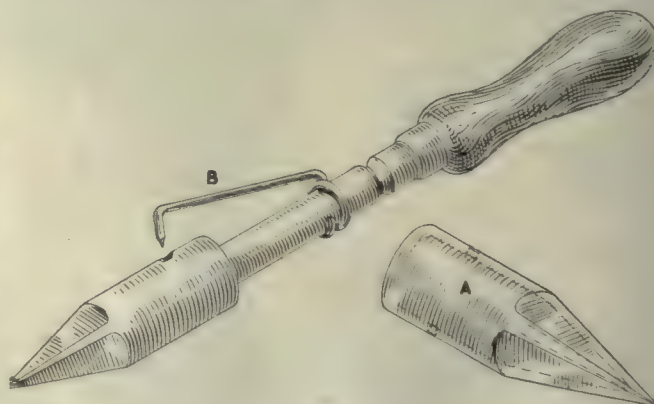
ADAPTED FOR A WIDE RANGE OF MILLING

With this attachment any and all forms of milling within the limits of its size and its appliances can be done. The lathe head drives it. Hence, any change of speed within the range of the lathe, with its back gears, is possible, and heavy cuts can be taken when needed. With the cutters shown, gear cutting up to 6 in. in diameter can be done, and of course all sorts and kinds of fluting for drills, reamers and the like.

Graduations on the screws enable cuts down to 0.001 in. to be set for and made. Hence, one can work as "fine" as one pleases. The feed is by hand with a traverse screw; it would hardly pay to put on an automatic feed for so small a machine.

Putting the attachment on or taking it off takes about five minutes. Vises, clamps, etc., such as are used with a

The copper is not brought into contact with any flame. In use, the copper sleeve A is removed, the end of the iron rod is heated and the copper sleeve slipped on and locked by the bent wire B. The locking arrangement is convenient and can be put in operation almost instantly.



SOLDERING IRON WITH REMOVABLE COPPER POINT

Heat is retained in this iron two or three times as long as in one made of solid copper. The end of the rod should not be less than $\frac{5}{8}$ in. in diameter or the heat will not be retained.

Manufacture of a Five-Piece Typewriter Frame--I

BY FRANK A. STANLEY

SYNOPSIS—The frame of this typewriter is made up of five main parts, consisting of two side plates, a front brace, a rear brace, and a front tie filling out the bottom of the frame. The members are put together securely with screws having heads finished flush with the castings, and no sign of a joint shows in the finished machine. This construction is worked out in this case much better than would be possible with a solid casting for the frame, and the subsequent machining operations are carried on more satisfactorily.

In an earlier article in these columns a description was given covering certain important features in the design and construction of the Noiseless typewriter. The methods of the manufacturer of this machine, the

as the methods of manufacture render this possible by conforming to the requisite degree of accuracy.

It will be shown in this and in succeeding articles that the process of manufacture of the Noiseless typewriter introduces into shop practice many high-grade methods, some of which are unique; and the whole order of operations is developed along such a line that from the important starting point to the conclusion of the series of machining operations the setting of both work and cutting tools correctly is maintained by working and gaging always from the given starting point.

The typewriter in its assembled condition and in various stages of assembly was illustrated in the earlier article, page 139. Fig. 1 herewith shows the frame of this machine before and after putting together. As there represented it is of five-piece construction, consisting of two side plates—right and left—a front-frame

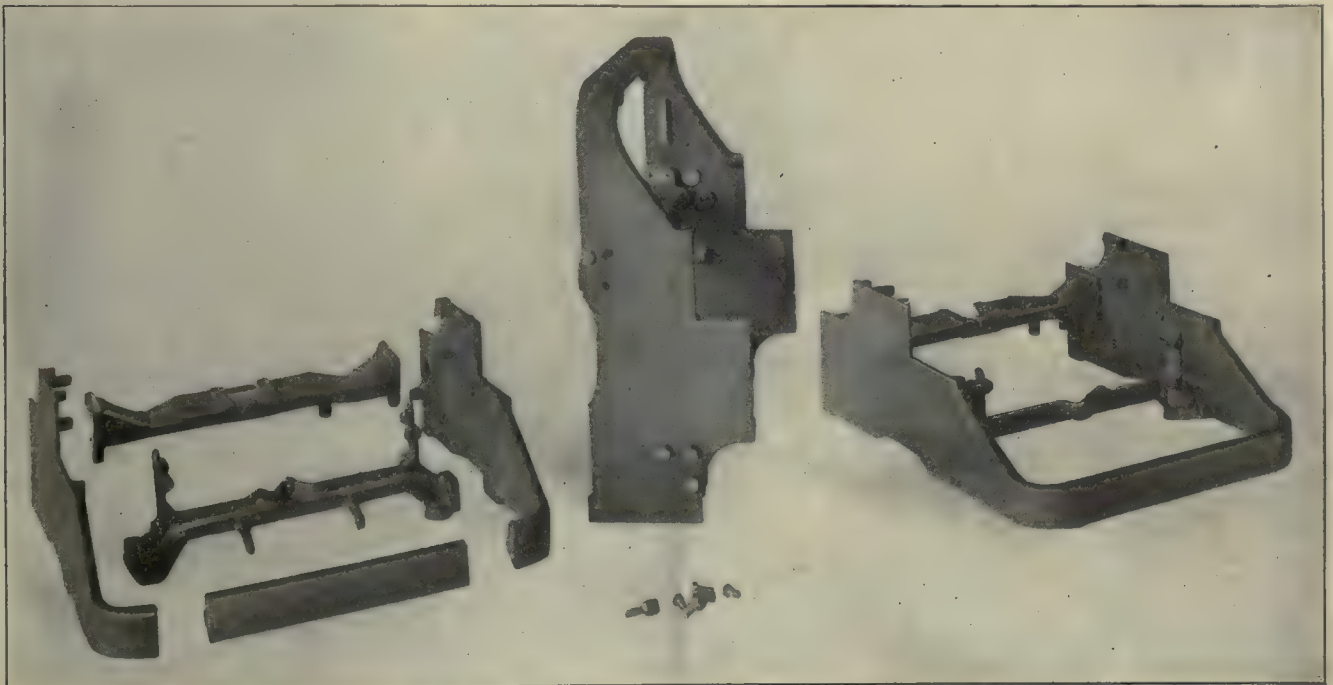


FIG. 1. FRAME OF NOISELESS TYPEWRITER DISASSEMBLED AND ASSEMBLED

Noiseless Typewriter Co., Middletown, Conn., embody many operations of precision and processes where a considerable degree of ingenuity has been resorted to in the working out of details of jigs, fixtures and other special appliances for conducting the work with rapidity and accuracy.

As already pointed out, this typewriter has many points of novelty; and it may be said that its operation as a noiseless machine depends in a considerable measure upon the correctness of the parts of which it is constituted. That is to say, as in numerous other cases which might be cited in various lines of manufacture, the important principles evolved by the designer, while theoretically correct, may be taken advantage of in the production of the finished machine only in so far

brace, a rear-frame brace and a front filling piece closing the gap between the two inner surfaces of the curved ends of the side plates.

Originally this frame was cast in one piece, and an ingeniously designed pattern and core block were utilized in the process of making the mold for the casting. In spite of this fact, however, the one-piece casting was always an expensive object primarily, and certain machining operations, particularly in connection with the cross-braces, were more difficult of accomplishment in the solid frame. The whole proposition was eventually converted into the sectional construction, under which economy in cost, both of original castings and in the later operations of machining, has been effected without incurring any disadvantage.

of plain and tapped holes, distances of seats from other important points, height of shoulders, and so on.

The side plates for the frames as they come from the foundry are shown clearly in Figs. 1 and 7. These castings come out of the mold so straight, so free from scale and so nearly a plane surface that a straight-edge

surfaces anywhere, but furthermore all the way through the process of manufacture, assembly and finishing for shipment.

Moreover, workmen handling material of this kind have much the same degree of respect for a smooth, unwarped, parallel casting with clean bosses and ribs as they

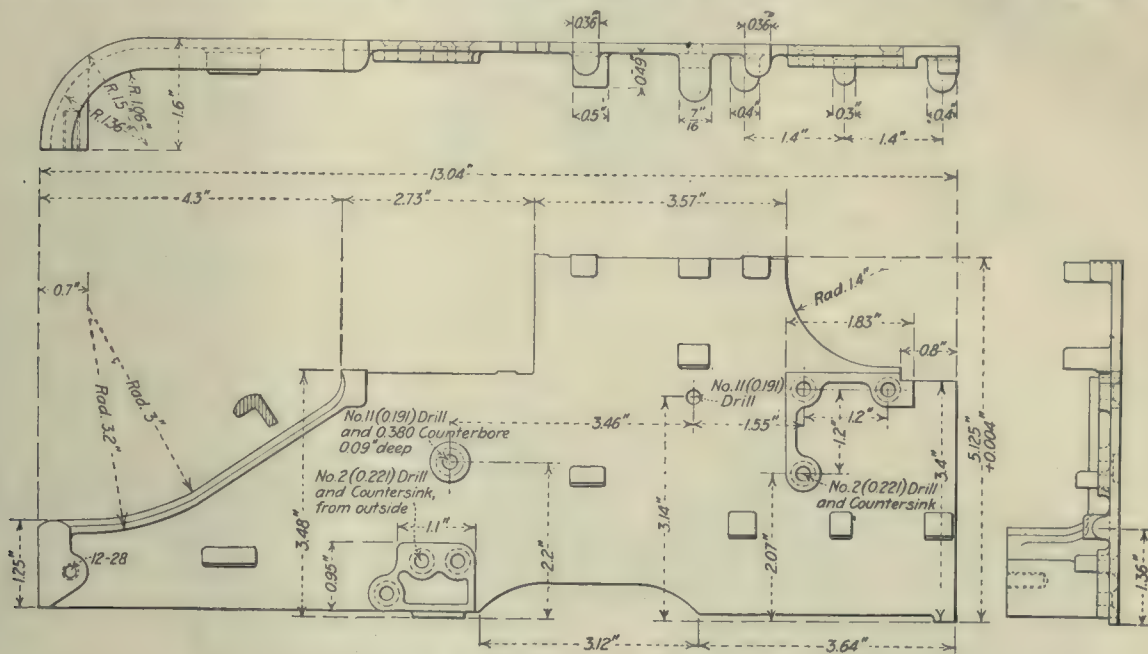


FIG. 4. THE LEFT-SIDE FRAME

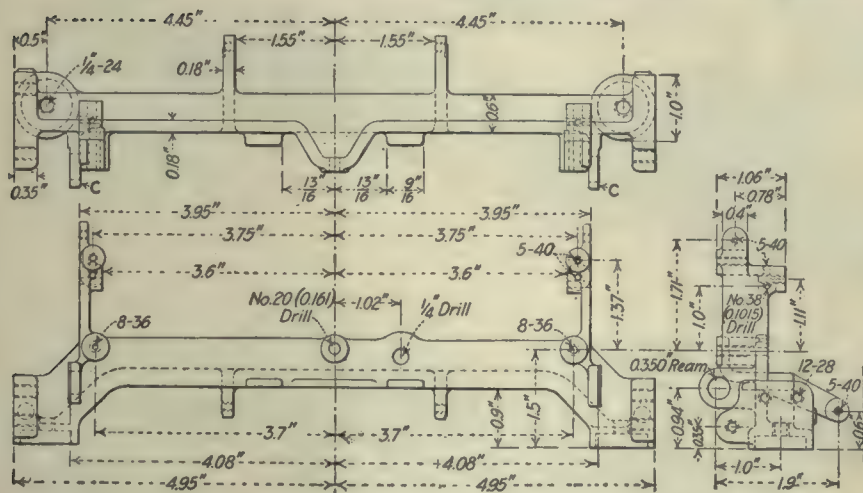


FIG. 5. FRONT-FRAME BRACE

may be swung across any two corners with very little light showing between it and the casting surface. The body of the plate is only a little over $\frac{1}{8}$ in. in thickness, and as represented there are a considerable number of lugs and bosses cast on the inner surfaces, giving the metal an excellent opportunity to warp in the cooling process. Yet if there is any tendency in this direction, it has been offset to such an extent that the outer face of the casting is actually a precision job as considered from a foundry point of view.

As a matter of fact these plates will lie dead flat upon the surface plate, with practically no vibration at corners and with no spring or sag at the center or rock at any point. Naturally this quality of foundry work not only makes it possible to carry the castings through successive operations with a minimum of time and effort spent in locating them properly, due to any inaccuracy of the

ordinarily have for finished metal parts; and in carrying such work through from one stage to another it is treated as it should be, with care in handling and with a proper appreciation of what the part means to the machine when completed. Without doubt, reasoning along this line, we would very often develop and maintain in a good many factories a much higher degree of workmanship on the average, if at the outset our best efforts were made to secure material, in the way of even the simplest castings, in as true and neat a general condition as possible. A pair of frame slides ready for milling along the upper edges are shown in the foreground of Fig. 7, and

a similar pair are shown back to back, clamped in the fixture at the left for the milling of the top, while another pair are represented bottom side up in the second fixture for parallel milling of two supporting lugs on each casting along the bottom of the frame side. These fixtures are duplicate devices of simple construction, consisting merely of a conveniently operated clamping bar which acts as an equalizer to pull up the clamping plate at the rear through the action of a pair of spring-controlled through-bolts with springs, which throw the clamping plate away from the work when the cam handle at the front is released upon the completion of the job.

The surfaces against which the work is clamped carry properly located stop pins, against which the work is pressed without possibility of deflection and between which the pair of castings are held with the two pieces parallel and secure against displacement.

A profiling fixture for finishing certain surfaces on the inner faces of these frame sides is illustrated at the right in Fig. 8, and the same view shows a drill jig for both right- and left-hand plates, the jig standing at the left of the profiling fixture. Both tools are of simple construction, working out satisfactorily in practice. In the case of the profiling device the work is dropped onto suitable resting pins, drawn down lightly by thumb-screws carried in swinging straps, and spring plungers are then allowed to come into contact with the bottom of the plate, after which they are secured to support

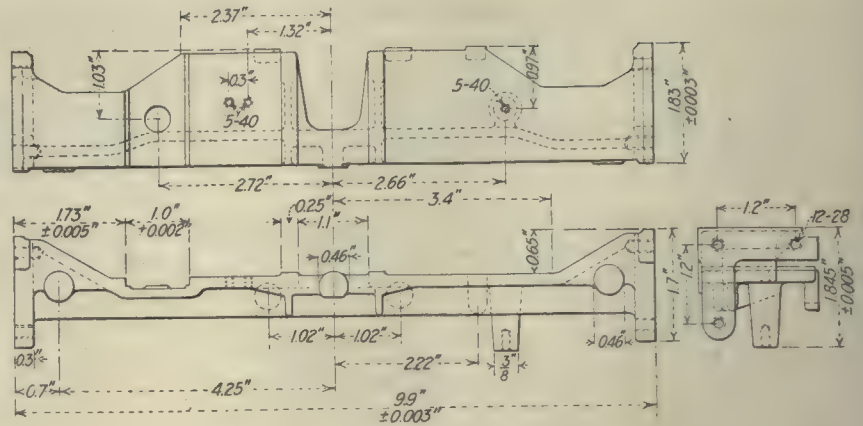


FIG. 6. REAR-FRAME BRACE

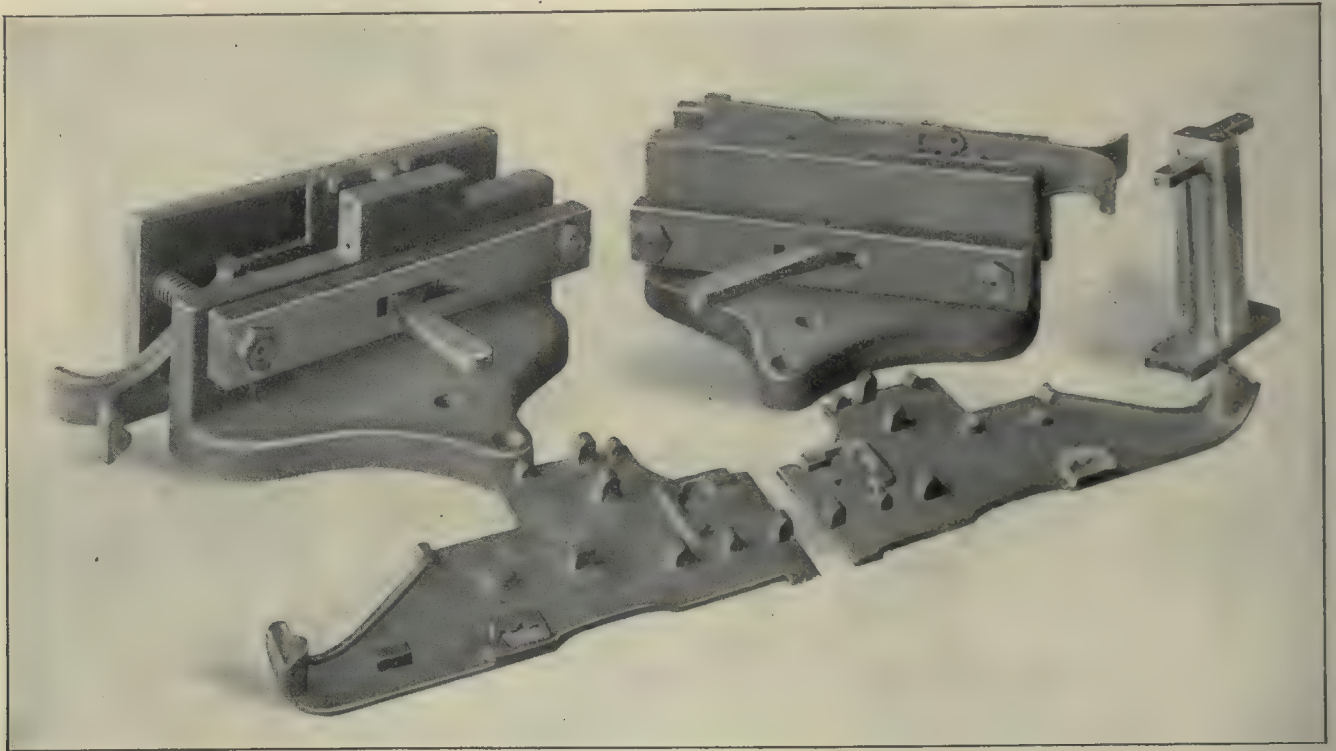


FIG. 7. PROFILING JIGS AND TEST GAGE

the casting under the cutter. The drill jig is made right- and left-hand with two sets of feet, as illustrated, and the castings to be drilled are placed at their respective sides of the central body of the jig. A stop bar used on the profiling machine for rapid positioning of the cutter to different heights to mill surfaces at the right distance apart, so far as height is concerned, is used in connection with the profiling fixture. Practically all the operations performed on the profiling fixture are facilitated greatly by the use of the stop bar, as the cutter is thus elevated to the exact point for milling off one boss or seat after another. Generally speaking, every operation of any importance has limit gages for checking up its accuracy, and at the

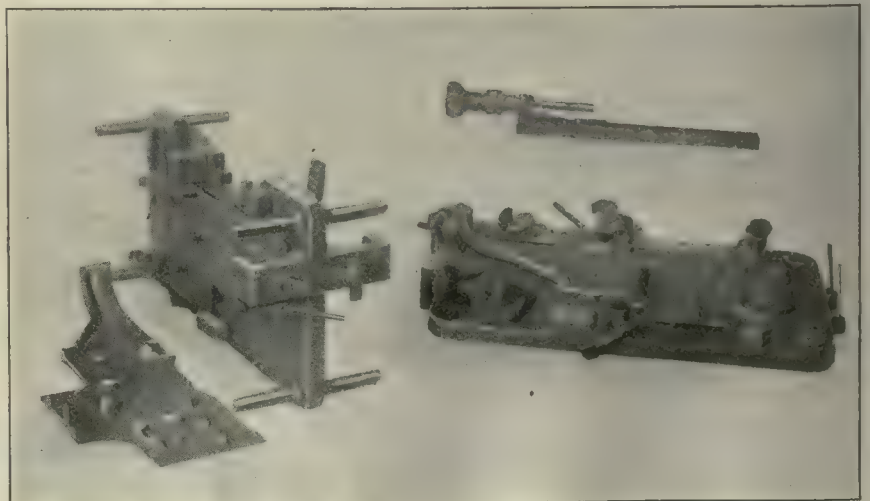


FIG. 8. DRILLING JIG FOR RIGHT- AND LEFT-HAND PLATES AND A PROFILING FIXTURE FOR FRAME SIDES

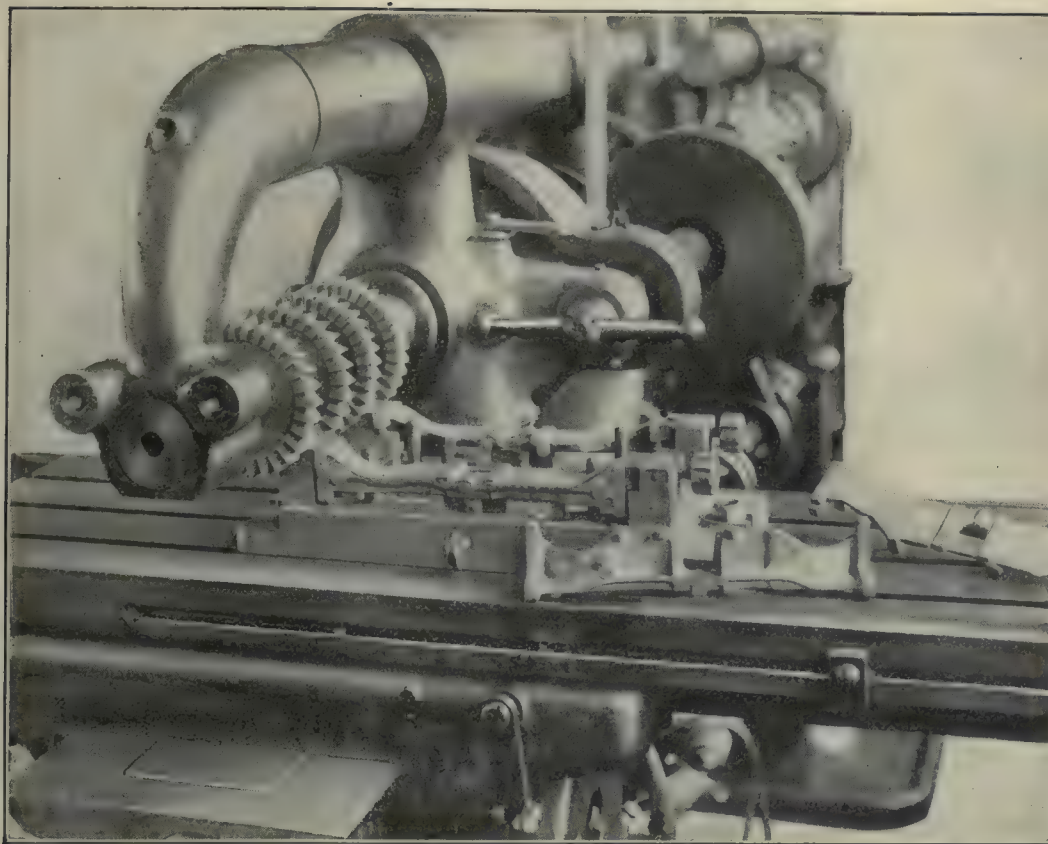


FIG. 9. MILLING FRAME BRACES

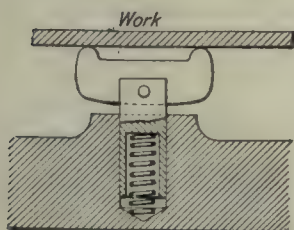


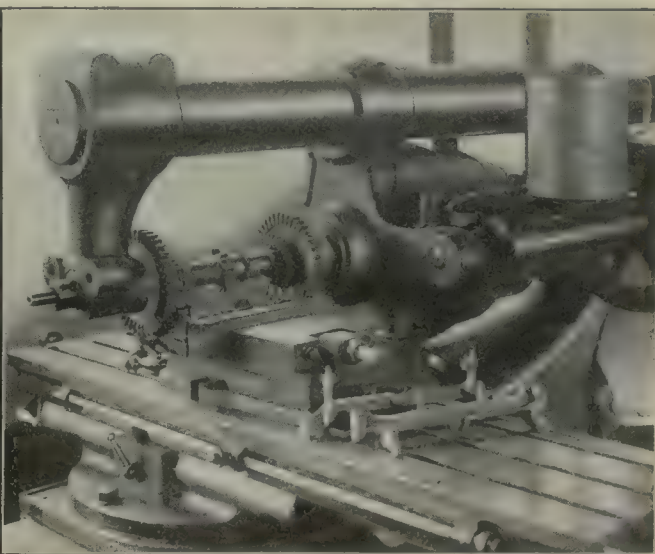
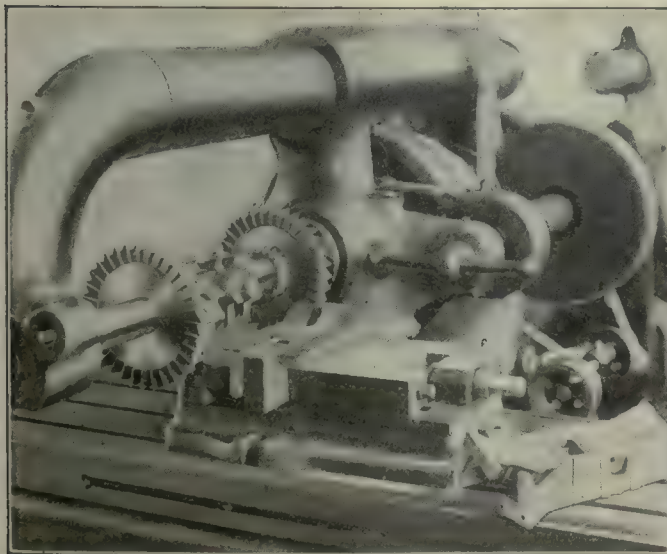
FIG. 10. TWO-POINT SUPPORT

right of Fig. 7 will be seen a height gage of this character for testing the relative positions of tool cuts taken on the frame side. The operations on these frame parts are comparatively simple and will not be detailed to any great extent herein. More in-

head screw. The two-point support under the work is constructed as in the detail, Fig. 10.

The next operation applied to this casting is represented in Fig. 11, which shows the method of gang milling the ends of the castings and taking a number of other cuts, as follows: The two large straddle mills at the ends of the group of cutters, surface the ends of the rear-frame brace, the work being held as indicated between special vise jaws, so that it is supported and gripped

method of milling and profiling these rear-frame braces in suitable holding fixtures. Fig. 9 illustrates a pair of the rear-brace castings in a duplex fixture, where they are passed between straddle cutters for facing off the casting to thickness and surfacing the bosses as represented. This fixture has stop pins inside of the work, against which the castings are placed to locate them sidewise; and near the middle there is an equalizing two-point support thrown up by a spring pressure and clamped by a thumb-screw, while at one end is a fixed hardened jaw and at the other end a movable clamping jaw operated by a grooved-



FIGS. 11 AND 12. GANG-MILLING THE BRACES

teresting methods are applied in the case of the rear-frame brace, owing to the fact that this member carries the center tie and must therefore be machined at various points with great accuracy. Several views illustrate the

against twisting out of the chuck. The second cutter from the outer end and the pair of coarse-pitch narrow cutters near the middle of the arbor, machine the bearing surfaces upon which the center tie is guided and sup-

ported while a pair of fairly small peripheral mills located against the inner faces of the straddle cutters, machine the upper edges of the frame-brace casting, thus forming finished seats at the points indicated.

The milling cutters used in the operations illustrated for machining the ends and sides and guiding surfaces on the rear brace are so mounted on their arbor with an adjustable collar in the set, that distances over all may be maintained at all times by adjustment of the collar referred to. This is shown also with the gang cutters, Fig. 12, set up for milling the front-frame brace, as illustrated. In this instance the work is held between two special jaws in the miller vise, and the gang cutters are then applied to mill off faces at the sides and surface a projecting lug near the middle. In Figs. 13 and 14 the drilling jigs are shown for putting in the holes in the front-frame braces. Referring to Fig. 13, the jig shown at the top is for drilling holes in the ends of the castings and holes in the sides. The jig in the middle, Fig. 13, prepares the holes in the bosses under the brace to receive the feet of the machine, and the jig in Fig. 14 is shown at the bottom of the group with the bushing plates removed to admit a counterbore for cutting out the seats to receive the machine feet. In this latter view, Fig. 14, the jig shown at the top is the same one as that seen in Fig. 13, but is turned up at a different position to show the interior construction. No special description of any of these jigs is necessary, as their general design and the method of using them are obvious upon inspection. It may be pointed out, however, that the work as milled to length in the operations illustrated gages itself as it passes into the jig, as it fits with either end against the finished interior faces of the uprights, which carry the drill bushings or against other fixed stop surfaces. The work in each case is secured by thumb-screws carried in swinging arms, which may be quickly brought into position and as readily swung out of the way when the work is to be removed. This method of securing the work is much used in this plant and has given satisfactory results. When the arms are swung aside the whole jig is open for the insertion or removal of the work.

(To be continued)

❧

New Process of Rust-Proofing

There has recently been invented by Augusto Bontempi, an Italian chemist, a process of rust-proofing which is reported to consist in the oxidizing of cast and wrought iron and steel pieces, thus rendering them immune to corrosive action.—*Brass World*.

Old Locomotives Doing Duty in France

It will be of interest to learn that on the Eastern Railway of France, or in that portion of it still in the hands of the French Government, there are a large number of locomotives of the older types still doing excellent service in the congestion of traffic consequent on the supply of material and munitions on the extended battle line. These locomotives, although not possessing high speed, are said to be reliable in freight traffic. The serv-

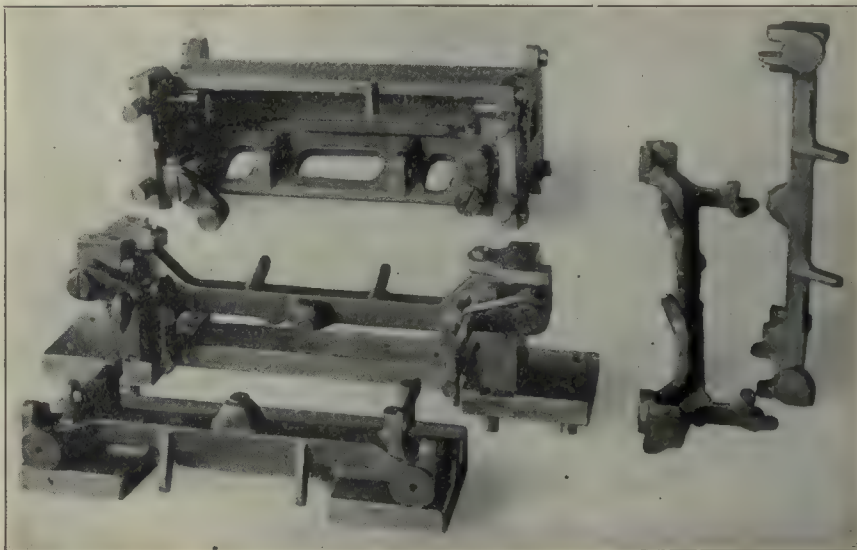


FIG. 13. DRILL JIG FOR BRACES

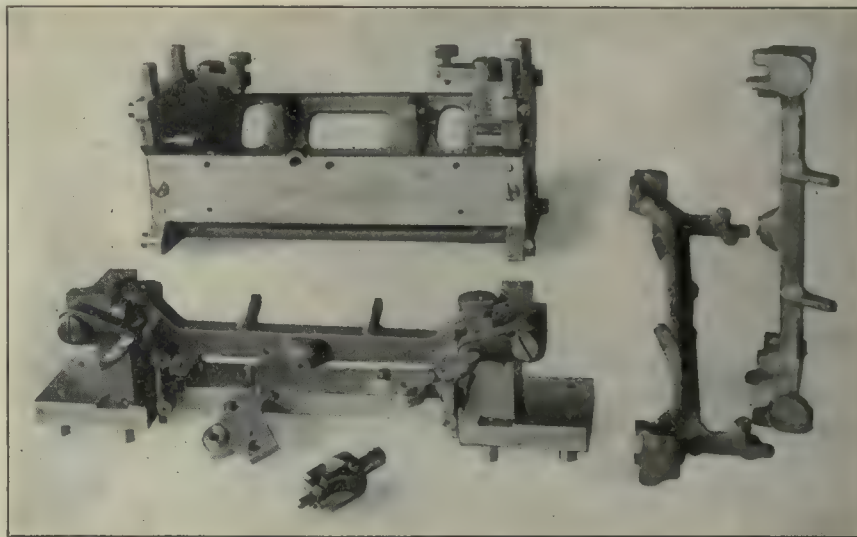


FIG. 14. SAME JIG AS IN FIG. 13, SHOWING CONSTRUCTION

ice may be said to be little more than that of a general switching kind, as the runs are comparatively short, but as the entire weight is on the driving wheels their adhesive qualities are of the best, and the roads are said to be in excellent condition. Near the front there are a large number of much smaller engines, running on narrow gages, the rails being laid with great rapidity on such temporary tracks as may be necessary to meet the requirements of the service. Repair work on this type of locomotive is easy of accomplishment, and the engines are kept running day and night, many of them having three crews.—*Railway and Locomotive Engineering*.

Heating Plant for Shell Forgings

SPECIAL CORRESPONDENCE

SYNOPSIS—Heating is one of the most important problems in the making of forgings of all kinds. This article describes a large and complete installation for the forging of projectiles, the heating for forgings, for heat treating and for annealing, and shows the location of the tanks, blowers and furnaces of a low-pressure system.

The heating problem, as it applies to forging, heat treating and annealing, is all-important in the making

The furnace equipment consists of twenty-four direct, over-fired furnaces of the double-chamber type. Each heating chamber measures 38x46 in., and is 22 in. high. The position of the furnaces with relation to the hydraulic forging presses is shown in the plan view, Fig. 2, one furnace taking care of two presses.

The heat-treating plant includes five furnaces for annealing and five furnaces for hardening. These are of the semimuffle oven type with double heating chambers. Each chamber measures 36x60 in. and is 22 in. high, as in the furnaces previously referred to. These furnaces



FIG. 1. MAIN BAY IN FORGE SHOP

of modern projectiles, so that the installation of the fuel-oil plant at the works of the Bridgeport Projectile Co., Bridgeport, Conn., is of particular interest at this time. The plant was installed by the Gilbert & Barker Manufacturing Co., Springfield, Mass., and includes the low-pressure fuel-oil system supplied by it together with a large number of furnaces for various purposes.

A general view of the forge shop, taken before the installation was complete and in operation, is shown in Fig. 1. There are eighteen hydraulic presses on each side of the main bay in addition to a steam hammer located midway between the fourth and fifth presses on each side. The 15-ton Niles crane handles any necessary material and was of particular value in the installation of the presses themselves.

are all provided with suitable openings for pyrometer thermo-couples, the Wilson-Maeulen instrument being used in this plant.

THE FUEL-OIL PLANT

An important part of such an installation is the fuel-oil plant for supplying the furnaces. This consists of two specially constructed high-speed centrifugal air compressors. Each compressor is rated to deliver 5,400 cu.ft. of air per minute at a speed of 3,450 revolutions, delivering air to the burners at a pressure of $11\frac{1}{2}$ lb. to the square inch. The pumps are direct connected to a 50-hp. motor.

The oil is pumped by two rotary oil pumps each directly geared to a 1-hp. electric motor. These pumps

deliver oil to the burners under a pressure of from 5 to 10 lb. per sq.in., and are so connected that whatever oil is pumped in excess of that used by the burners goes back through suitable release valves to the underground storage tanks.

A Gilbert & Barker automatic cutoff valve is connected to both the oil and air lines so as to shut off instantly the flow of oil to the burners if for any reason

measuring 5x4 ft. and 4 ft. deep. There are two oil-storage and cooling tanks, each 10x12 ft. and 4 ft. deep, with an approximate capacity of 3,000 gal. each.

The pumps for circulating the cooling oil are of the rotary type direct connected to 3-hp. electric motors. These pumps are so connected that the quenching oil circulates from the quenching tank back to the cooling tank where, after cooling, it is again returned for use in

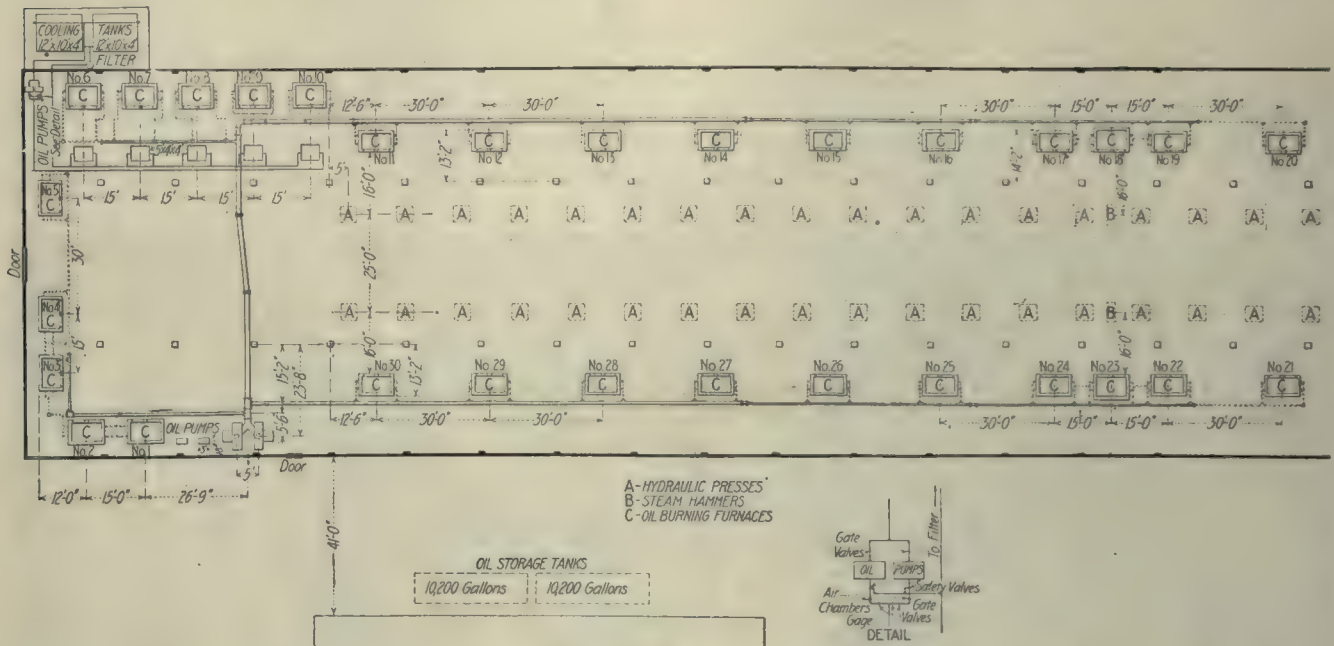


FIG. 2. GROUND PLAN, SHOWING FURNACES, PRESSES AND OIL TANKS

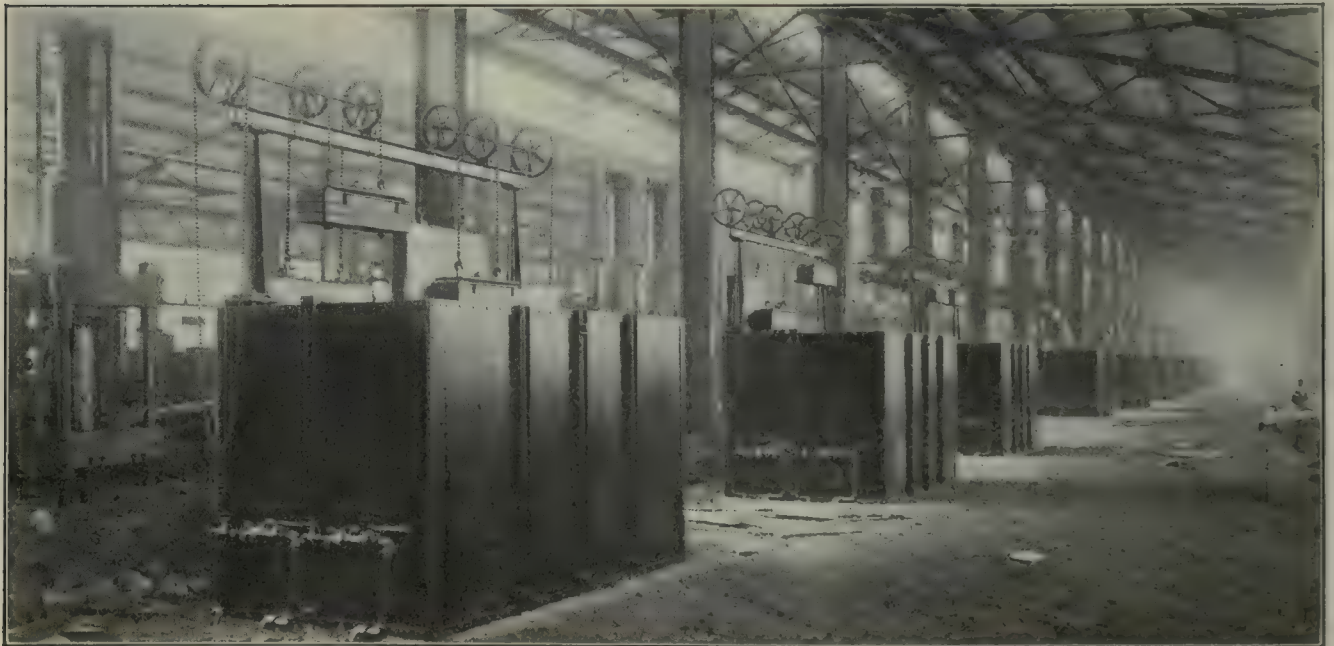


FIG. 3. BATTERY OF HEATING FURNACES

the flow of air should stop. This arrangement prevents the flow of atomized oil into the hot furnace and provides a safety device that seems quite necessary in such installations.

The fuel-oil storage consists of two tanks, each with a capacity of 10,200 gal. These are outside the building and underground, their location being shown in Fig. 2. The oil-quenching system consists of five tanks, each

quenching. These tanks are provided with a series of cooling oils through which cold water is circulated, the coils being so proportioned that they reduce the temperature of the oil to the desired point and keep it circulating at a known velocity, thus maintaining its temperature in the quenching tank at a uniform point. The cooling tanks are buried in a concrete pit below the surface outside the building, as shown.

The other illustrations need very little explanation. Fig. 3 is the battery of heating furnaces on one side of the shop, and shows their relative position with regard to the forging presses and the outer wall of the side bay.

A few of the heat-treating furnaces are shown in Fig. 4, with a quenching tank in the foreground. This tank is supplied with the usual mesh baskets for catch-

man here—bright, quick and active and one who knew his business thoroughly. We boys were all sorry to have him go, but we were still sorrier when we found out that Big Dan Martin was to take his place. Big Dan is a fair mechanic, none better, in some ways; but he has some grave defects and limitations. He is a big, two-fisted chap, able and willing to defend his physical rights

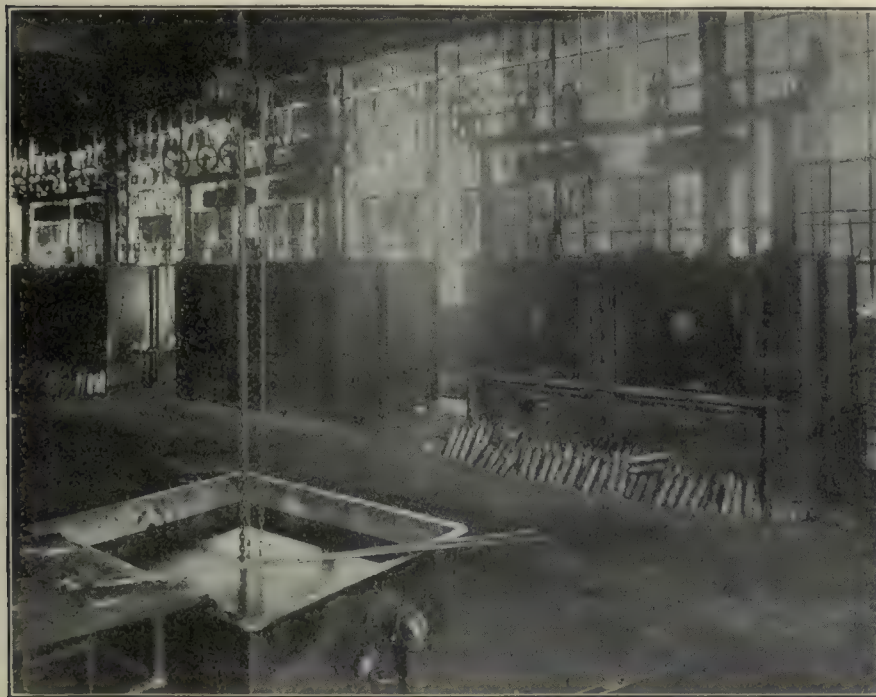


FIG. 4. HEAT-TREATING FURNACES AND QUENCHING TANKS



FIG. 5. ANNEALING FURNACES AND SAND BOXES

ing the shells so that they can be easily hoisted out and drained for removal. The annealing furnaces are shown in Fig. 5, and are similar, except as to the temperature used. After the shells are removed from the furnace they are placed point up in sand boxes with low edges, and allowed to cool thoroughly. It will be noticed in both Figs. 4 and 5 that the windows of this section of the shop have been blackened so as to cut down the light. A continuous record is kept of the temperature of each furnace, and each shell in a heat is correspondingly numbered, making it easy to trace defects due to improper heating.

✽

A. L. A. M. Any Lead and Mesh

BY FRANK MCPHERSON

We had a funny thing happen in our shop the other day. A man came along who wanted a special device made for him. As he was an old timer, he called things by old-time names, so to speak, which resulted in stirring up some brisk trouble among us for a while.

Our "Old Man" is just a trifle arbitrary. When men take exception to what he says or seriously object to what he orders done, somebody has to give in or get out. Generally, of course, it is the other fellow. Tom Smith had been an adjutant about the shop for several years, and a good one too, but too much giving in and giving up his honest opinions and beliefs has irked him. So not long ago he went away to a better job. He was a good

man here—bright, quick and active and one who knew his business thoroughly. We boys were all sorry to have him go, but we were still sorrier when we found out that Big Dan Martin was to take his place. Big Dan is a fair mechanic, none better, in some ways; but he has some grave defects and limitations. He is a big, two-fisted chap, able and willing to defend his physical rights

against all ordinary comers; but his mental abilities are somewhat limited, and his early education has been sadly neglected. Our customer had an adjusting rod in his device and wanted to have a fine thread cut on it to insure close control. He specified 20 threads per inch of the old American Licensed Automobile Manufacturers' style of the days of George R. Selden—the same that is now called the Society of Automobile Engineers, or S.A.E. Of course, our friend abbreviated it to A.L.A.M.

We have a number of apprentices here; some of them are pretty good, but Peter Bright is far and away the best of all of them. He is bright and quick, a quizzical, adaptive chap, and is always asking questions, not for fun, but to find out "why." Big Dan gave Peter the sketch calling for the threaded rod in question, the thread on which had to fit a part that Jim Burgess was making. Peter went ahead and turned up the rod ready for threading, but he did not know what the thread was. He knew United States standard well enough, but this was different. He took the sketch to Dan and asked him what the A.L.A.M. meant. Big Dan happened to be angry and answered him shortly: "That means 'any lead and mesh'; now you get right at it and cut it and no nonsense about it, kid."

Peter went away dissatisfied. "Any lead! Why it's 20 lead, and 'mesh' doesn't mean anything," said Peter under his breath. Then he remembered that Jim Burgess had the other part to make, so he went to Jim and asked him. Jim told him. "How do you know that

it means that?" asked Peter. Jim got out a catalog and showed him. "Where can I get a tap to correspond?" asked Peter. "It is one of a set that Tom Smith had," said Jim; "ask Dan to get it for you." Peter went back to Dan and asked him for the automobile tap to suit his job. "What for?" demanded Dan. "To fit my job to," answered Peter. "Didn't I tell you 'any lead and mesh'?" roared Dan. "I know that you did, but it was wrong," Peter replied. "Who told you that?" "Jim Burgess told me," said the unabashed Peter.

In a raging passion Dan went to Jim Burgess and demanded to know just what it was he meant by telling the apprentice boys about the place that he, Dan Martin, did not know his business and thus giving him the "double cross" in the shop. Things began to look decidedly "squally," for Jim is a determined chap too and is fairly well able to look out for himself. Jim wanted to know what he meant, and Dan told him as best he could. Jim said that there were just two modes of procedure—either to tell the apprentice boys nothing at all when they asked questions, or to tell them what was right to the best of his ability. The altercation grew so hot that all work in the room ceased.

Finally the storm cleared away without anyone getting killed or even any blood being shed. Big Dan at last wanted to know what the highbrow who was getting the work done *did* mean in his specifications. Jim showed him the tool catalog and explained that Tom Smith had a set of those special taps and dies in one of the tool cabinets, and then he had to get them and show them to Dan before he would believe it. Dan struck an attitude and exclaimed: "Well, I'll be d—d; how was I to know that the man's hieroglyphics meant a measly set of taps that Tom Smith kept locked up in his dinky tool cupboard?"

Things are calm in the shop again, but we are all quietly wondering what the ultimate result will be. Just now Big Dan's stock is running way below par. We are not greatly given to gossip, for, of course, there are various factions among the men. Occasionally a pert boy has the temerity to ask another boy, quietly to be sure, if he really means "any lead and mesh."

Take it as a whole, the incident has had a decidedly bad effect on the men in our shop. Our "Old Man's" skull would have to be trephined before he could be brought to believe that the fault for lack of harmony among the men in reality lies with him instead of with us. We cannot look for any earthquake to jumble things up so that they must be straightened out before we can go on; and really, the millennium may be a long way ahead.



Die-Shaping Facilities

By E. A. DIXIE

In Fig. 1 is shown a die-shaping outfit at the Smith Premier Works, Syracuse, N. Y. The special clapper block *A* interchanges with the regular clapper block used on the machine. When the ordinary clapper block is used for die shaping or any other work where an extension tool is necessary, there is greater tendency for the tool to either lift as it enters the cut or to dig in after the cut is started. Often both these conditions are met with during a single stroke of the machine.

A glance at Fig. 2 will perhaps make the reason for this more apparent. This illustration shows the difference of the entering angles with tools of the same extension length in the ordinary post and this type of tool post.

A small flat spring *B* bears on the face of *A*. This spring is swung to the side when changing clapper blocks

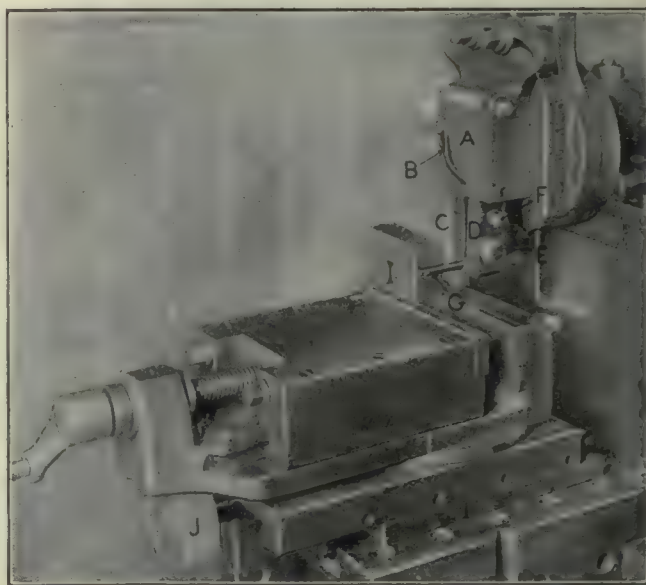


FIG. 1. DIE SHAPER, CLAPPER BLOCK AND VISE

The lower part of the clapper block *A* is extended at *C* and has a horizontal V-groove in it. A cover or clamp plate *D* is held to *C* by a cap screw *E*. It is also provided with a "heel" screw *F* for clamping the tool *G* in the V-grooves in *C* and *D*. The tools *G* have cylindrical shanks of uniform diameter and the cutting ends are forged or ground to various shapes to suit the work. The vise *H* is a particularly handy tool for die work. The upper part is just an ordinary vise with graduated base. This is provided with an auxiliary slide that works on the base plate *I* secured to the shaper table. This extra slide is provided with an adjusting screw with a knurled knob *J* that permits the work and vise to be moved in either direction in line with the ram. The ability to move

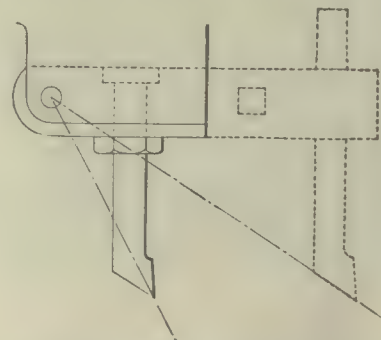


FIG. 2. COMPARISON OF ENTERING ANGLES WITH OLD AND NEW CLAPPERS

the work endwise with relation to the cutting tool is of great value in forming and drop-forging dies, and in work of a similar character. The adjustment can be made while the ram is in motion and in any event is more easily accomplished than by adjusting the ram.

Results of Some Tests on Milling Cutters

By CHARLES N. UNDERWOOD*

SYNOPSIS—These tests group under four general heads—to determine power consumption; effect of cutter feed on cutter life; effect of cutting speed on cutter life; effect of depth of cut on cutter life. For each case the results of the tests are given and conclusions drawn, one of the important being that the best life of the cutter is obtained where the linear feed per tooth is at least 0.002 in.

The claims for the wide-spaced-tooth milling cutter, made by the Cincinnati Milling Machine Co., were directly responsible for a series of tests to determine whether or not those claims would hold good in the Remington

ing a regulation of 25 per cent., almost any desired cutter speed could be obtained.

This test was made to determine the power consumed by a wide-spaced-tooth cutter in comparison with that consumed by a regular stock cutter. Accordingly a 3½-in. high-speed cutter having 26 teeth with no spiral nor undercut was obtained. The stock milled was soft machine steel 0.510 in. wide, cut into pieces each 7 in. long. A cut 0.050 in. deep was made at various feeds and speeds with this cutter and the current and voltage read on instruments connected with the motor. The total amount of metal chips that was removed per minute during these tests ranged from 0.15 cu.in. to 0.80 cu.in. The power consumed by this cutter is shown in Fig. 1

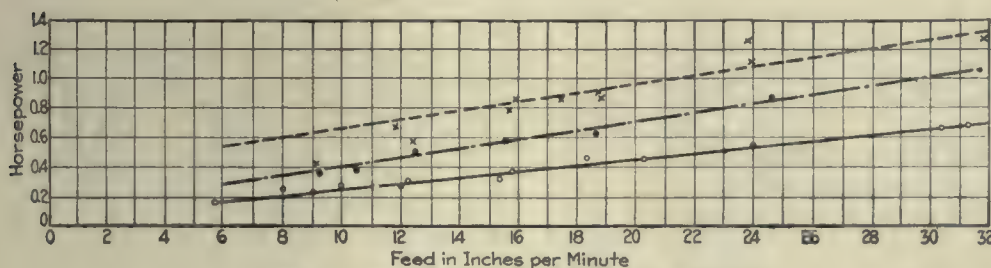
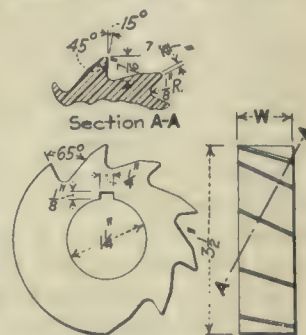


FIG. 1. POWER CONSUMPTION OF MILLING CUTTERS



Cutters to have 25° Spiral, 10 Teeth
FIG. 2. SECOND CUTTER USED

typewriter factory where only light milling cuts were made. While it is not claimed that the figures obtained in these tests are absolutely accurate, yet we believe they will serve to indicate the general tendency of the laws of milling cutters and may help to solve some problems of manufacturing milling. These tests were made on a Hendey & Norton No. 2 plain miller that was equipped with a cast-iron tank holding 13 gal. The coolant, a 1 to 20 mixture of mineral lard oil and water,¹ was delivered to the cutter at the rate of 4 gal. per min. by means of a Brown & Sharpe No. 1 rotary pump driven from the countershaft. The entire stream of coolant was confined to the cutter by means of a hood that fitted closely about the cutter and its arbor. The machine was driven by a 5-hp. Crocker-Wheeler shunt-wound motor, through a countershaft having four cones. This arrangement gave, with the back-shaft, 8 different speeds. Six different driving pulleys were used on the motor so that a total of 48 different speeds was available. By means of a field rheostat, hav-

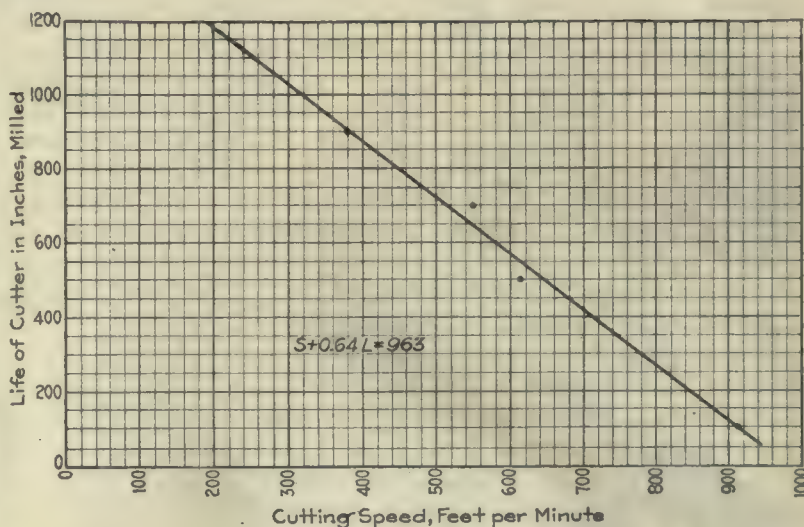


FIG. 3. EFFECT OF SPEED ON CUTTER LIFE

ing by the dash line. This cutter was then taken to the grinding room and its alternate teeth were ground completely out, and a like test made. The power consumption of this remodeled cutter is shown by the dash and dot line in Fig. 1. A high-speed, 3½-in. cutter, Fig. 2, having 10 teeth, undercut 15 deg. and having a 25-deg. spiral, was next used in a like test, and a like series of observations made. The power consumed in making the cut is shown by the full line in Fig. 1. A comparison of the power consumption of three styles is thus shown.

*Mechanical engineer, Remington Typewriter Co.

¹In the preparation of the coolant for use on milling cutters, soda ash is employed to saponify the oil. One ounce of soda ash for each gallon of water to be used is first dissolved in a small quantity of hot water. When it is thoroughly dissolved, cold water to the required amount is added and the whole solution is allowed to stand for at least two hours before the oil is added. Very thorough agitation of the water before and after the addition of the oil is necessary to insure a good mixture.

The power consumption in all cases shown is for the cutting of the metal only, the power consumed in driving the machine light having been deducted from the total used while making the cut.

The curves show clearly that the power actually consumed in the cutting of the metal with the wide-spaced cutter is just about half that consumed by the old-style stock cutter, and that it is much more uniform.

EFFECT OF CUTTER FEED UPON CUTTER LIFE

The feed of a milling cutter is usually expressed in inches per revolution and sometimes in inches per minute. For every revolution made by the cutter, the work is fed in a certain amount. The amount of this feed is shown on the cut surface by the distance between the "revolution marks." The closer together these revolution marks occur, the smoother is the finish of the cut surface. Therefore, the smoother finishes are produced by the lower feeds per revolution. This was found to be true by making cuts on similar pieces of steel at high speeds and at low speeds, holding the feed per revolution constant. These tests were made at various depths of cut and in all cases the finish of the cut pieces was identical. The conclusion is, that the finish of the cut surface depends upon the feed per revolution of the cutter.

When the finish required on a piece of work is such that a low feed per revolution is necessary, each tooth in the cutter, instead of biting right into the stock, has a tendency to slide over the work until the pressure causes it to dig in. Aside from the tendency to cause chatter or spring of the arbor, this rubbing or lapping action causes the cutter to dull quickly.

TABLE 1. RESULTS OF TESTS TO DETERMINE LIFE OF MILLING CUTTERS

Feed per Tooth, Inches	Cutting Speed, Ft. per Min.		
	330	380	505
	Linear Inches Cut Between Grindings		
0.0005	434	238	140
0.0010	427	665	175
0.0020	868	735	161
0.0030	735	819	175
0.0040	896	1,085	140
0.0050	861	679	...
0.0060	*266	...	...
0.0060	*266	...	...

*Cut too heavy for machine.

Stock—Hot-rolled black machine steel.

Scleroscope hardness, 18; C, 0.13; Mn, 0.609; Si, 0.022; P, 0.009; S, 0.11.

Depth of cut, 0.075 in.

For design of cutter see Fig. 2.

In Table 1, which is a summary of a large set of observation sheets, is shown the life of a cutter in linear inches, at various feeds per tooth of the cutter. The speed was held constant in each case. It is quite evident that where the feed per tooth of the cutter is 0.002 in. or over the best life of cutter is obtained. The life is also fairly uniform. The conclusion drawn is that, where the feed of a cutter is 0.002 in. per tooth or over, there is no difference in the effect upon its life.²

Table 2 shows the same result as Table 1. In this case a 16-tooth high-speed cutter having a 15-deg. undercut and a 25-deg. spiral was used. The depth of the cut was 0.125 in. This cutter was designed for this depth of cut so that but one tooth was cutting at a time. Cutters so

designed, for cuts of slight depth, are not economical, because the teeth become too small for many grindings. For this reason the wide-spaced cutter has an advantage over the old style. Also, for a given feed per revolution, the feed per tooth of the wide-spaced cutter is greater.

The reason for expressing the life of the cutter in linear inches of cut is that as a cutter wears down its

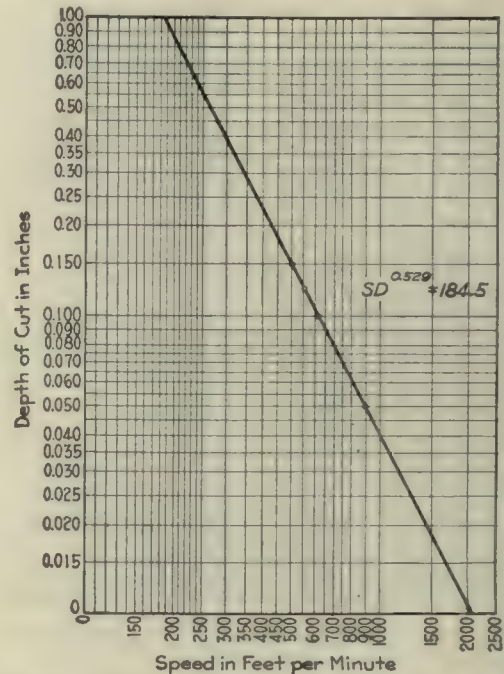


FIG. 4. EFFECT OF DEPTH OF CUT ON CUTTER LIFE

revolutions per minute must be increased in order to keep the cutting speed constant. Consequently, with a given feed per revolution and a given cutting speed, the table travel is faster with a small cutter than with a large one. For this reason the same number of linear inches would be cut more quickly by a small cutter than by a large one. If the life of cutter was expressed in minutes, the larger cutter, taking more time to make the cut, would appear to have the longer life.

TABLE 2. RESULTS OF TESTS TO DETERMINE LIFE OF MILLING CUTTERS

	Diameter of Cutter, Inches	Revolutions per Minute Cutter	Cutting Speed, Feet per Minute	Number Pieces Milled	Number Inches Milled	Duration of Cut, Minutes	Condition of Tool
Feed, Inches							
			0.125 In. Depth of Cut				
0.050	3.24	330	279	100	700	42.4	G
	3.24	390	330	100	700	36.0	G
	3.24	480	405	100	700	29.1	G
	3.23	575	485	100	700	24.3	G
0.040	3.23	700	590	83	581	16.6	DN
	3.20	700	585	100	700	25	D
	3.06	700	560	100	700	25	DN
	3.19	850	710	43	301	11.8	DN
0.030	3.09	700	565	91	637	30.3	DN
	3.06	700	560	72	504	30.3	DN
	3.02	700	553	...	...	...	...
	3.19	1,020	847	33	231	11.3	D
0.020	3.19	850	706	40	289	16.4	DN
	3.17	850	705	43	301	17.7	DN

Cutter—High-speed steel, 16 teeth, 15-deg. undercut, 25-deg. spiral. Lubricant—Mineral lard oil and water, 20 to 1 solution; supply—4 gal. per min.

Stock—Black machine steel, 0.316x0.670 in.

Scleroscope hardness, 26; C, 0.150; Mn, 0.850; Si, 0.045; S, 0.102; P, 0.089.

Symbols—G, good; F, fair; N, nicked; D, dull; DN, dull and nicked.

In making these tests it was arbitrarily decided, from general shop conditions, and after preliminary tests, to adopt 700 lin.in. of milling as the proper life of a cutter and to find under different conditions the cutting speed which would give this life. Table 3 shows a data sheet of tests made on cold-rolled machine steel in which all

²Although these data show that the best life of a milling cutter is obtained when the feed per tooth is 0.002 in. or over, we have adopted the rule on typewriter work that the feed should be at least 0.001 in. per tooth. The reason for cutting in half the factor obtained by experiment is on account of the good finish required on typewriter parts. For such work a feed of 0.002 in. per tooth is generally too great, hence the rule for our shop practice given above. However, in cases where heavier roughing cuts are made, the feed per tooth should be 0.002 in. or more.

of the conditions were held constant except the feed. Inasmuch as the results obtained with feeds of 0.040 in. and 0.050 in. per revolution were the most uniform, a straight line is $S + 0.64L = 963$, where S is speed of

TABLE 4. RESULTS OF TESTS TO DETERMINE EFFECT OF CUTTING SPEED ON CUTTER LIFE

500-In. Run							900-In. Run							1,100-In. Run						
Diam- eter of Cut, Inches	Revol- utions per Minute of Cutter	Cut- ting Speed, Feet per Minute	Number of Pieces Milled	Number of Inches Milled	Dura- tion of Cut, Min- utes	Con- di- tion of Tool	Diam- eter of Cut, Inches	Revol- utions per Minute of Cutter	Cut- ting Speed, Feet per Minute	Number of Pieces Milled	Number of Inches Milled	Dura- tion of Cut, Min- utes	Con- di- tion of Tool	Diam- eter of Cut, Inches	Revol- utions per Minute of Cutter	Cut- ting Speed, Feet per Minute	Number of Pieces Milled	Number of Inches Milled	Dura- tion of Cut, Min- utes	Con- di- tion of Tool
3.18	833	697	42	294	7.0	DN	3.18	510	424	55	385	15.1	D	312	320	261	157	1,099	68.6	D
3.15	740	610	71	497	13.4	DN	3.14	471	387	123	861	36.5	DN	310	320	260	157	1,099	68.0	D
3.12	833	680	40	280	6.7	DN	3.10	471	382	124	868	36.8	DN							
3.13	740	604	71	497	13.4	DN														
Conclusion		610					Conclusion		380					Conclusion		260				
														3.10	1,128	913	15	105	1.8	DN

Cutter—High-speed steel, 10 teeth, 15-deg. undercut, 25-deg. spiral.
Lubricant—Mineral lard oil and water, 20 to 1 solution; supply—4 gal. per min.
Feed per revolution 0.050 in. Depth of cut 0.075 in.
Stock—C, 0.12; Mn, 0.87; Si, 0.02; S, 0.102; P, 0.091.
Scleroscope, 27.
Symbols—G, good; F, fair; N, nicked; D, dull; DN, dull and nicked.

TABLE 3. RESULTS OF TESTS TO DETERMINE EFFECT OF CUTTING SPEED ON CUTTER LIFE

Feed, Inches	Diameter of Cutter in Inches	Revol- utions per Minute of Cutter	Cutting Speed, Feet per Minute	Number of Pieces Milled	Number of Inches Milled	Duration of Cut, Minutes	Condition of Tool
0.075 In. Depth of Cut							
0.050	3.50	470	430	100	700	29.8	D-N
	3.48	505	459	100	700	27.7	D
	3.50	600	550	100	700	25.4	D
	3.48	725	660	28	196	5.4	DN
	3.47	655	595	32	224	6.8	DN
	3.46	655	595	28	196	6.0	DN
0.040	3.39	600	532	100	700	25.4	D
	3.47	600	546	37	259	10.8	D
	3.47	600	546	50	350	14.6	DN
	3.44	548	493	67	469	21.4	DN
	3.44	548	493	100	700	31.9	DN
	3.42	548	493	100	700	31.9	DN
0.030	3.42	600	537	100	700	29.1	D
	3.36	670	590	76	532	19.8	DN
	3.39	670	594	35	245	12.1	DN
	3.36	603	530	73	511	30.2	DN
	3.36	603	530	38	266	15.6	DN
	3.32	603	524	53	371	22.0	DN
0.020	3.34	580	507	43	301	18.5	DN
	3.30	542	468	50	350	23.0	D
	3.31	500	431	71	497	35.5	DN
	3.26	600	512	30	210	17.5	D
	3.29	552	520	45	315	28.5	DN
	3.24	471	444	25	175	18.5	D
0.010	3.20	407	340	17	119	14.6	D
	3.20	662	554	22	154	11.6	DN
	3.22	603	508	22	154	12.7	DN

Cutter—High-speed steel, 10 teeth, 15-deg. undercut, 25-deg. spiral.
Lubricant—Mineral lard oil and water, 20 to 1 solution; Supply—4 gallons per minute.
Stock—Machine steel, $\frac{1}{4}$ x $\frac{1}{4}$ in.
C, 0.12; Mn, 0.87; Si, 0.02; S, 0.102; P, 0.091.
Scleroscope hardness, 27.
Symbols—G, Good; F, Fair; N, nicked; D, dull; DN, dull and nicked.

TABLE 5. RESULTS OF TESTS TO DETERMINE EFFECT OF DEPTH OF CUT ON CUTTER LIFE

Depth, Inches	Diameter of Cutter, Inches	Revol- utions per Minute of Cutter	Cutting Speed, Feet per Minute	Number of Pieces Milled	Number of Inches Milled	Duration of Cut, Minutes	Condition of Tool
Feed per Revolution 0.050 Inch							
0.050	3.05	655	523	100	700	21.3	G
	3.04	732	582	100	700	19.1	G
	3.04	755	600	100	700	18.5	F
	3.02	845	668	100	700	16.5	F
	3.00	1,027	806	100	700	13.6	F
	3.03	1,125	892	100	700	12.4	F
0.100	3.10	1,130	911	88	618	10.9	D
	Conclusion		900	...	...	...	
	3.26	680	580	100	700	20.6	G
0.125	3.20	850	711	76	532	12.5	D
	3.19	740	619	100	700	18.9	D
	Conclusion		619	...	...	...	
0.150	3.16	662	547	100	700	21.1	D
	Conclusion		547	...	...	...	
	3.13	615	503	100	700	2.27	D
	Conclusion		503	...	...	...	

Cutter—High-speed steel, 10 teeth, 15-deg. undercut, 25-deg. spiral.
Lubricant—Mineral lard oil and water, 1 to 20 solution; supply—4 gal. per min.
Stock—steel. C, 0.12; Mn, 0.87; Si, 0.02; S, 0.102; P, 0.091.
Scleroscope, 35.
Symbols—G, good; F, fair; N, nicked; D, dull; DN, dull and nicked.

feed of 0.050 in. per revolution was adopted as a standard feed while the other conditions were varied.

Table 4 shows the results of tests made to determine the speed of the cutter which would give a life of 100, 500, 900 and 1,100 in. These points plotted on section paper give a straight line curve as shown on Fig. 3.

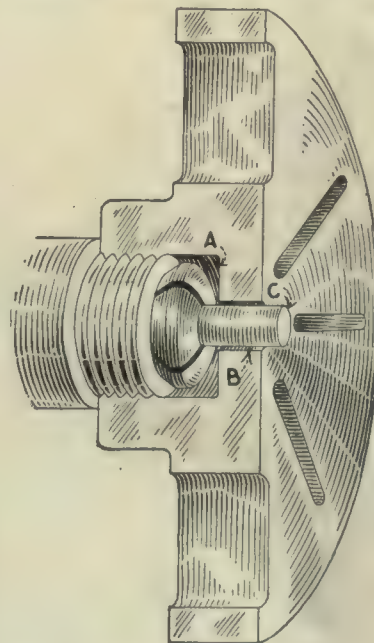
cutter in feet per minute, and L is life of cutter expressed in linear inches milled.

Table 5 shows the results of tests made to determine the effect of the depth of cut on the life of a cutter. The speed at which the cutter life was 700 in. was determined for each of several depths of cut. These points plotted on logarithmic paper are shown in Fig. 4 and form a straight line of the equation $SD 0.529 = 184.5$, where S is the speed of the cutter in feet per minute and D is the depth of the cut in inches. The depth of cut is therefore an important factor in the life of a cutter.

Faceplate for the Bench Lathe

BY GUSTAVE A. REMACLE

When making precision jigs, gages or other tools, the tool maker frequently has recourse to what is known as the "master-plate process." When using the master-plate



FACEPLATE FOR THE BENCH LATHE

in the bench lathe, stud C must be turned true in the lathe and also to a good fit in the holes in the master-plate.

In too many instances provision is not made in the faceplate for the master-plate process. A plain hole is sometimes bored at B for some unknown reason, and the tool maker when wishing to true a plug will proceed to bore this hole taper to receive a piece of steel or perhaps will drive a piece of steel into the straight hole. In that event

it is a difficult matter to machine this piece of steel to size when located in the faceplate, as the portion protruding from the plate is usually very short and is difficult to reach for machining, filing and measuring with the micrometer.

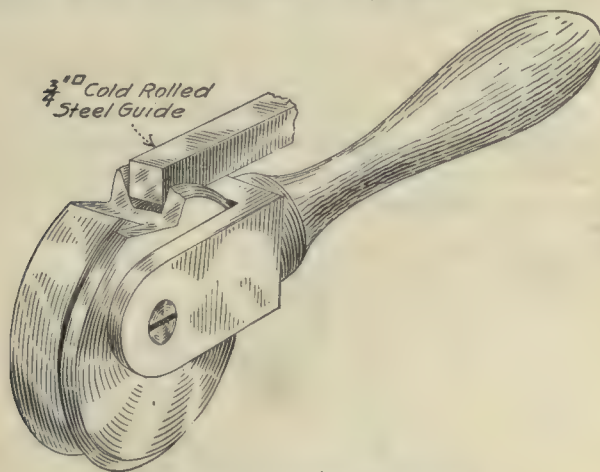
If when the faceplate is being made the space shown at *A* is machined so that the faceplate may be put in position on the lathe while the spring collet is in place, a piece of drill-rod may readily be turned true and to fit the master-plate, after which the faceplate may be mounted in place and other operations proceeded with.

The common error in constructing these faceplates is the absence of space *A*, thus not permitting the faceplate to be mounted while the spring collet is in place. Besides the time saved in turning the plug to diameter must be added the time saved through not having to fit the plug to the hole in the faceplate.

High-Speed Paper Cutter

By J. B. MURPHY

The illustration shows a tool designed for cutting, sizing and trimming sheet paper in the drawing room. As will be noted, the shear wheel is provided with a cleared shearing flange on one side, and by means of the beveled portion of the face a pressure on the handle tends to hold



CUTTER FOR SHEET PAPER

the shear or cutting flange against the guide shown, producing a clean cut. While the periphery of the cutting flange is not correct for a high-duty paper cutter, it works well for this particular case.

It is not necessary that the wheel be held perfectly true in use, for even though the wheel may vary several degrees from the perpendicular the bevel will still draw the cutting edge against the guide, producing the proper "shear," and making a clean cut. The square-section guide shown is of $\frac{1}{8}$ -in. cold-rolled steel and can be made as long as desired.

This guide will give three edges that can be used by turning the guide over one-quarter as the preceding edge becomes dull. At the start two edges will wear dull at the same time, one by the action of cutting paper and the other by the "ride" of the beveled part of the wheel. The guide is so turned that the present cutting edge becomes the edge upon which the bevel travels.

The wheel must be made with sufficient allowance for facing the cutting side of the shearing flange, by grinding when it becomes dull, as is suggested in the drawing. Grinding the face will be the most economical method of

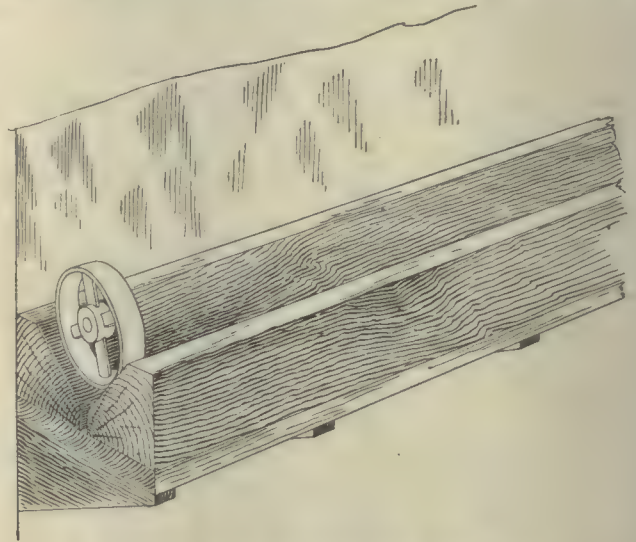
sharpening. The guide is a stock size, and while it will last a long time may be replaced for a few cents. The wheel may be hardened, but the guide should be left soft.

Safety Pulley Holder

By J. H. MOORE

Simplicity is perhaps the chief point of the construction of the pulley holder shown in the accompanying illustration.

When pulleys are stored in a trough, as shown, they cannot roll or tip over on someone's foot; in other words,



A SAFE WAY OF STORING PULLEYS

the plan is a safe one. A rack like this can be used not only for castings of pulleys, but can also be utilized for the storage of pulley patterns or other objects that are round in shape.

Value of Knowledge Added to Skill

The work of railroad repair shops is varied, and the greater portion can be done satisfactorily by men who possess no exalted order of mechanical ability. But, on the other hand, special work arises which calls for the highest order of dexterity, besides unerring judgment and accurate knowledge of details. A tool gets out of order, whose anatomy is a mystery to ninety out of every one hundred machinists. An air pump comes in that is working indifferently, is intermittent in its action and seems to pound the cylinder head. A machinist, who can work as closely as a mathematical instrument maker, takes the pump apart and can perceive nothing wrong. The pistons are both apparently in good order, the valves seem to be faultless and the machinist can change nothing without the probability of doing more harm than good. Another man goes through the pump, and previous investigation and study of such machines give intelligent direction to his examination, and he quickly discovers that the trouble lies in the air valves having too much lift. Knowledge gave that man power.

In railway repair shops there is a constantly growing demand for machinists capable of doing the intelligently skillful work that is becoming so plentiful about air brakes, injectors, gages, hydraulic and electric apparatus.—*Railway & Locomotive Engineering*.

Making Bayonet Scabbards--II*

BY ROBERT MAWSON

SYNOPSIS—In this part of the article the operations subsequent to the polishing are described. Not only are the presses and other standard machines shown, but the various punches, dies and other small tools are also illustrated by drawings, fully dimensioned. The rate of production is included. In all the article describes fully and completely the making of this piece, which seems simple yet has proved difficult to many firms.

The next operation is bluing. The scabbards are held on the fork-type fixture for dipping into the solution. The tank and holding fixture are shown in Fig. 30. The composition of the bluing mixture is in the proportion

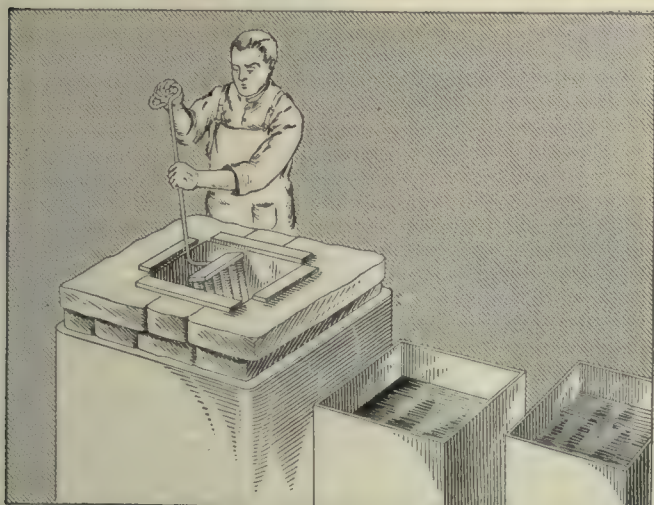


FIG. 31. OPERATION 9: BLUING

Machine Used—Chicago flexible-shaft furnace, 800 deg. F.
Production—200 per hr.
Reference—Fig. 30.

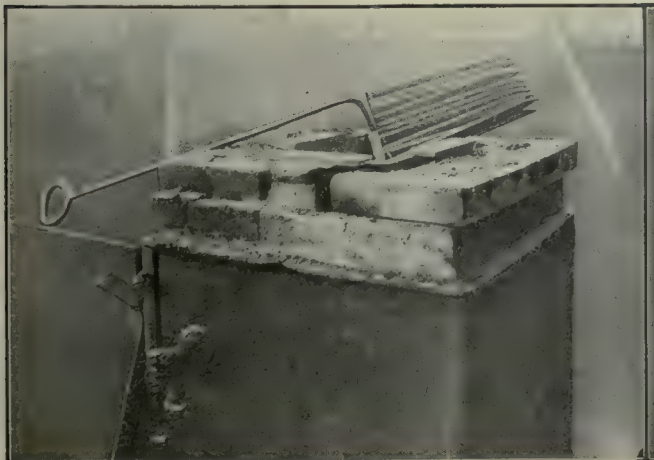


FIG. 30. BLUING THE SCABBARDS

boiling water and placed in a tank containing sperm oil. The operation appears in diagrammatical form in Fig. 31.

The scabbard is straightened with wooden blocks, Fig. 13. The production is approximately 1,000 per hour. The washers used—one on each side when fastening the strap, which is purchased, to the scabbard stud—are made in the press shown in Fig. 32. The punch and die for making this part may be seen in Fig. 33. The punch holder is illustrated in Fig. 24 and the bolster in Fig. 23. The operation is also given diagrammatically in Fig. 34.

The next operation is riveting the strap on the scabbard stud. The washers are made in two thicknesses—0.031 in. and 0.072 in.—the first being placed between

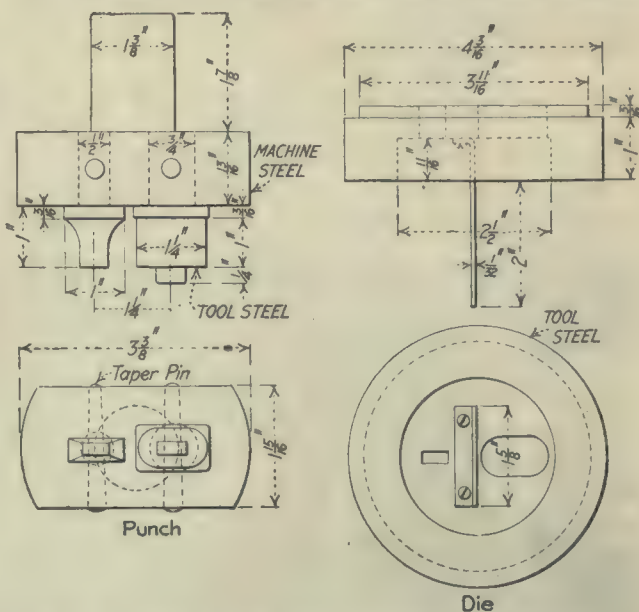


FIG. 33. PUNCH AND DIE FOR STRAP WASHERS

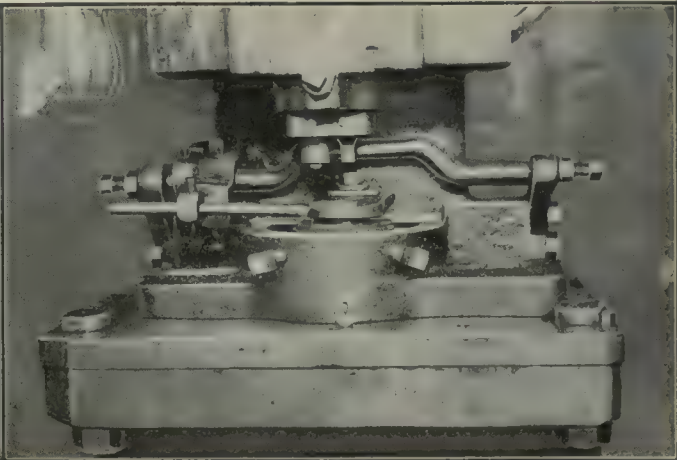


FIG. 32. PUNCHING THE SCABBARD WASHER

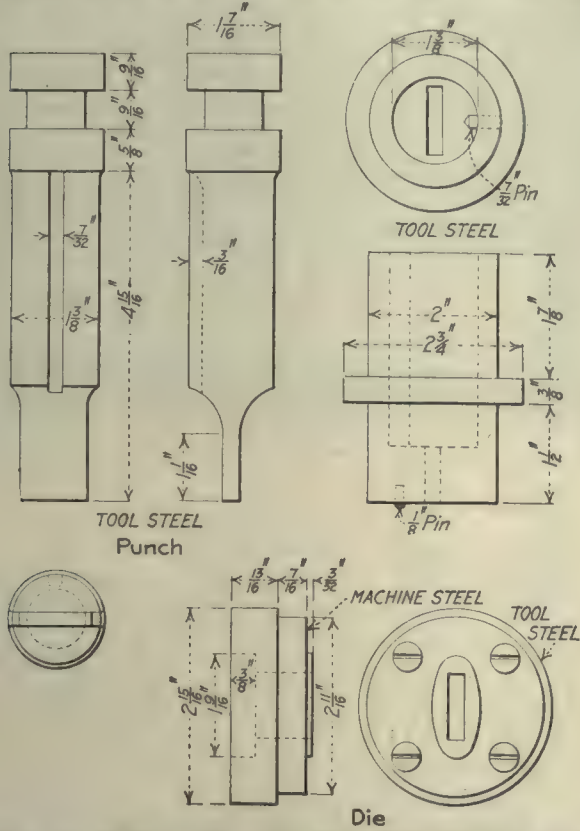
of 12 lb. of crystal saltpeter to 1 lb. of black oxide manganese. This is kept at a temperature of 700 deg. F. The scabbards are allowed to remain in the solution for about 45 sec., after which they are removed, dipped in

the strap and the scabbard, the thicker washer being put on the outside of the strap. The machine for riveting on the strap is shown in Fig. 35. The operation is shown in diagrammatical form in Fig. 36.

The next is a bench operation, being the filing of the end of the scabbard to make it square, to receive the

*Previous installment appeared on page 245. Copyright, 1916, Hill Publishing Co.

The spring is then bent to shape in the punch press, Fig. 51. The punch and die are illustrated in Fig. 52. It will be observed that the die is made with springs under the forming element. By this arrangement the forming die is pushed down with the punch when bend-



ing the part. As the punch is returned with the press, the springs in the die pass up the sliding forming element and force up the part that has been bent, thus

face of the die. The punch is then forced down on the spring, closing it to the shape of the arbor. The mouthpiece is assembled to the spring in the fix-

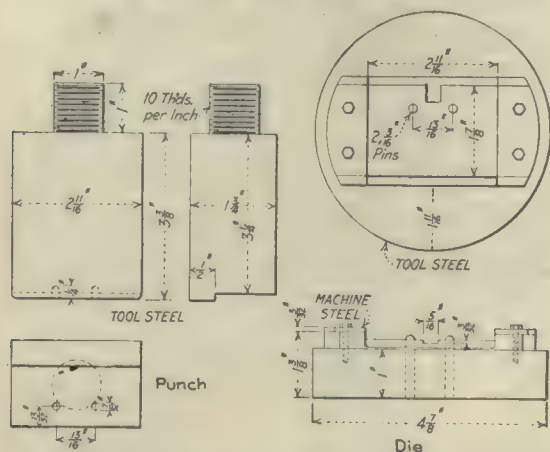


FIG. 47. PUNCH AND DIE FOR FIRST SPRING-FORMING OPERATION

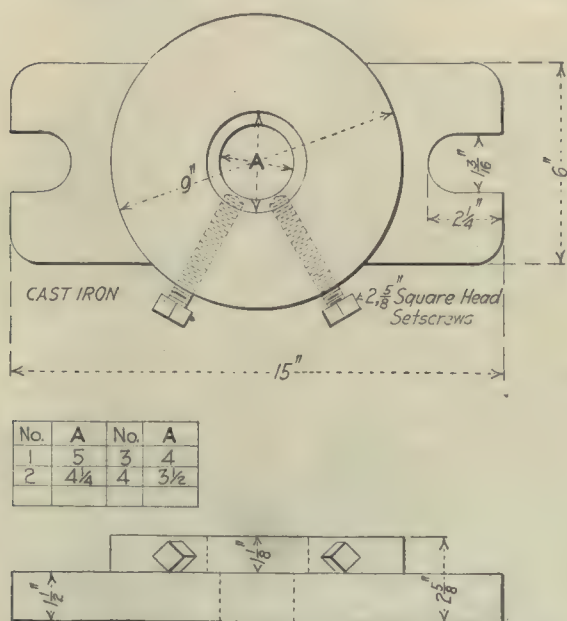


FIG. 48. BOLSTER FOR SPRING-FORMING PUNCH AND DIE

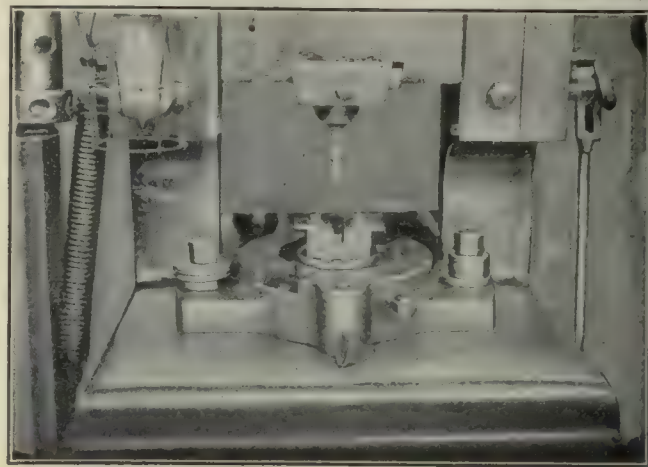


FIG. 51. BENDING THE SPRING

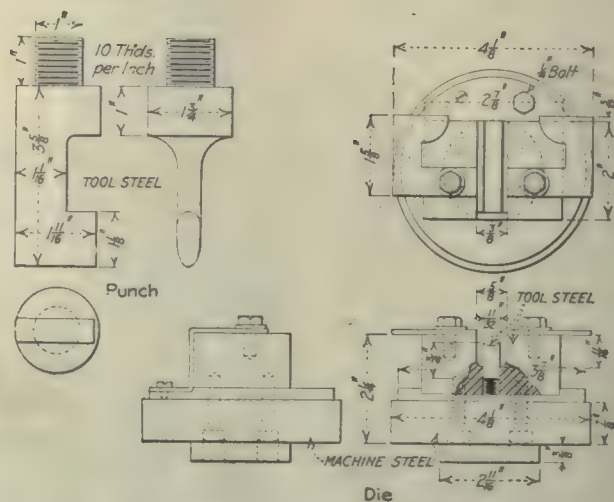
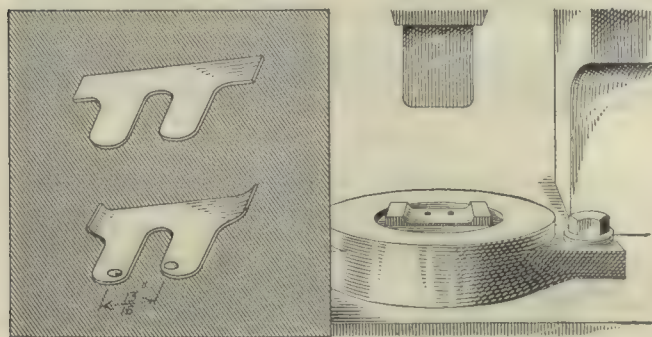


FIG. 52. SPRING-BENDING PUNCH AND DIE



FIGS. 49 AND 50. OPERATION 2: FORMING THE SPRING
Machine Used—Toledo 5-in. stroke press.
Production—800 per hr.
References—Figs. 46, 47, 48, 1 and 49.

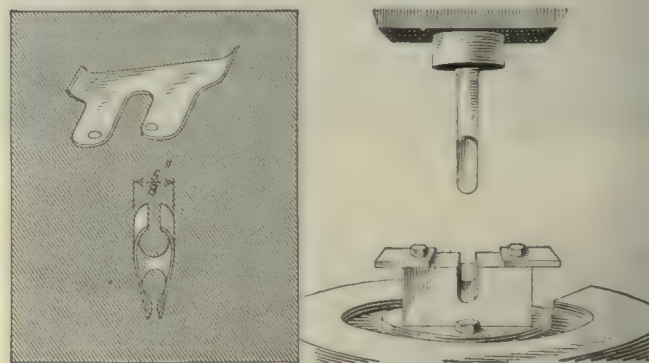


FIG. 53. OPERATION 3: BENDING THE SPRING
Machine Used—Toledo 6-in. stroke press.
Production—1,000 per hr.
References—Figs. 48, 2, 49, 51 and 52.

acting as a stripper. The bending operation is shown in diagrammatical form in Fig. 53.

The spring is closed in the press, Fig. 54. The punch, die and arbor for this operation are seen in Fig. 55. In using these tools the arbor is slid inside the spring, which is placed in the concave sur-

ture, Fig. 56, and brazed, the welding torch serving as the heating means. The operation is also described in a diagrammatical manner in Figs. 57 and 58.

The next operation is sizing the brazed joint on the mouthpiece and spring. One of the mouthpieces is slid into the die and the punch, being forced down, removes



FIG. 54. CLOSING-IN THE JOINT



FIG. 56. BRAZING SPRING AND MOUTHPIECE

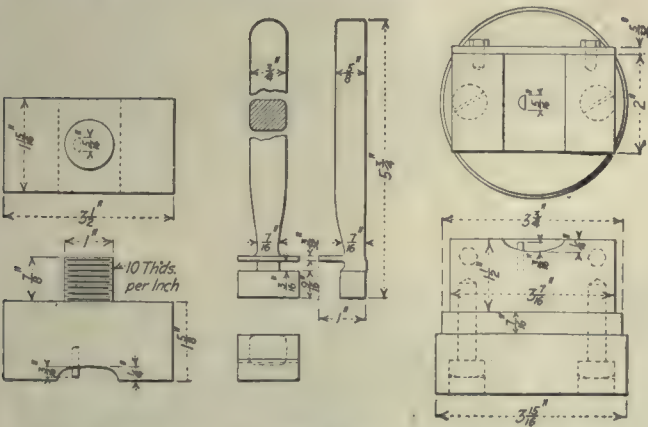


FIG. 55. SPRING-CLOSING PUNCH, DIE AND ARBOR

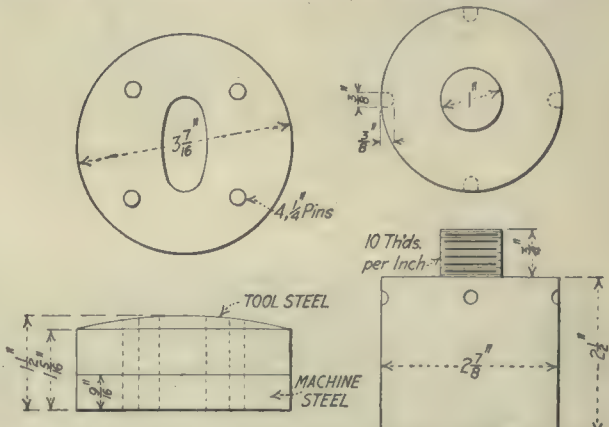


FIG. 60. PUNCH AND DIE FOR SIZING BRAZED JOINT

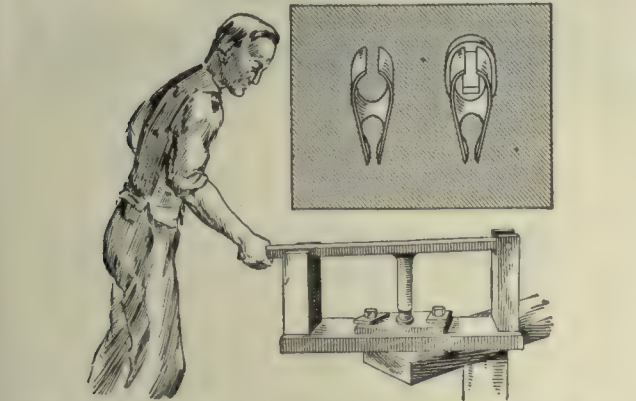


FIG. 58. OPERATION 5: ASSEMBLING MOUTHPIECE TO SPRING

Machine Used—Brazing-in fixture.
Production—55 per hr.
Reference—Fig. 57.

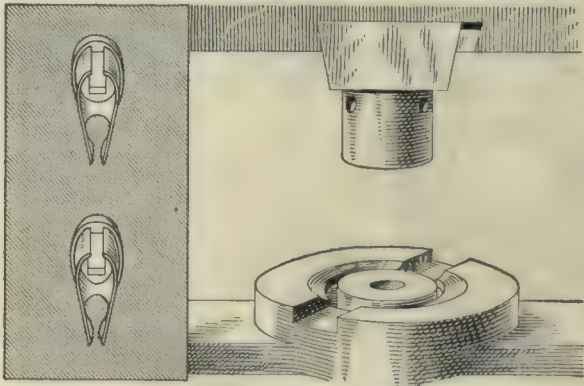


FIG. 61. OPERATION 6: SIZING THE SPRING AND MOUTHPIECE

Machine Used—Toledo 3-in. stroke press.
Production—800 per hr.
References—Figs. 48, 4, 49, 59 and 60.

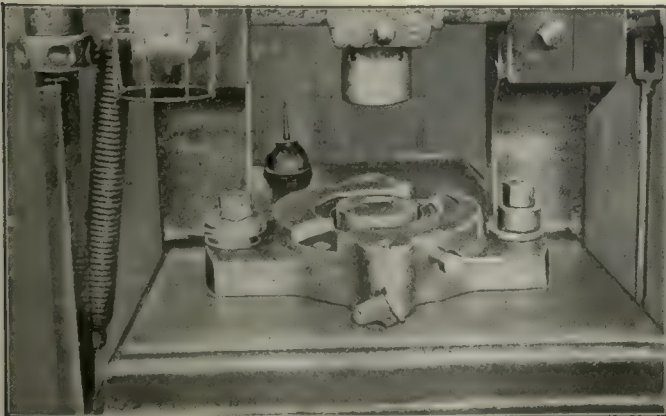


FIG. 59. SIZING THE SPRING AND MOUTHPIECE



FIG. 62. HARDENING THE SPRING

all the surplus spelter and makes the corner square. The machine set up for this operation is illustrated in Fig. 59. The punch and die are shown in Fig. 60. The operation may be seen diagrammatically in Fig. 61.



FIG. 63. OPERATION 7: HARDENING TWO-THIRDS OF SPRING

Solution Used—Lead bath at 1,400 deg.
Production—350 per hr.
Reference—Fig. 62.

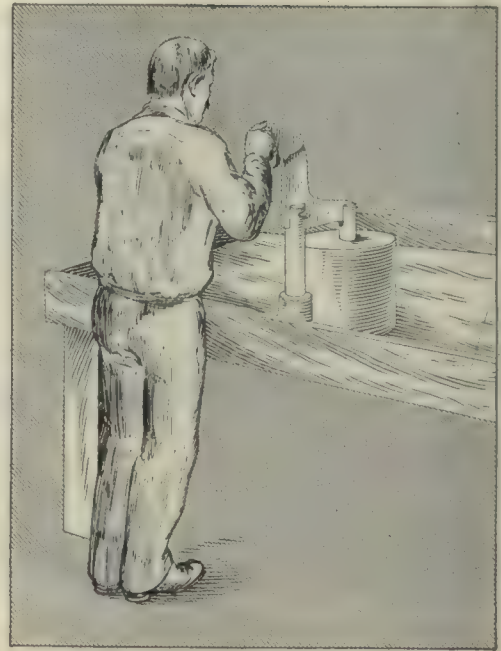


FIG. 66. OPERATION 11: INSPECTION

Production—800 per hr.
References—Figs. 64 and 65.

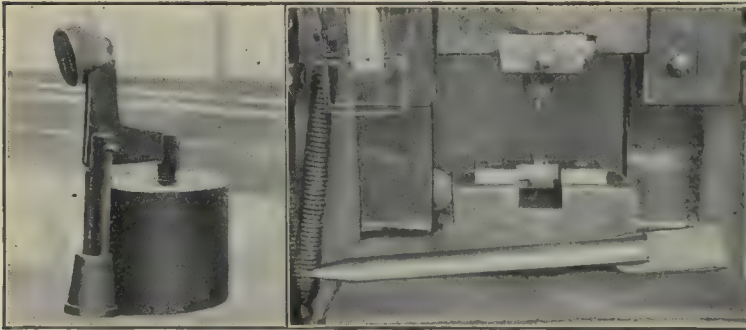


FIG. 64. TENSION GAGE FIG. 67. PIERCING HOLE IN SCABBARD

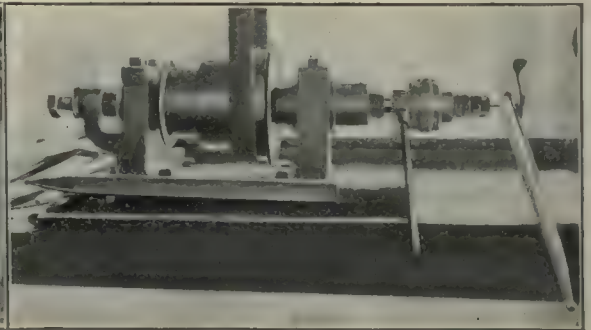


FIG. 70. TAPPING THE SCABBARD

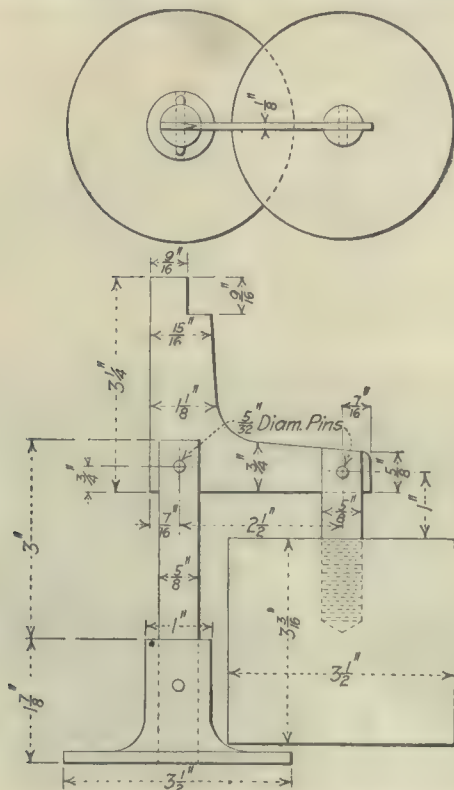


FIG. 65. SPRING-TESTING FIXTURE

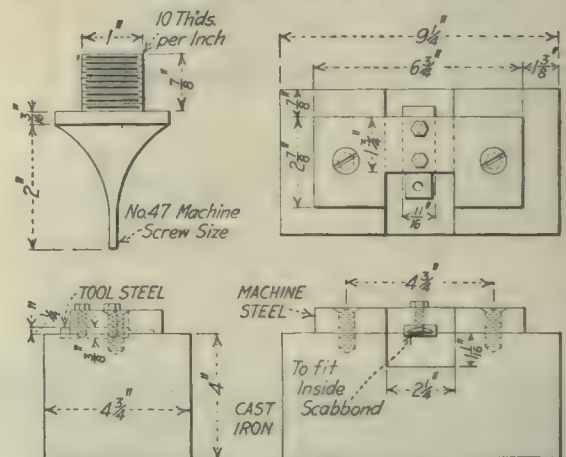


FIG. 68. HOLE-PIERCING PUNCH AND DIE

The springs, held in the fixture shown in Fig. 62, are hardened for two-thirds their length, in a lead bath heated to 1,400 deg. F. They are quenched in sperm oil. The operation of hardening is shown in diagrammatical form in Fig. 63. The mouthpieces are ground and polished in the usual manner, the production being approximately 80 per hour. The temper of the springs is next drawn by dipping them in the bluing solution used for operation 9 on the scabbard body. The solution is heated to a temperature of 600 deg. F., and the

springs are afterward quenched in water. The mouthpieces are blued in a manner similar to that described for the scabbard body. The average production for this operation is 350 per hour.

According to the specifications, the spring must sustain a weight of 13 lb. before it opens. To test the springs, the fixture shown in Fig. 64 was designed. The spring is placed on the end, as shown, which is made with a shape similar to the blade of the bayonet. The inspector then pulls on the spring. If the weight can

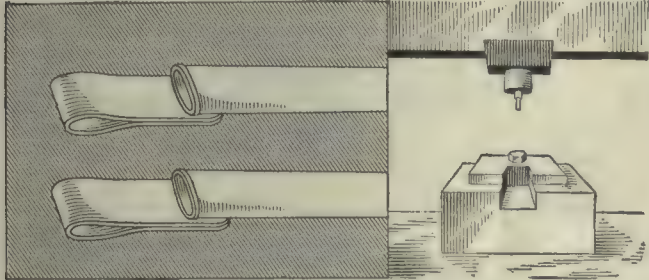


FIG. 69. OPERATION 14: PIERCE HOLE THROUGH SCABBARD AND SPRING

Machine Used—Toledo 3-in. press.
Production—400 per hr.
References—Figs. 49, 67 and 68.

be raised before the spring opens, it is accepted. If, however, the spring opens, it is rejected and must be retempered. A detail of the fixture is given in Fig. 65. The rate of this inspection operation, which is shown diagrammatically in Fig. 66, is 800 per hour.

The mouthpiece and spring are then assembled in the scabbard body. This is a bench operation, and the average production is 23 per hour.

The next operation—piercing the hole through the scabbard and spring—is performed in the press, Fig. 67. The punch and die are shown in Fig. 68. The

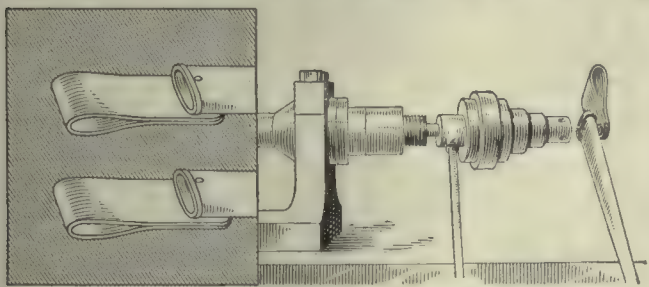


FIG. 71. OPERATION 15: TAPPING

Machines Used—Tap No. 3—48 threads; special bench lathe.
Production—500 per hr.
Reference—Fig. 70.

punch is fastened in the holder, Fig. 49. For piercing this hole the scabbard is slid over the tongue shown, thus supporting it. The punch, being fed down, pierces the hole. The operation is illustrated diagrammatically in Fig. 69. The pierced hole is tapped for a No. 3-48 thread fillister-head screw in the machine shown in Fig. 70. The operation is also shown in diagrammatical form in Fig. 71. The fillister-head screw is placed in the scabbard body and spring, thus preventing the latter from coming out.

The scabbards are given a final inspection for finish and shape, the average production being 500 per hour. They are then wrapped in paper and packed in cases for shipping. The rate at which they can be wrapped and packed is 500 per hour. The scabbard is then ready to be assembled with its business partner—the bayonet.

Teaching Shop Management by Motion Pictures

The use of motion pictures in analyzing and perfecting human motions in industry has been a prominent feature of the professional work of Frank B. Gilbreth. Many of his methods have become well known through his consulting work, lecturing and writing. One of his latest developments is the application of these pictures in teaching shop management to foremen and workers who are employed on details of the management system.

Mr. Gilbreth points out numerous advantages for his methods. At the outset he obtains a record on his films of the best skill of the worker whom he photographs. The person who is working before the motion-picture camera becomes for the time being a "movie hero." Realizing that all that he does will be shown to others under conditions where it can be commented upon and criticized, he naturally does his very best. Thus a natural trait of human nature insures that the film will show accurately the best method and procedure that the individual has been taught or has worked out for his particular operation.

Again, it is pointed out that there is no quicker or more comprehensive way to show the sequence and relationship of a series of operations than by having them photographed and exhibited through a motion-picture machine. By this means in a very few minutes a worker can see all the things that he or she is supposed to do in carrying out a particular part of a shop system. Most people learn through the eye. Thus, if a picture of one's own work is shown a number of times, small details of what is done become fixed in the memory and later on are easily and surely put into practice.

Still again, the presentation of such pictures before groups of foremen or workers gives ample opportunity to ask questions, offer objections and seek for an explanation of just what is seen. The darkened room necessary to show the pictures is really an advantage, for there are many persons who would hesitate to speak freely in a lighted room before others. In the kindly darkness, however, such individuals will not hesitate to state their opinions and ask for the help that they need.

These motion pictures are a help to the one who is describing and illustrating a system, for they present a record of just what has been successfully done, with all its minute steps. A mechanical advantage of the method is found in the possibility of returning to a part of the film that has been passed, if a question about it is raised during another part of the teaching period. It is easy to spin back the reel until the picture showing the point at issue is brought upon the screen and then discuss it or explain it to a finish. Further, the motion-picture machine can be stopped at any point and project on the screen a still picture upon which particular features can be pointed out by the lecturer or concerning which special questions can be asked by any of the spectators who might be especially interested.

There is still another phase of this use of motion pictures. A shop can take pictures for itself of particular operations that have been brought to a high state of perfection and thus have a permanent record of mechanical operations on difficult work. This application is quite apart from the one previously described as a phase of the process of teaching shop management.

Fig. 1 is from a bit of film showing the motion study of a small miller. The result of this investigation was a production of 3,000 pieces per day by one boy instead of 700 pieces per day formerly turned out by a man. This is a typical film used in explaining to a workman some parts of the theory of motion study as applied to machine operation. It is also an indication of motion

Fig. 4 is a record film from office work and is used in teaching the details of the management system. This shows the balance-of-stores girl handling the balance-of-stores books on her cross-sectioned desk. Similar views are taken from the side, at the back, close up—with all the forms on which the young lady is working shown in large-sized detail and explained by means of a pointer



FIG. 1

FIG. 2

FIG. 3

FIG. 4

FIG. 5

Fig. 1—Bit of film showing milling operation. Fig. 2—Assembling a braider. Fig. 3—Another form of braider assembling. Fig. 4—Balance-of-stores girl at work. Fig. 5—Clerk preparing papers for route file

pictures that might be taken to record successful operations for the benefit of the shop.

Figs. 2 and 3 are of an assembling job and were taken in 1912, four years ago. Recently other pictures have been taken of this same job, and Mr. Gilbreth states that they are extremely interesting, as they show exactly wherein the men have fallen down and wherein they have continued to make good. As a matter of fact, the initial practice and skill that they acquired have enabled them to keep on making their task of some 60 to 66, where formerly it was 18 to 20.

that is photographed on the film. This is typical of the kind of films used in detailed teaching. A young lady who is to be a balance-of-stores clerk can study this film as long as she chooses and thus become familiar with all the operations and their sequence before she actually has to do them.

Another film of this kind is shown in Fig. 5, where a ticket writer is preparing papers for the route file. This is one of many complete sets of pictures following through every act of every worker and depicting each function in the planning department.

Letters from Practical Men

A Tribute to Professor Sweet

Permit me to express my personal appreciation of Professor Sweet's personality and character. I had the pleasure of meeting him only once, but was decidedly impressed by his readiness to acknowledge merit in anything that came under his observation and to impart information as well as receive it.

These characteristics of his really formed the inspiration that induced me to begin contributing to the *American Machinist*.

Some time early in 1895, I think, the professor had been on a European trip and on his return described matters of engineering interest in the *American Machinist*. Incidentally, he praised some good points that he had noticed in British tools. One little wrinkle of Messrs. Shanks, of Johnstone, Scotland, described by him I may say I have since often used with good results—making eccentric oil grooves on the working faces of thrust washers, thus obtaining a constant film of oil between the faces. In some cases this has answered where commercial ball thrusts—of the period—failed.

This trait of Dr. Sweet's, as displayed in his articles, appeared to cause some resentment among certain American readers who, in letters addressed to the editor, practically asked if any good thing could come from anywhere outside the states. The professor of course easily held his own in the discussion.

Personally happening to have two lathes of the same swing working next to each other—one English, the other American—I compared them point by point, showing the good features of each and admitting I would not care to be without either of them. This attitude seemed sufficiently unusual to justify the editor in inserting a leading article commenting on my letter under the heading of "The Importance of Seeing Both Sides."

Incidentally, this letter led eventually to my making many interesting friendships and acquaintances, for which I always feel indebted to Professor Sweet. The connection with the *American Machinist*, too, has brought variety and color to my life generally.

A year or two later, seeing in either the *American Machinist* or *Machinery* that the professor had set out on another European tour, I sent him through the editor an invitation to call on me, if possible. This letter followed him about Europe, reaching him at Berlin, from where he wrote me, giving a couple of days' notice that he would give me a look-in. True to promise, he turned up; and I had one of the most interesting couple of hours in my life, looking round the shop and comparing notes. He had just previously visited Hans Renold's shop and was full of appreciation of what he had been shown there.

In a subsequent article he made kindly reference to his call on me, and I have felt myself in a measure since to have had the privilege of being one of his "boys" and should have been hugely delighted to have had the same contact with him as his actual students had. He re-

minded me very much in some of his ways of the late John Berry, a practical engineer and a teacher of evening students in Bolton and Manchester, who taught in the same manner and who curiously enough also was, for many years, the honored guest at an annual social of "John Berry's old boys," the membership of which fraternity included men scattered over the world.

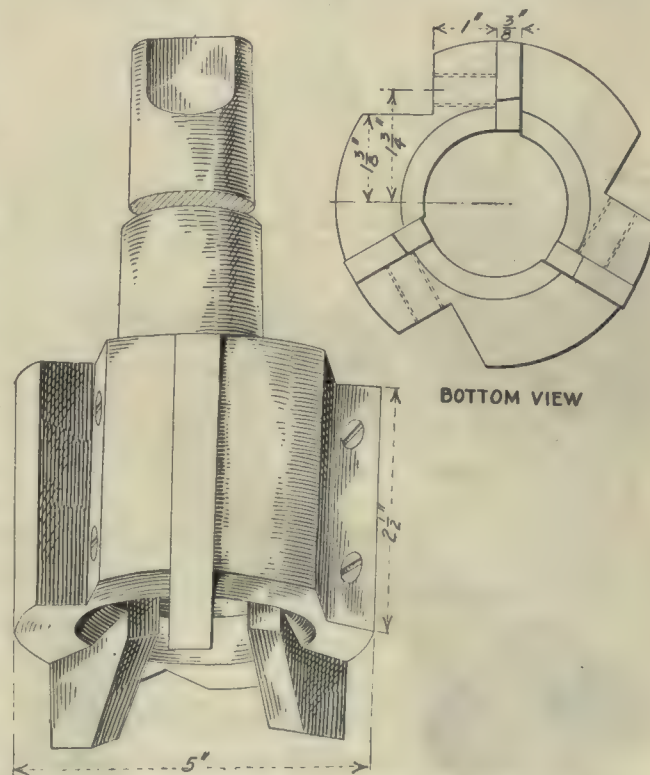
Doubtless Professor Sweet could have made a lot more money and had a much better shop if he had liked, but personally I feel he expressed himself best and did more service to the world by living his life in his own way and letting the results be what they might—which were beneficial to all and injurious to none.

JAMES VOSE.

Manchester, England.

Tool for Nose Sockets

The sketch herewith shows a hollow mill for screwing in the nose sockets in the 4.5-in. British high-explosive shells. The tool is easily made and is of ample strength for the work. In addition to screwing in the socket it



HOLLOW MILL FOR SCREWING IN NOSE SOCKETS

will rough-turn the flange, leaving only one cut to be taken off in the finishing lathe.

This hollow mill is used in a drill press. The shell, after having the socket entered a few threads by hand, is placed in a split chuck fastened to the table of the drill press, the chuck of course being central with the drill-press spindle. The drill being started, the spindle is fed down by hand. The cutters in the hollow mill bite into

the socket and screw it in. The drill spindle is fed down as the socket advances, until the socket is screwed home, when the cutters commence to cut. The cutting is continued until the flange is turned down to within about $\frac{1}{16}$ in. of the diameter of the nose of shell.

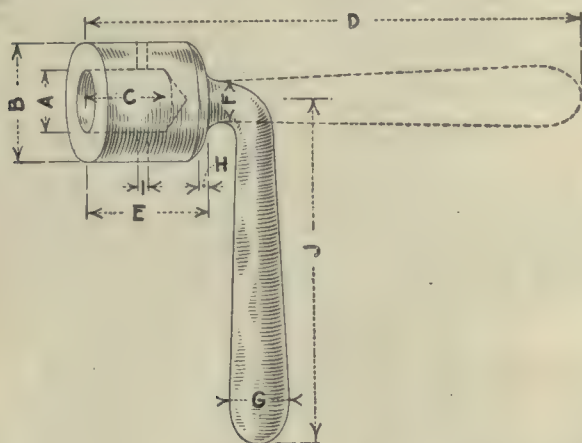
With this equipment one man can daub the Pettman cement on the threads, enter and screw in 200 nose sockets per 10-hr. day.

JOHN S. WATTS.

Nova Scotia, Canada.

Solid Jig and Fixture Handles

Conditions often arise in jig and fixture design where it is desirable to tighten screws more than is possible with thumb screws, wing nuts, starwheels or knobs. The handles shown in the accompanying drawing are very effective for this purpose. They are turned and finished



Size.....	A	B	C	D	E	F	G	H	I	J
1-1 1/2	1 1/2	1 1/2	1 1/2	3 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	2 1/2
1-1	1	1	1	4	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	2 1/2
1-3/4	1 3/4	1 3/4	1 3/4	6	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	3
1-1/2	1 1/2	1 1/2	1 1/2	8	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	4 1/2
1-1/4	1 1/4	1 1/4	1 1/4	10	2	1 1/2	1 1/2	1 1/2	1 1/2	5 1/2
1-1/8	1 1/8	1 1/8	1 1/8			1 1/2	1 1/2	1 1/2	1 1/2	7

This handle may be used as a nut or may be pinned to the end of a stud. C is the maximum depth of hole in both cases. J is an approximate dimension depending on radius of bend of handle. Dimensions are in inches.

SOLID JIG AND FIXTURE HANDLES

up straight, as shown by the dotted line, and then heated and bent over. They are made of machine steel and are case-hardened after bending.

Although shown with a straight hole for pinning to a stud, they can also be used as nuts. In large plants, where the production of jigs would warrant it, these handles could be drop-forged to size and the finish omitted.

Bridgeport, Conn.

W. BURR BENNETT.

Driving Headless Screws

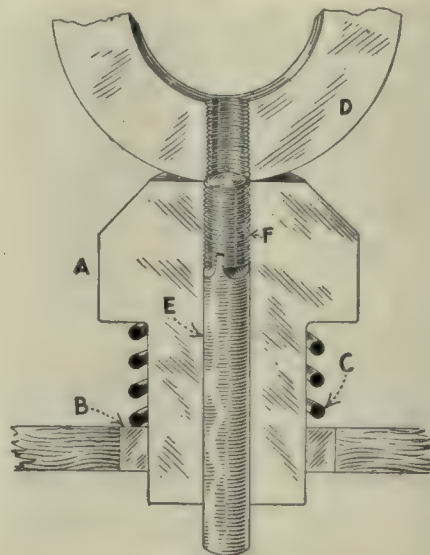
Here is a device for rapidly screwing in headless setscrews in repetition work. With it an operator can easily average 100 an hour.

The plunger A is made a sliding fit in the collar B, which is driven into the bench. A piece of $\frac{3}{8}$ -in. drill rod E is a running fit in the reamed hole in A, with a lip on the end to drive in the setscrew F, and connects on the lower end with the power shaft.

Care must be taken to have the spring C of such length and tension that, when at rest, the setscrew will project almost $\frac{1}{64}$ in. above the top of the plunger. When fully

compressed, the setscrew should be driven in the desired distance. An adjustable stop could be provided to determine the distance that the setscrew should be driven in, if necessary, especially if the collars D varied in thickness.

The operator is simply required to place the setscrew in the hole of the plunger, bring the collar square against the end of the screw and exert a downward pressure.



A HEADLESS SCREW DRIVER

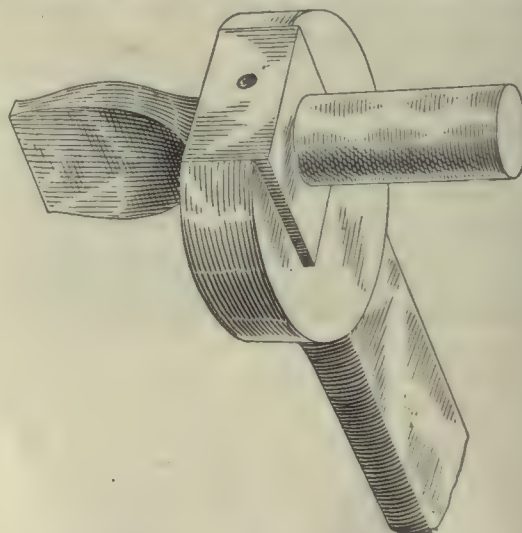
When the screw is in its proper place, the lip of the revolving driver will release itself automatically from the screw, because the plunger has come to a stop and can go no farther.

WALTER GABRIEL.

Newark, N. J.

A Screw-Driver for Heavy Work

When forcing home large screws in dies where cap-screws cannot be used, it is necessary to have leverage on



A SCREW-DRIVER FOR HEAVY WORK

the screw-driver in order that the screws may be driven tightly.

One of the best methods of obtaining this leverage is to shrink-fit and pin a square nut on the shank of the screw-driver, as shown, and apply a wrench.

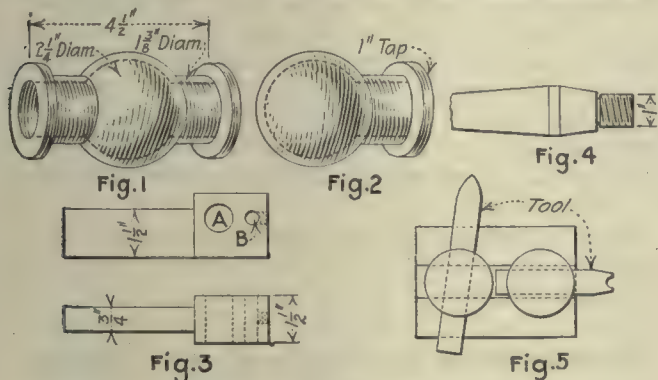
Newark, N. J.

G. WALTER.

Machining Bronze Fittings in an Engine Lathe

Not long ago a job came into a small marine shop on the Pacific Coast. The order was to finish a large number of fittings for the brass railing around the machinery on a boat that was being overhauled. These fittings were of bronze and of several different designs, the greatest number being as shown in Figs. 1 and 2. The only machine available at the time was an 18-in. engine lathe that was too old and worn for most work. This was fitted up with a few tools and rough jigs, and the job was handled in much better time than was at first thought possible.

A description of the way in which the piece shown in Fig. 1 was finished will show the method used on all. As the finish on the outside was mainly for looks, close limits were not required. An old three-jaw universal chuck was put on the lathe, and the pieces were chucked on one end with the jaws just touching the ball part, to steady them. A jig was made as shown in Fig. 3, the hole *A* being bored so that a $\frac{7}{8}$ -in. drill would slip



FIGS. 1 TO 5. SHIP-RAIL FITTINGS AND TOOLS USED

through. The hole *B* was drilled to take an ordinary piece of $\frac{3}{8}$ -in. round tool steel, with a setscrew to hold it. The jig was blocked up in the tool post to the correct height, and a stop was put on the cross-slide, so that when the tool rest reached the stop, the hole *A* was at the center of the lathe. An ordinary twist drill with the cutting edges ground back so that they would not dig in was used in the tailstock.

The operations of facing, drilling and tapping were then accomplished by running a cut by hand across the face, with a tool inserted in the hole *B*, and bringing the tool rest up against the stop. The drill was run in by hand, the jig holding it true. The shank of the tap was put through the same hole in the jig, with a wrench on the square part to keep it from turning, and the tapping was done.

After all the pieces had been finished on one end, the same operations were gone through on the other end, except that instead of chucking them they were screwed onto a mandrel, Fig. 4, which fitted the taper hole in the lathe spindle. The chuck was removed entirely.

The outside was finished on the same mandrel, the compound rest being used and a tool set up as shown in Fig. 5. Two tools were put in, one an ordinary tool to turn the ball and the straight parts, and the other a formed tool to shape the ends. Stops that could be quickly removed were put on the carriage and lathe bed, to hold the center of the compound rest under the center of the ball.

The turning was done by swinging the rest by hand until the ball was finished and then taking out the stops and turning the straight parts in the usual way. The rest was turned one-quarter around, and the other tool was used to form the rim on each end of the casting. The whole fitting was polished a little and taken off the mandrel completed.

The lathe was run at its highest speed, which was about 300 r.p.m. As the bronze was rather soft, the tools lasted a long time between sharpenings. After the job was well started, an apprentice was able to go on with it.

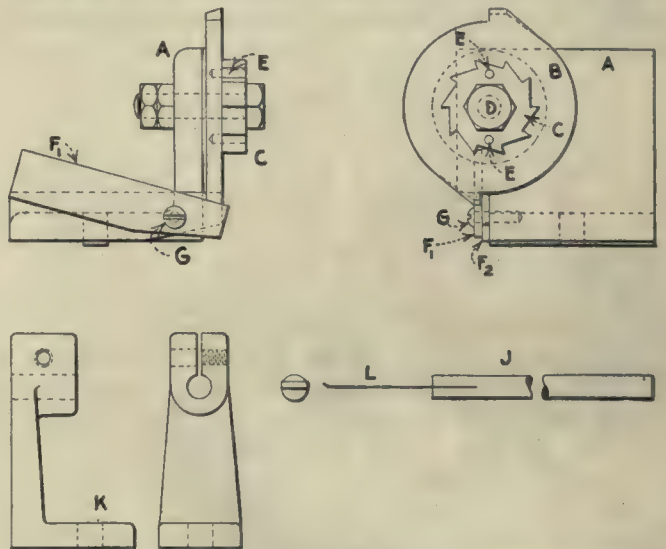
E. W. WRIGLEY.

Seattle, Wash.

Graduating Micrometer Collars

Some years ago, in the shops of the Oliver Machinery Co., of Grand Rapids, Mich., the compound slides of the lathes were graduated in degrees by hand on the miller. To help relieve congested conditions, the herein described device was made to enable this work to be done on the automatic gear cutter, as this machine was idle part of the time.

This attachment is very simple and cheap to make. It consists of a frame *A*, of 3x3-in. angle iron, having a tongue in the base to fit the cutter slide of the No. 3 Brown & Sharpe gear cutter. A cam *B* and a ratchet of 10 teeth *C*, which are doweled together by two pins *E*, are a tight fit upon the bolt *D*, which is an easy fit in *A*. Between the cam *B* and the frame *A* is a fiber



GRADUATING ATTACHMENT FOR BROWN & SHARPE GEAR CUTTER

washer *H*. The locknuts on *D* permit the friction between *A* and *B* to be adjusted and to be kept in adjustment. The frame is cut away, as shown, and two fingers *F*₁ and *F*₂, which swing on the screw *G*, are fitted so that the lobe of the cam *B* lifts the outer end as it passes over them.

As under the style of graduation then in use the degree marks were of a certain length, the 5-deg. marks longer and the 10-deg. marks still longer, the stroke of the outer slide, which carried a stationary V-tool, had to be increased at these divisions. The 5-deg. lobe lifted both fingers and allowed the rear one to drop, thus lengthening the stroke by the thickness of *F* and making a longer mark. The 10-deg. lobe held both fingers up.

The ratchet wheel *C* engages with a spring pawl *L* sweated into the pawl rod *J*, which in turn was clamped in a bracket *K*, bolted to the main frame of the machine. The regular rear stop on the cutter slide was removed, the attachment substituted, and the position and length of stroke for the degree marks were obtained. Then the pawl rod *J* was slid along and clamped so as to turn the ratchet *C* one tooth when it came back on the quick return, care being taken to see that it allowed the finger *F*₂ to drop when in the 5-deg. position.

The machine was set up to divide 360 and run at its fastest feed and speed. The results were very pleasing, little attention was needed, and fine graduating was done.

It may easily be seen that this attachment may be used for graduating collars for feedscrews, where thousandths are to be indicated, or with suitable cams and ratchets any simple graduating may be easily accomplished.

ROLAND V. HUTCHINSON.

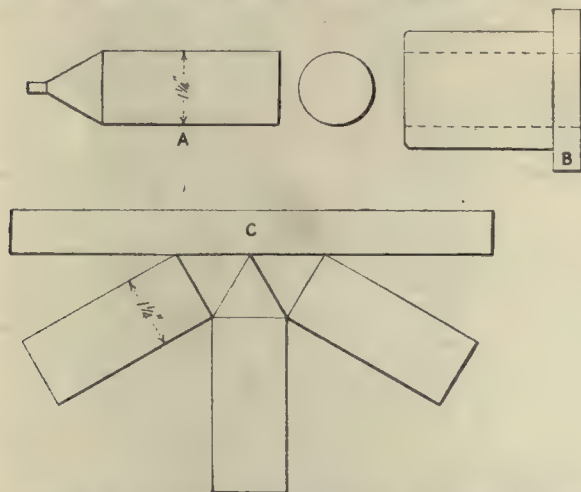
Ironton, Ohio.

✕

Exact Angles for Lathe Centers

The center gages made by manufacturers of machinists' small tools serve their purpose admirably, are convenient and enable the machinist to keep his lathe centers 60 deg. within a small limit of error. If reasonable care is used, the small error has no appreciable effect when turning, because the centers in the work soon assume the shape of the center.

Where the work is afterward hardened and work from several lathes goes to a grinder, any variation in the lathe centers is noticeable on the grinder centers. A recent



METHOD OF MAKING AND TESTING 60-DEG. CENTER GAGE

investigation demonstrated that lathe centers ground by different men to the same gage will vary somewhat and it is easy so to hold the gage on the center that it will appear to be inaccurate.

This slight inaccuracy was again brought to our attention when making hardened arbors for use in manufacturing lathes. These centers had to be large and accurate and were tested with a 60-deg. hardened gage.

Being anxious to meet our customer's requirements, an effort was made to produce a 60-deg. male gage that we knew was accurate. We proceeded as follows: Three pieces of tool steel were centered and turned as shown at A. These were hardened, the centers lapped and the

outside ground to $1\frac{1}{4}$ diameter, making all three pieces so near alike that they would just wring in the same hole. We next mounted a hardened bushing on the face plate of a Brown & Sharpe grinder and trued it by the hole, using a test indicator. The bushing was clamped by the flange *B*. The head was swung to the proper angle according to the graduations, and one piece was wrung into the bushing and ground on the angle. Without disturbing the head, the other pieces were also ground, and we were confident that all three were alike. To test the angle, we laid them on a plate, on which a parallel or straight-edge *C* was held.

We experienced some difficulty in holding all three pieces in proper position and getting light so that we could tell just how the angle was. The theory was that the three 60-deg. centers would total 180 deg. and therefore occupy just the amount of space on one side of the parallel. We adjusted the grinder head and reground the gages until we obtained the desired result. Any error will be cumulative and can be easily detected.

After making the effort outlined above, we still failed to meet our customer's requirements for accuracy of angle and were obliged to obtain a gage from his factory and lap the centers to conform to his gage. To satisfy ourselves as to the accuracy of the gages we had made, one was submitted to the Bureau of Standards at Washington and was reported to be right within 2 min. We think our theory was correct and know that our apparatus for testing was crude. Has anyone else had a similar experience, and can someone suggest a better way to produce the 60-deg. angle?

Would centers accurate to within 2 min. be considered good?

R. W. GREENE.

Cleveland, Ohio.

✕

Protective Coloring of Tools

In our main erecting shop, where apparatus in large units is assembled, we employ four groups or construction gangs, each with its head man. With these four distinct gangs working on the same main floor it is found extremely difficult to prevent trouble and dissatisfaction caused by one gang's using and abusing the tools and equipment of another.

We tried stamping the number of the gang on each tool, but this was not altogether satisfactory because we could not readily detect when anyone was using another's tools.

To provide the necessary distinction, it was decided to assign to each gang a certain color. On all the tools and equipment belonging to the gang in question was painted a band of the color given to that gang. Blue was chosen for one group, red for another, white for the third and a bright yellow for the fourth. Hence on all the wrenches, bars, slings, etc., belonging to the first gang a blue band was painted, affording instant detection in case the tools were being used by a member of another gang. This provision of a means of ready detection of course resulted in the "cubbing" practice being abandoned. In fact, so distinctive was the designation that before long the different groups became known as the "blue gang," the "red gang," etc.

While the color scheme was adopted for convenience, we also continued stamping the gang numbers on all tools and equipment to guard against changing tools, etc., by merely painting on a band of another color.

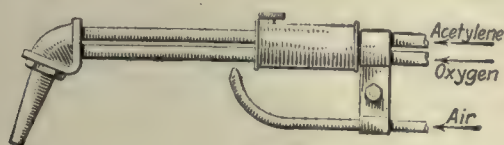
Philadelphia, Pa.

W. A. LAILER.

Discussion of Previous Question

Oxyacetylene Welding Kink

H. Howard, on page 1001, Vol. 44, described a device for the use of oxyacetylene welders. It consists of an air hose and a short piece of plugged pipe with a number of small holes drilled in it. The pipe is laid on the bench or work under the hands of the welder, and the air protects his hands and face from the intense heat.



OXYACETYLENE-WELDING TORCH WITH PIPE

The disadvantages of this device are that it does not follow the movements of the worker, is easily shifted or knocked off the bench or work and, if laid on the heated article being welded, tends to cool it.

The illustration here shown is an arrangement consisting of a $\frac{1}{4}$ -in. pipe connected by a light hose to the air line. The pipe is bent to surround the hand of the welder and fastened by a light bent-iron clip to the torch. By this means the welder can keep his hands and face cool without any of the disadvantages of the other method.

J. D. CUMMING.

Copper Cliff, Ontario, Canada.



Successful Suggestion System

I have read with interest the letter from J. Watt, page 123; I also read the article to which his is an answer. I think that Mr. Watt is right in his general position that the reason suggestion plans do not work satisfactorily is that the men are not satisfied with the returns. While from their point of view they are justified, at the same time neither they nor Mr. Watt takes into account two vital aspects of the whole proposition.

They forget in the first place that in ninety-nine cases out of one hundred their suggestion would be valueless without the organization of their employers with which to put it into practice, and furthermore on the open market it is worth what can be got for it and not what it may bring to the purchaser.

The suggestion that produced \$6,700 per year and for which was given a \$50 watch is of course an extreme case. Reducing this to percentage and calling the total valuation \$110,000 is probably very far from the facts, for the chances are that the particular suggestion did not bring returns of \$6,700 per year for any length of time; probably one or two years would be the limit.

To go back to my first proposition, the fact that the organization was there with men at the head of it capable of taking the suggestion and fitting it in to bring the results was an extremely large factor. The whole question is closely allied with that of new inventions. Anyone who has any experience in this line of work knows that there

are hundreds of inventions lying dormant because the inventor has neither the skill nor the capital to put his invention in shape to bring returns. Many of them have been lost and the inventor got nothing because he was not willing to take the small share of the returns which the men with capital and business ability were willing to give him. For the same reason the majority of the men in the shop are not willing to give any suggestion and see it prove profitable to the firm, while they receive only a fraction of 1 per cent. as their share.

Plymouth, Mich.

W. B. GREENLEAF.

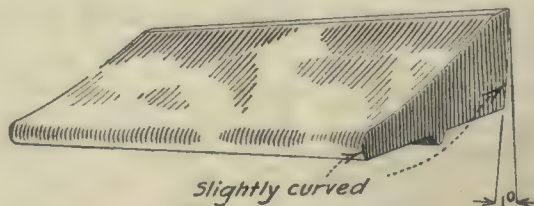


Design of Holding Jaws

In answer to Mr. Beuter's question on page 1002, Vol. 44, in regard to "Design of Holding Jaws," I will say that I have used both kinds and agree with Mr. Green in his answer on page 36, Vol. 45, as to which of the two is better.

However, I do not consider either design efficient for all purposes.

Many years ago I had a job in a shaper using this style of holding jaws, but could not hold the work down because



AN EFFICIENT HOLDING JAW

the sliding jaw of the vise was badly worn and the work, only $\frac{1}{8}$ in. thick, could not stand the pressure necessary to bring it down. I designed and made the holding jaws illustrated herewith, which held the work firmly to the parallel without tightening the vise screw hard enough to spring or buckle the work. I have never used any other kind since, but have made them in different thicknesses at the gripping point for larger work.

Brookline, Mass.

HENNING G. SAHLIN.

I noticed Robert J. Beuter's article on page 1002, Vol. 44. I have had considerable experience with such devices and I suggest that he simply ignore the $2\frac{1}{2}$ -deg. taper on the front or short bearing side. Then the side of the "hold-down" will not rise up.

Worcester, Mass.

HARRY F. CLIFFORD.

We notice on page 78 an article by Hugo F. Pusep, of Dayton, Ohio, on holding jaws, or "hold-downs." From our experience we hardly believe the design that he mentions would work satisfactorily in all shops. We have tried all kinds of "hold-downs" and all kinds of angles, and it seems impossible to design a solid pair of fingers that will not ride up on the back.

Our spring "hold-downs" are designed to overcome this trouble. The springs in the jaws back of the fingers pull the fingers up on the shortest line, and pressure of the back brings down the fingers in front, which will press down on the works on both sides, forcing it to the head of the device and holding the same firmly and without any pounding or hammering.

THOMAS FISH,
Bridgeport, Conn. President, Ready Tool Co.

Aeroplane Propeller Problems

Your interesting editorial, "Aeroplane Propeller Problems," on page 125, on the subject of aeroplane propellers prompts me to go on record with the following statement: So far as perfect running balance is concerned, it is not only possible, but even easy to produce a machine for securing such balance. We do not care anything about reciprocating or static balance; the former is secured by means of calculations; the latter can be obtained on the beautiful Jost machine.

As regards dynamic balance proper, a machine can readily be constructed to secure the balance of the shaft, of the propeller proper and finally of the combination—that is, the shaft mounted in the propeller. This should preferably be done in the crankcase and at the speed at which the propeller is supposed to operate in actual work. This would mean a good-sized variable-speed motor and all sorts of precautions. Such a machine would not be cheap to build, but it can be made and positively guaranteed to do the work.

N. M. AKIMOFF.

Philadelphia, Penn.

Standard-Size Holes--Why?

Your editorial on standard holes, p. 1137, Vol. 44, is interesting. Apparently this is one of the traditions that have so far survived the weeding-out process. The mechanical trades are full of just such traditions. Although there were, no doubt, reasons for their existence at one time, they have now become useless and are retained simply because no one advocates a change vigorously enough.

In times gone by, before machine tools had been brought to their present state of perfection, it was undoubtedly easier to make all allowances for different kinds of fits, on the shafts, but with the machines in use at present no such conditions exist. It is just as easy to bore a hole to any variation from standard as it is to turn a shaft, and when, as with most of the smaller bores, reamers are used, there is every reason for the change. Nearly every shop man has been up against the provoking incident of having an expensive and possibly not easily duplicated reamer begin to cut small and delay the job simply because all the holes had to be made standard, even though they were finally to be used on different kinds of fits.

The extensive use of cold-drawn steel shafting has partly tended to overcome this standard hole tradition; but, as you suggested, most cold-drawn steel is slightly undersize, so it is only a half remedy at best.

It might seem that there would be a chance for confusion in reading orders and drawings on which the holes were all marked oversize or undersize, but when it is remembered that all shafts have to be so marked now it will be seen that it is only transferring the reading from one place to another.

The suggestion seems sound and one that, if it can be carried out, will meet with the approval not only of those who watch the profits, but also of the mechanics themselves, as tending to avoid confusion and embarrassment in the shop.

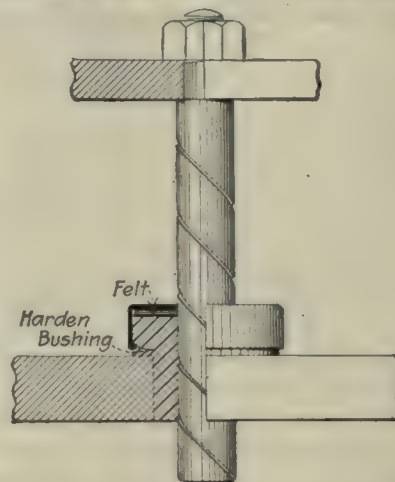
E. W. WRIGLEY.

Seattle, Wash.

Grinding Die-Setting Pins

After reading the controversy between Mr. Remacle, page 915, and W. B. Greenleaf, page 1090, Vol. 44, I submit the accompanying illustration to show the method of building and applying die-setting pins.

This method is not original, but there seems to be a great many who are not familiar with it. In this method the pins are fixed permanently in the punch and operate through bushings in the die shoe. When necessary, holes



SATISFACTORY METHOD OF SETTING DIE PINS

are bored into the bedplate of the press so that the guide pins may pass down through the die. The pins are left soft and an oil groove is cut on a spiral around the pin, but the shoulder bushings are hardened and ground and are forced into the die shoe. The hole in the die shoe and in the punch are both bored. A felt washer approximately $\frac{1}{8}$ in. thick is secured on top of the bushing by means of a partly split collar, which snaps in the groove turned in the bushing. This washer acts as an automatic oiler for the guide pins. Guide pins built this way and given a reasonable amount of care in regard to oiling, etc., will run almost indefinitely without the least sign of wear.

R. P. THRONE.

Syracuse, N. Y.

Take Warning!

On page 1089, Vol. 44, George Little gives his opinion against the metric system. Many advocates of the English system will regret that he did, especially if they know the great advantages of the metric system when used for intricate calculations. While still sticking to the English system—because of certain inherent advantages of which few men in America are aware—Mr. Little himself says that he only gave the matter scant attention. It is therefore no surprise that he makes incorrect statements. A cause is never furthered by such conclusions, as they leave their maker open to attack.

I am opposed to the metric system, not because it is metric, but because it has a base of 10 instead of a base of

8. Several oriental peoples use systems with a base of 8 to great advantage. There are, however, many short cuts in the verbal use of the metric system. For instance, channel iron with a flange 11 cm. wide is called channel No. 11, though these things have little significance in connection with such a grave question. The following criticism of the metric system by a Chinese fitter in my employ may be of interest.

After I had been petrified with the metric system at a continental college, circumstances drove me into an oriental forest, with a theodolite, a Chinese "fitter" and two score Macao coolies. The fitter, Yim Yam, did all the work and I drew the salary. His duties were even to amuse me at night time. The evenings in a forest are long and as no outside news penetrated, we talked mathematics under the veranda of my leaf hut, and Yim Yam, one of the ablest mathematicians one could meet, was at his best if he was allowed to run down the metric system. He had a little abacus with beads, like children use, and often we had a race in figuring. I used a slide rule at which I was rapid, but I lost every time. With a Chinese grin my fitter told me why he won and why Chinese tellers are favorites in Singapore banks. Only because they use the base 8, which is natural. Yim Yam said that the decimal system was stupid because of its base of 10. One could not feel it, as it had no connection with our body and brains. They were built by fours and threes, Yim Yam said. What he meant has become clear to me after years of thinking about the matter, and will be explained farther on.

Then he would discuss the English system and "his eyes found good points," but he did not think it faultless. There is rhythm in it, one of threes and fours. There are four eggs in a "throw," and three throw in a dozen; four dozen make 48 and three times 48 gives a gross. This was not said without a reason. Again, four thumbs (inches) make a hand (the expression palm or hand indicating four inches is still used in continental villages), three palms are a foot and three feet make a pace (yard), a system taken from our very body and therefore closely connected with the brain. Yim Yam alleged that there never was any trouble gaging English measurements by the eye, but with the metric system one could never hope to bring that art to a high level, as all feeling was excluded.

The Chinese base 8, however, was superior to all and he would incessantly talk of its beauties. When he compared our music to their one-string violin, with its rhythm of fours only and not threes and fours, a creepy feeling came over me and I bade him good night.

Since then I have worked in Australia and the English system came to me quite naturally. I used it to the greatest extent without any trouble. Soon I noticed I could guess sizes which metric men couldn't. That is why Englishmen in Europe are regarded as being very practical. When I again worked in Europe, the metric system appeared clumsy to me as it seemed to lack something natural. Guessing at sizes by eye failed utterly. Continental carpenters always speak of wood in terms of feet and inches and often refer to a centimeter as a Dutch inch. Mechanics in out-of-the-way places indicate bolts and bars in the English system because there is something easy about it that one cannot explain. The most successful continental architects of the present day take their beautiful lines from a combination of triangles

and squares—that is, out of fours and threes. In fours and threes there is harmony with our brains, and before adopting a new system it would be wise to see if the English system is after all so stupid as one regards it. Perhaps a touch or two might make it superior to the metric.

The foregoing is "philosophy," but now to the practical. Nobody seems to think of the damage the adoption of the metric system would cause, and that those injured by the adoption of the metric system have a right to be repaid in full for their loss. The pro-metrics believe that each year of use of their system will show a reduction in cost of the change over the previous year and it will not be difficult for them with the backing of their superior system, to figure out in plain dollars, the gain to the nation as a whole. Those injured can figure out their damages and perhaps ask a little more to soothe their feelings, just as is done in other damage suits.

The injured won't only be manufacturers, mechanics and toolmakers, but grocers and storekeepers will find themselves with expensive weighing apparatus which they cannot legally use. The damage done will amount to millions. Even a city like New York could not tear down one section and improve another without paying the owners for the property destroyed. It stands to reason that if there are such great material advantages in the adoption of the metric system, damages should be paid to all who suffer by the change. Even the young draftsman who possesses a two-foot rule is entitled to his proportion.

If no damages can be paid out of the future gains, there certainly is no positive assurance that the metric system will bring the advantages claimed by its advocates.

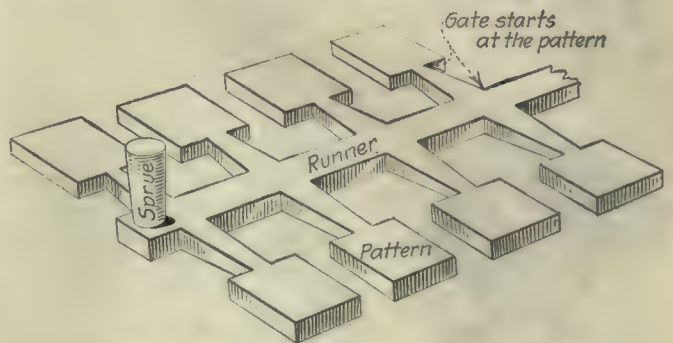
JAN SPAANDER.

Brooklyn, N. Y.

What Is a Gate, and What Is a Sprue?

Regarding the editorial, "What Is a Gate, and What Is a Sprue?" page 1005, Vol. 44, the following may be of interest.

One of the leading dealers in foundry supplies describes in his catalog a band sprue saw, in part, as follows: "The saw will shave all sprues and fins off close to the castings." Another machine he describes thus: "These



GATED PATTERNS WITH NAMES OF PARTS

machines are commonly known as sprue cutters, being designed for use in brass foundries in cutting castings from the gates." Here we have sprues from the castings and castings from the gates.

Some years ago, while in the employ of Gray & Sharp, I had a gate of metal patterns made by Green & Dull

and the castings made by Brown & Blunt. The pattern, being too large for the flask, was returned to the makers with instructions to cut $\frac{1}{4}$ in. off each end of the gate, meaning the center bar.

The pattern maker's understanding of a gate was where it joins the pattern; that is where he took the $\frac{1}{4}$ in. off. Then there was trouble. I don't know who paid the pattern maker. All this trouble and expense because the same name was used for different things.

I have never heard a molder use the term "sprue a pattern." I have never heard him use any other term than "gate a pattern, and a gate of patterns." If you ask the molder where he is going to gate the pattern, he will point to the spot—or spots—on the pattern or at the edge of the mold.

A gate of patterns and the names of the parts, as I know them, are shown in the illustration. In the case of a single pattern or a drop forging the parts would be gate and sprue.

M. E. DUGGAN.

Kenosha, Wis.



Why Not Same Hours for Office, Drawing Room and Shop?

The suggestion offered on page 125, to do away with the privileges enjoyed by the office and drawing room and thus diminish the existing antagonism between these two bodies and the shop, is an expression of fairness and justice.

No thinking man can have any objection to bettering the condition of the shop people, yet, one may ask, will industry as a whole be really benefited by reducing the difference in advantages, be it by shortening the hours of the shop or by taking away the privileges of the staff? Many a manufacturer will object strongly to this way of obtaining the desired ends. Should he take this method, the natural law of supply and demand will soon show it to be a flat failure, especially in the case of the drafting room.

The drafting force in high-class concerns is by no means regarded as nonproductive. It is often the brains of the plant, and many of its members not only boast long experience, but also an education that ranks with the highest to be had in the country. Their pay, compared with that of medical and judicial fellow students, is ridiculously small, and if they had understood beforehand the poor remuneration awaiting their services, they certainly would have entered through another door of the college. America is already poorly supplied with high-class draftsmen; even good second-raters are scarce, and this will be felt more keenly after the United States is forced into a bitter international commercial struggle. By placing the drafting room on a still lower standard the last inducement for an American youth to become a draftsman will be taken away.

No father will be foolish enough to obtain for his son a position equal in hours and pay to that of a second-rate mechanic, at an extra outlay of from one to ten thousand dollars for education. No young man will waste his time in commercially valueless studies, when during this period he may earn from one to five thousand dollars, depending on the length of his course. If the status of the draftsman is further reduced, the privilege of being one can then be obtained at a direct and indirect

loss, aggregating from \$2,000 to \$15,000, without the slightest return.

In *Engineering News* I have read a protest against the misstatements of the earning capacities of the engineering profession, of which draftsmanship is a substantial branch. Not only small technical schools, but also colleges of standing have been guilty of misleading parents. By still further reducing the privileges of the drafting force, even the most credulous and hopeful father will not be fooled any longer by unscrupulous teachers, and American industry will then have been supplied with enough rope to hang itself.

New York City.

W. DE GRUYTER.



The Advantages of Machinist Draftsmen

The letter by F. J. Badge on page 31 contains much food for thought. His question: "Why do not more machinists become draftsmen?" might be answered in many different ways as there are several factors governing this point. Actual machine work is productive, whereas drafting is purely creative, and the step from one to the other can not be made in a day or a month because it invariably requires a large amount of diligent preparatory work.

Drafting, in any of its various forms, is largely a matter of manual skill developed through many years of daily practice and chief draftsmen, as a rule, are very reticent when it comes to breaking in a man who has had no practical experience. Then, there is sometimes a certain amount of prejudice against the man who has worn overalls. Many of those in the higher positions look down upon the shop man and resent his trying to enter their field. This, however, is not nearly so noticeable today as it was fifteen to twenty-five years ago when draftsmen were considered "high-brows" and machinists "rough-necks."

Education is a great leveler, and the opportunities for study through correspondence schools, evening classes and home study from textbooks are so numerous that it is possible for the shop man of today to acquire theoretical knowledge on a diversity of subjects that heretofore were reserved for those who happened to be born in fortunate circumstances as far as dollars and cents are concerned. My experience is strongly in favor of encouraging the practical man to enter the engineering field, as it has been proved many times that his services are of great value. To be sure, he can not make "pretty pictures" at first; his lettering and the general appearance of his work will appear crude but, on the other hand, as Mr. Badge says, other advantages will offset this. As a matter of fact many machinists do become draftsmen and it can be said to their credit that they generally become skilled workmen, as their practical experience on actual work proves of value.

Getting started in new work, however, is sometimes a serious problem, but if he is persistent he will eventually succeed although he may have to start at low wages. A machinist who has a liking for drawing and is good at mathematics should make a skilled draftsman after a few years of practice and the advantages of the prior training are bound to make themselves felt.

Indianapolis, Ind.

F. B. JACOBS.

Editorials

Progress of the Industrial Inventory

The progress of the inventory of our industrial resources is extremely gratifying, whether it be considered solely as a military measure or in its broader significance of mobilizing our machine shops and other industries to know their possibilities. Legislation has now been practically completed which will carry out the entire program of the committee of industrial preparedness, and so establish a firm and enduring foundation for national defense. And this by being aware of our capacities, rather than by piling up thousands of tons of ammunition. This plan includes the placing of small, or educational, orders for munition, and all other military and naval supplies, so that should necessity arise, their production can be insured without delay. Legislation is also expected which will bring the skilled mechanics into an industrial reserve, so that in time of war they will be kept at home where they will be of more value than on the firing line.

An interesting and hopeful phase of the whole matter is the way in which this voluntary and unpaid organization of business men and engineers has conducted its campaign to secure the desired information. This marked definitely a new era in the recognition of the engineer, and can hardly fail to bring him into a more prominent position with regard to municipal and national life.

While it is impossible to go into details of the progress made, a brief outline of the work already done, and of some of the features which have been brought out, can hardly fail to be of interest. A letter of Chairman McLain, of Florida, outlines the task of his assistants and their reward. It says: "You are asked to give your time and labor to a task which carries no profit and but little glory. There is no money in it for you, but there is a meed of honor; and when finished, you may very justly feel that you have rendered to your country a patriotic service of the highest type." This same spirit is being impressed upon manufacturers, who are for the most part responding to the request for information in every way.

Such an inventory as is now being taken will also be of value to the manufacturing capacity of the country even in other lines. As an indication of this, there is a report from Florida that charcoal could easily be produced in considerable quantities should the demand arise, although this is an industry which has never before been considered in this connection.

Some idea of the magnitude of such an undertaking can be had when we learn that there are more than 30,000 manufacturing concerns in the country doing a business of over \$100,000 a year. All these are being inventoried as well as many smaller concerns whose equipment can turn out material for the fighting line. Some states, such as Missouri, can furnish lead and zinc in large quantities, as well as shoes, harness and leather products. Nebraska, however, not a manufacturing state, has a rail-

way motor shop which can turn out 1,000 high-explosive shells a day.

This inventory is bound to be of great value entirely aside from its military significance. We are going to know more of our manufacturing industries and the possibilities of utilizing them in other directions. It will also make manufacturers generally feel that a closer connection exists between them and the Government at Washington, which is very desirable in every way. When we cease to consider the Government as a thing apart from ourselves, we will have taken a long step toward useful coöperation along all lines.

There are many evidences of the growth of this feeling, one instance being the case of Chairman Berresford of the Committee in Milwaukee, the office of which has been supplied with all necessary furniture by a local maker; and the State Telephone Co. gave its best services to assist in the gathering of the desired information. The whole undertaking has been well worth while, and the information secured cannot fail to be of even greater value than we perhaps realize at this time.

✻

The Immigrant as an Asset

Every healthy adult immigrant that comes into the United States has intrinsic value. He increases our human wealth. The addition that he brings to us costs us nothing, for the United States has not borne the expense of rearing him to manhood, educating him and training him in whatever industry or work he is skilled.

This—the manufacturers' way of looking at the immigrant—is not as well understood among persons who are fond of talking about the foreigner and his problems as the truth of the situation deserves. The bald fact is, America's industries could not be carried on without foreign-born labor. A little investigation on anyone's part will impress the truth of this statement and—what is more important—will bring home forcibly to the investigator the importance of the immigrant in our business, our shops and our factories. There is not, and probably never was at any time in our history, a sufficient amount of native-born labor to man our industries. How important it is then that the means of entrance for the immigrant shall be made as easy as possible and at the same time safeguard our national life!

If all of this was understood and valued at its true worth, we would hear less about the so-called immigrant problem in the United States. On the other hand, we would hear more about efforts to educate, train and assimilate the newcomers. There would be more night schools for the teaching of English, more instruction in the history and ideals of our great country, more preparation for the duties of citizenship and a stronger example of straightforward Americanism. Here and there an industrial community has awakened to the importance of doing some of these things, with direct good to itself and the immigrants in its midst. But only a beginning has been made.

1620--New England--1920

Some kind of fair or celebration is to be held in Plymouth, Mass., in 1920. At least, everyone seems to believe that something should be done in that year and at that place to commemorate the first landing of English settlers on our North Atlantic coast. All sorts of ideas have been offered. These include an exposition, a series of glorified pageants, a model municipality and a New England institute.

No international, or even national, celebration can be held unless its exhibits in some way touch the lives of all the people. This fact seems to squelch the last three suggestions. The business of the world today is industry; thus some part of industry must be the central idea around which the whole is planned, and this means some kind of fair. Past expositions have shown products—the things that the industries of the world have made. To a very limited extent only they have shown methods and processes. Why not, then, build the celebration of 1920 around the central idea of *how* industry does things, not *what* industry does? And when we are approaching the how of things, why not make the plans and exhibits of the few months of 1920 the foundation and beginning of a great museum of industry for the United States?

To put the thing a little more concretely, would it not be possible to interest the manufacturers of the United States in a national fair that should show how the industries do the things that they do. Show machinery in operation, processes being carried out, methods being followed, and by a comprehensive scheme teach just what has to be done to make all the things of everyday life. Emphasize the historical side of all these industries. As a matter of fact, practically all started in New England; thus in a very true fashion such a fair would show what New Englanders have contributed to the growth and development of this great nation. Let all the exhibits, particularly the historical ones, be so carefully planned that after the fair closes its doors toward the end of 1920, many of them can pass immediately into the halls of some great permanent museum of industry located either in the City of Washington or in New York.

This suggestion embodies three important elements: First, emphasis on the part that New England has played in the development of the United States; second, means of bringing about a better understanding of the importance of industry in our national life; third, the laying of the foundation for an institution that we sorely need—a great central museum of industry to be administered as one of our educational forces.

✽

The Need for More Thinkers

The belief will not down that, as the war closes, American industry will face outside competition such as has never been known before. Some men also have a grave fear that not all the forces behind American industry are as well organized as they should be. These forces are of two kinds, the physical and the mental. When it comes to machines and their operators, we are not badly off. Labor-saving machinery is more highly developed here than in any other part of the world. The producing power of the American workman is said to be unsurpassed. But are our mental forces on a par with the others?

It is said that we lack thinkers in our industries—men who can plan work for others to do. Our record in foreign trade during the past two years is pointed to as proof of this fact. While we have gained tremendously in our exports to the belligerent nations of Europe, we have, in general, lost in the markets of the rest of the world. There is little evidence that preplanning is being done for foreign trade during the after-war period. Our shipping problems have not been solved. Factors that should mean stability in our industry and commerce are being disregarded.

How can these things be explained except from the viewpoint that we lack the necessary intellectual forces to take full advantage of our material resources and the physical forces behind our great industries? In other words, the belief is being driven home that we lack thinkers.

Any young man who accepts this as a truth should receive a tremendous stimulus toward working for advancement. If there is a lack of thinking men, there is open a rich field into which one may enter if he is qualified.

✽

Bargains in Shells

If anyone believes that all of the shells that are made for the Allies and rejected in inspection find their way immediately into the scrap heap, such a one has "another guess coming." There are bargains in shells as well as in most other things.

The interesting fact is that some of the smaller nations of the world are increasing their supplies of ammunition by buying up rejects or seconds. After these shells have been turned down by the rigid inspection of the belligerents, inspectors of some of these bargain-hunting nations come along, look the lot over and accept what they can use. Of course, they get these shells for a price that is pretty close to their junk value.

Just how the purchasers obtain the necessary guns in order to use such shells is not so easily guessed at. But the fact remains that many of the shells that, for one reason or another, are not considered good enough to go into the battles now being fought in Europe are nevertheless going into the storehouses of some of the nations that are not now at war. Each one has the privilege of deciding for himself whether this is merely an act of thrift, a yielding to the temptation to pick up a bargain, a careful estimate of quality and value without regard to formal and perhaps too rigorous inspection, or astute preparedness.

✽

Ambrose Swasey has specified the nine essential qualifications of a machine-shop foreman as: (1) Good character and habits. (2) Ambition to succeed through meritorious work. (3) Adaptability to chosen occupation. (4) Studiousness and industry. (5) Tidiness in personal appearance and surroundings. (6) Faculty for reading and handling men. (7) Knowledge and experience in modern machine-shop practice. (8) Judgment as to amount and quality of work done. (9) Resourcefulness in new and improved methods.

✽

Healthy workmen do best work and earn most wages.—*The Spirit of Caution.*

Making Typewriter Platens

BY FRANK A. STANLEY

The rubber platen roll on the Noiseless typewriter is used solely for feeding the paper and not as a printing platen, the paper passing instead over a flat steel bar at the point of printing immediately in front of the rubber cylinder. In appearance this rubber platen resembles the usual typewriter platen.

Several lengths of platens are seen in the accompanying illustration. The regular roll is 9 in. long, although for wider machines it is made 12, 14 and up to 18 in. in length. The roll is of the same diameter in all cases—1.59 in.

These platens are built up with a piece of seamless drawn-steel tubing, threaded at each end and having shallow heads screwed in. The heads are provided with hard and ground-steel spindles to carry the platen. A rubber tube is then drawn over the steel core preparatory to grinding down to diameter. Before the rubber tube is

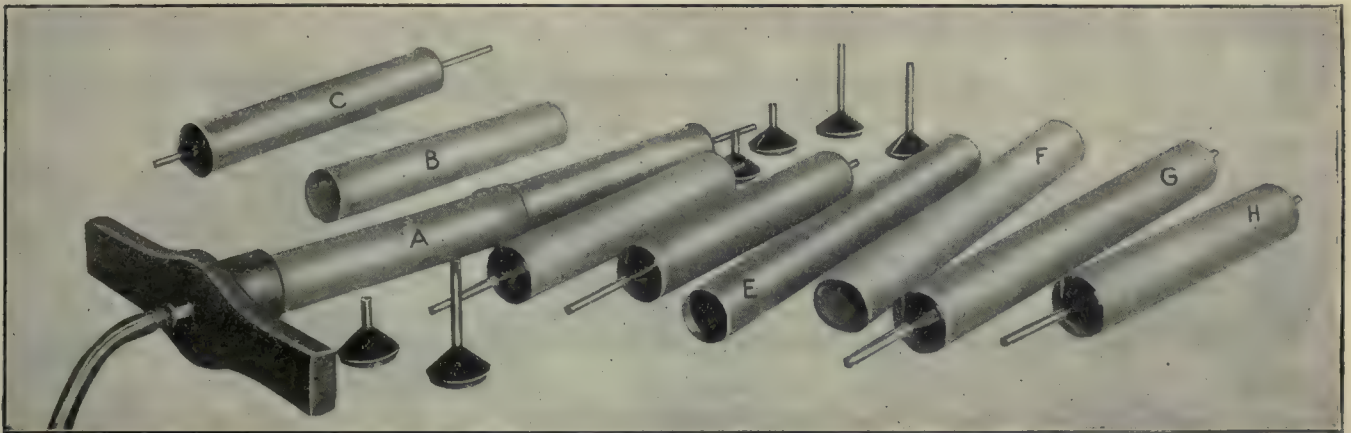
ature, for the period in which the work remains subjected to the steam heat, the shellac flows sufficiently to adhere to the entire inner surface of the rubber. After about 2 hr. of drying in the atmosphere the rubber sticks firmly to the steel core.

GRINDING STEEL AND RUBBER

The steel spindles in the platen head are finished and ground to correct diameter and parallel, after which they are screwed into the steel core and pinned securely against possibility of turning out of their places. After grinding, they are mounted upon their own centers, and both of them are thus brought to the required size and in true alignment with each other.

The outside of the rubber rolls are also ground to size—that is, to 1.59 in.—with the platen mounted upon the spindle centers, the abrasive wheel being Alundum 60-K. The work is rotated at a speed of 400 r.p.m.

Before grinding, the roll is $\frac{1}{8}$ in. oversize and it is roughed down to within 0.01 in. at one pass of the wheel.



TYPEWRITER PLATEN PARTS MADE OF SEAMLESS DRAWN TUBING

put in place shellac is put on the steel tubing and allowed to dry for 5 hr.

The rubber is $\frac{3}{8}$ in. thick and has an internal diameter of $1\frac{3}{8}$ in. When drawn over the steel core it expands to 1.64 in. in diameter. The steel tubing has a diameter of 1.46 in. The rubber is extended sufficiently to allow it to be drawn over the projecting head of one end of the steel tube and over the body of the tube by forcing the end of the rubber over the head and then pumping it up with an air pump applied as shown at A in the illustration, where the end of the rubber is shown slipped into a fixture with an air-pipe connection at the back. The illustration also shows one of the lengths of rubber tubing at B, while the steel cylinder with its heads will be seen at C. The blank cylinder before the heads are in place will be seen at E, and the length of rubber tubing at F.

After the rubber cover has been drawn into position the platen is steamed in an oven for 1 hr. to heat the shellac sufficiently to allow it to keep the rubber firmly in place. The work is then removed from the steam oven for 2 hr., to allow the shellac to set fully, preliminary to grinding the outside of the platen. This steam oven is part of the equipment of the plating department, and is equipped with coils of small pipes through which live steam is passed at a temperature of 180 deg. F. At this temper-

The wheel used is $\frac{3}{4}$ in. face, recessed at the middle of the width so that a cutting surface is left at each side $\frac{3}{8}$ in. wide. This breaks what would otherwise be a broad surface of contact and allows the wheel to cut very freely in reducing the rubber surface nearly $\frac{1}{8}$ in. in the single pass across.

The finishing operation—that is, the grinding down of the 0.01 in. left in the roughing process—is accomplished in another grinder with a wheel of the same type and grade.

Two rolls of different lengths finished to size are shown in the photograph at G and H, the latter a standard platen 9 in. long. These rolls as finished by the grinding process come out true to size and perfectly straight from end to end. It would appear that in removing so much material in the roughing operation there would be a tendency for the soft surface to creep ahead of the wheel, producing irregularity in diameter and tending to throw the work out of round. However, it has been found that with the wheel face cleared as noted, and with the coarse feed used in roughing, a free cutting action is maintained. In the finishing process where only a few thousandths of an inch are removed from the diameter, the material is brought to size and kept parallel to practically the same degree of accuracy as obtains in the grinding of metal surfaces.

Shop Equipment News

Belt-Tension Machine

The illustration shows a belt-tension machine built by the Tabor Manufacturing Co., Philadelphia, Penn.

This machine has three cast-iron legs, carrying an H-beam, forming a runway for a carriage supporting a movable drum (or pulley), fitted with roller bearings to render it practically frictionless. At the head of the H-beam is a fixed weighing head. The H-beam is graduated to indicate distances of one foot in the length of a belt, and the carriage is fitted with a scale graduated in inches and fractions of an inch. When it is desired to apply tension to a belt, the carriage is set by means of the graduation on the H-beam and the scale on the carriage to the exact length of the belt in question, and then clamped to the H-beam by means of a handwheel and a ratchet.

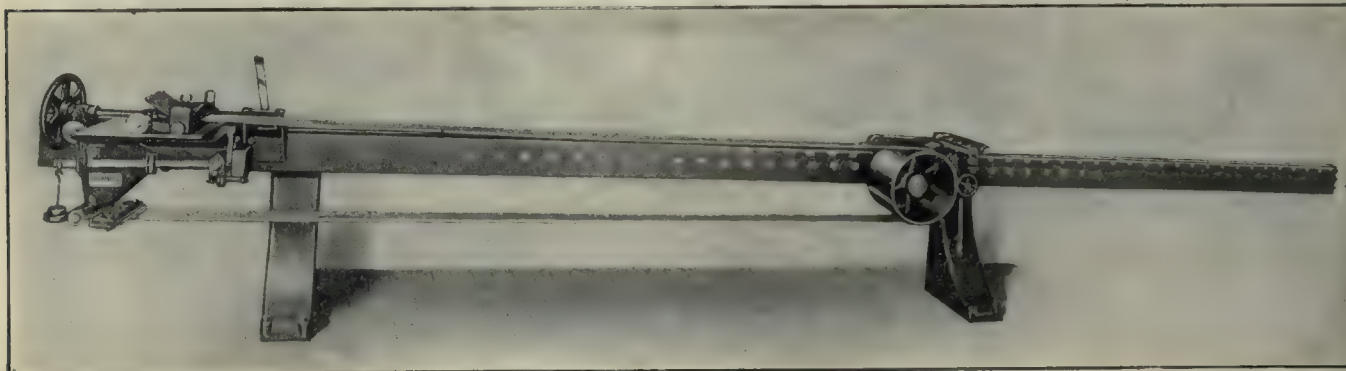
When a new belt is to be fitted over a pair of pulleys or an old belt repaired, the carriage is set to the length

drawn up to maximum tension and the overlapping end marked with the straight-edge for cutting. In cutting off the excess, care must be taken to cut it absolutely square.

The operator then releases the clamps, removes the belt and inspects it to see that the laps are all right, makes any minor repairs that appear to be necessary and laces in the belt-lacing machine the end of the belt that has been cut off.

Drills with Inserted High-Speed Steel Tips

Following along the lines suggested by the use of inserted high-speed steel blades in reamers, boring bars, milling cutters and other tools, the Campbell Mfg. Co., 3715 Wentworth Ave., Chicago, has brought out a series of drills with inserted high-speed steel tips. A feature of this type of drill is that the tips are easily inserted or



BELT-TENSION MACHINE WITH GRADUATED BEAMS AND SCALE

of the belt. The belt clamp on the weighing-head table is drawn toward the carriage by means of the handwheel and screw. The belt is fastened in the lower, or fixed, clamp attached to the weighing head by means of a raw-hide pin, then passed around the carriage drum and the end fastened in the upper, or movable, clamp on the weighing-head table. The screws on each side of the clamps are set and drawn down to distribute the pressure uniformly over the whole width of the belt. In putting a belt on the drum and in the clamps care must be taken to see that the belt occupies the same position sidewise, a series of parallel lines being scribed on the periphery of the drum for this purpose.

The belt-tension scales consist of a handwheel connected to a screw and nut in the first lever of the scales. By this means the clamp is drawn up, and the tension in the belt is transferred to the scales. The scale beam, now registering the tension required, is locked by means of an eccentric over the beam end. The belt is then agitated to equalize the tension on the two strands and also overcome any difference due to friction in the bearings of the drum and scales. The tension is read; and if it is found to have fallen to or near the minimum required, the belt is

removed and seven different sizes of tips are regularly furnished with one size of shank. Either straight or fluted shanks may be used, as the work may warrant. The tips are about 2 in. in length, forged to shape, and may be made

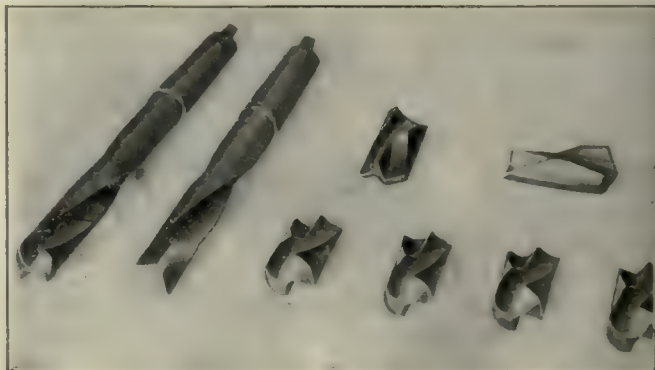


FIG. 1. DRILLS WITH HIGH-SPEED STEEL TIPS

considerably harder than usual with drills made of one piece. It is so joined to the shank that the strain of drilling into metal has a tendency to lock the parts together. The tip being harder, it requires fewer sharpen-

ings and is less likely to break. The entire drill can also be kept close to the same length, as other tips may be inserted at any time. The smallness of the amount of high-speed steel in the tips makes them comparatively cheap.

One of the fluted shanks with tip in place is shown at the left in Fig. 1. Next to this is a shank without the



FIG. 2. DETAILS OF SHANK AND TIP

tip. At the right are several forged high-speed steel tips ready to be placed in the milled forks of the shank. The method of attaching the tips and the details of construction are shown in Fig. 2.

Helical-Drive Engine Lathes

The lathe shown is made by the Phoenix Manufacturing Co., Eau Claire, Wis. The head is cast solid with the bed, and the entire construction is heavy enough and sufficiently well designed to give a rigid and powerful

The lathe is made in two standard sizes, 21 and 28 in., with 10-ft. bed. The latter size is also made with a hexagon turret on the cross-slide, and another form

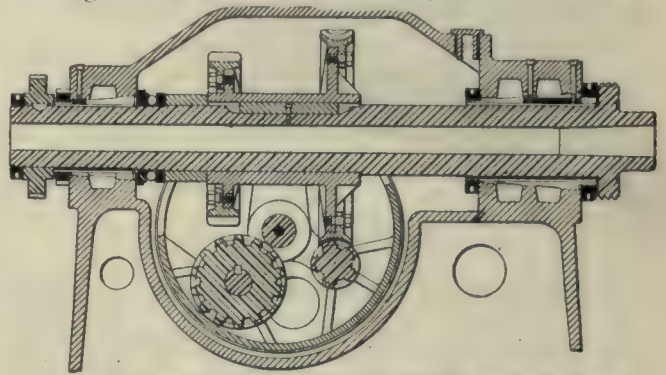


FIG. 2. DETAILS OF PART OF HEAD MECHANISM

has a special tailstock for bar-operating mechanism and 14-ft. bed for projectile work. Some of the mechanical features of the larger size, such as the apron mechanism, differ from those on the smaller, but in general they resemble each other. Motor drive for either alternating current or direct current* can be furnished on all machines.

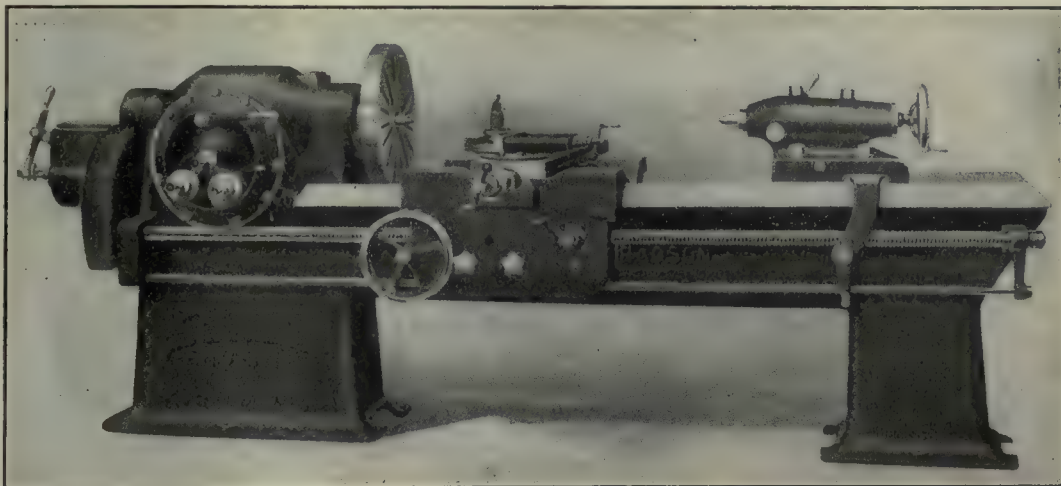


FIG. 1. HELICAL-DRIVE ENGINE LATHES

Specifications: Swing over shears, 21½ in.; swing over carriage bridge, 14 in.; between centers, 10-ft. bed, 5 ft. 1 in.; tail-spindle diameter, 2½ in.; front-spindle bearing, 4½x7½ in.; rear-spindle bearing, 3¾x4¾ in.; hole through spindle, 2½ in.; diameter of driving pulley, 14 in.; width of driving belt, 4 in.; driving pulley, 400 r.p.m.; feeds, 0.005 to 0.200 in.; number of spindle speeds, 12; spindle speeds r.p.m., 10 to 208; net weight of lathe with 10-ft. bed and pulley drive, about 5,750 lb.; additional weight per each 2 ft. of bed, about 500 lb.

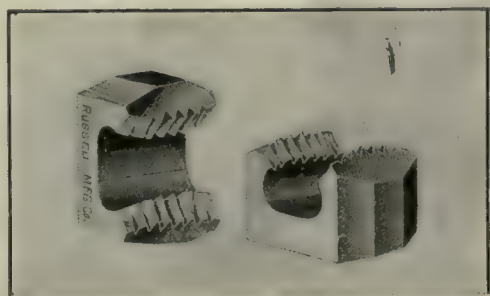
machine. The spindle drive is through duplex worms and worm gears of widely varying ratio, partly shown in Fig. 2. Sliding gears of chrome-nickel heat-treated steel are used for obtaining the required range of speeds. All shifting knobs or levers are within easy reach of the operator. Ample thrust bearings are provided, the whole mechanism runs in oil, and the spindle is driven with great smoothness. The bearings are of the conical split-sleeve type fitted in the solid metal of the headstock. The ways are of new form, providing large bearing area and also assuring accurate lateral guiding, as the angle is only 15 deg.

The carriage is especially rigid, the dovetail being inverted, which makes the bridge very stiff. The tailstock is also heavy, made with the usual shift-over device, and has crank attachment for movement along the bed. The feed box gives four changes of speed and is also made to reverse. Metric screws are furnished on order at the same price as the standard.

Double Reversible Die

In the illustration is shown the latest improvement offered by the Russell Manufacturing Co., Greenfield, Mass., in connection with its line of screw plates.

The dies are made to cut from both faces. This feature makes it possible to cut a thread on very short pieces or



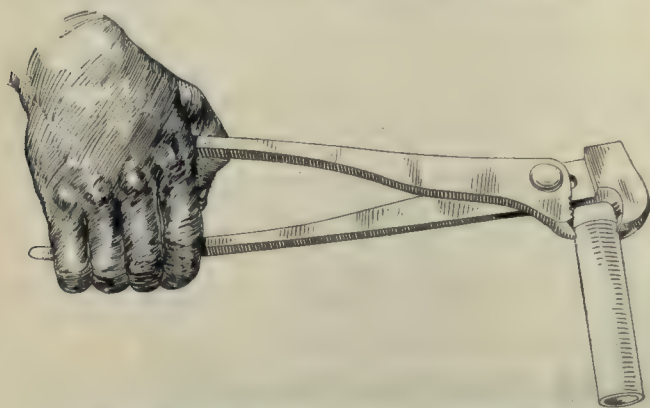
DOUBLE REVERSIBLE DIE FOR SCREW PLATES

close up to the shoulder, which would otherwise be impracticable where the work has to be fed through a die guide. The same die is therefore available for either hand or machine work without turning the die over.

In addition to the double feature the dies are made reversible, so that they may be turned over in their holders in order to present to the work either the front or the back face of the die. This reversibility is designed to double the life of the die, inasmuch as when one set of cutting edges become worn the die is simply turned over to bring the other set into action.

Wrench for Odd-Shaped Work

The "Eagle-Claw" wrench shown in the accompanying sketch is being made by the Mechancial Specialties Co., Peoples Gas Building, Chicago, as a general-utility tool for holding pieces of any regular or odd shape. The



"EAGLE-CLAW" TURTLE-MOUTH WRENCH

Three sizes, 7-, 10- and 13-in.; capacities: 0 to 1 in., 0 to 1 1/4 in. and 0 to 1 1/2 in. respectively

wrench consists of two pieces and a bolt and nut. The under jaw has a single prong and the upper jaw two prongs in addition to gas-pipe grips, which hold for turning both ways. For getting into difficult places one model is made with jaws at 45 deg. to the handles.

Endless Fabric Belts

The Victor Endless Belt Co., Camden, N. J., has developed an oilproof and waterproof endless fabric belt. These belts are intended for high-speed short drives. It is claimed that they are stronger than leather belts of similar width and thickness.

Fuel-Gas Plant

The Tirrill Gas Machine Lighting Co., Park Ave., New York City, has developed and placed on the market a plant for the production of fuel gas from gasoline. The plant is almost self-operating, is built in a large number of sizes and is claimed to be safe.

Engineering Students Number Over Thirty Thousand

The appended tabulated figures on students in the engineering schools of the United States were presented at the recent annual meeting of the Society for the Promotion of Engineering Education, through the coöperation of the United States Bureau of Education and the

society's Committee on Statistics. A variety of interesting comparisons are possible, such as the great increase

Engineering Branch	1906	1911	1915
General	2,501	5,591	6,059
Chemical	1,234	1,452	2,383
Civil	7,962	8,934	7,182
Electrical	5,696	6,128	6,637
Mechanical	7,426	7,052	7,751
Mining	2,826	2,337	1,922
Other	82	....	958
Total	27,727	31,499	32,843

in chemical engineers, the decrease in civil and mining, and the slump and recovery in number of mechanical engineers.

Machine-Tool Shipments from Port of New York

	During June, 1916	During Six Months Ending with June, 1916
Argentina	2,932	53,552
Australia	78,749	357,552
Australia and Tasmania		213,891
Barbados		281
Bermuda		120
Bolivia		10,253
Brazil	878	7,479
British East Africa	285	413
British South Africa	14,277	33,811
British West Africa		3,894
British Honduras		
British East Indies, other		4,990
British West Indies, other	36	40
British India	8,770	34,128
British Guiana		240
Canada		
Chile	4,599	36,330
China	1,352	9,293
Colombia	493	3,624
Costa Rica	33	2,285
Cuba	18,593	76,038
Danish West Indies	30	39
Denmark	5,061	51,247
Dutch East Indies	4,304	7,073
Dutch West Indies	2,332	5,034
Dutch Guiana		
Ecuador	195	2,331
Egypt		178
England	1,762,619	9,784,151
Finland	3,058	16,939
France	2,181,683	8,709,792
French Azores		
French China		
French Oceania		3,061
French West Indies		
Gibraltar		1,015
Guatemala	3,244	3,915
Greece	836	8,277
Haiti	21	782
Honduras	9	1,018
Hongkong	201	248
Ireland		552
Italy	793,101	3,735,374
Jamaica		12
Japan	5,694	145,935
Liberia	10	10
Mexico	3,712	88,313
Newfoundland and Labrador	800	4,149
Netherlands	26,194	150,061
New Zealand	2,130	50,874
Nicaragua		58
Norway	17,976	152,856
Panama	3,084	46,994
Peru	349	28,323
Philippine Islands	2,933	3,931
Portugal	267	14,651
Portuguese Africa	226	1,623
Russia in Asia	24,376	80,037
Russia in Europe	876,457	4,937,420
Salvador	27	1,235
Santa Domingo	1,453	3,550
Scotland	26,589	277,506
Spain	211,743	638,525
Straits Settlements	955	2,808
Sweden	25,179	83,618
Switzerland	1,376	13,428
Trinidad and Tobago	1,304	1,846
Uruguay	118	2,247
Venezuela	994	4,993
Total	6,121,637	29,915,787

Industrial Patriotism is most significant when it shows a mutual spirit in employer and employee. An example of this kind of patriotism may be found among the working forces of the main plant of the General Electric Co. at Schenectady, N. Y. It is here that more than 20,000 employees of the giant electrical manufacturing plant have contributed freely from their pay envelopes to buy an American flag for nearly every workshop and office building on the company's property.

Tool Manufacture at the Smith Premier Typewriter Works

By E. A. SUVERKROP

SYNOPSIS—The system employed for the production of tools in the toolroom of the Smith Premier Typewriter Works, Syracuse, N. Y., is based upon the same principles as that under which they manufacture typewriters. In other words, the toolroom is a manufacturing establishment and as such is divided into various departments, where everything is done in accordance with a system of control.

While nominally there are turning, grinding, planing and other departments in the Smith Premier toolroom, the lathes, grinders, planers, etc., are not arranged each

mentioned in passing, for I have no desire even if I were able, to go into a thorough explanation of the system. It is sufficient to say that the system is highly spoken of by those who use it.

The toolroom foreman and his assistant do not fulfill the usual duties of these positions, but act more as instructors. In fact, the assistant toolroom foreman is officially known as the "Toolroom Instructor."

One feature of great value to the industry at large is the method of operating the toolroom help at these works. In the so-called uptodate toolroom, the men are usually kept on one class of work—the lathe, miller, etc. At the Smith Premier works the men are shifted around from one machine to another, and as they become expert are

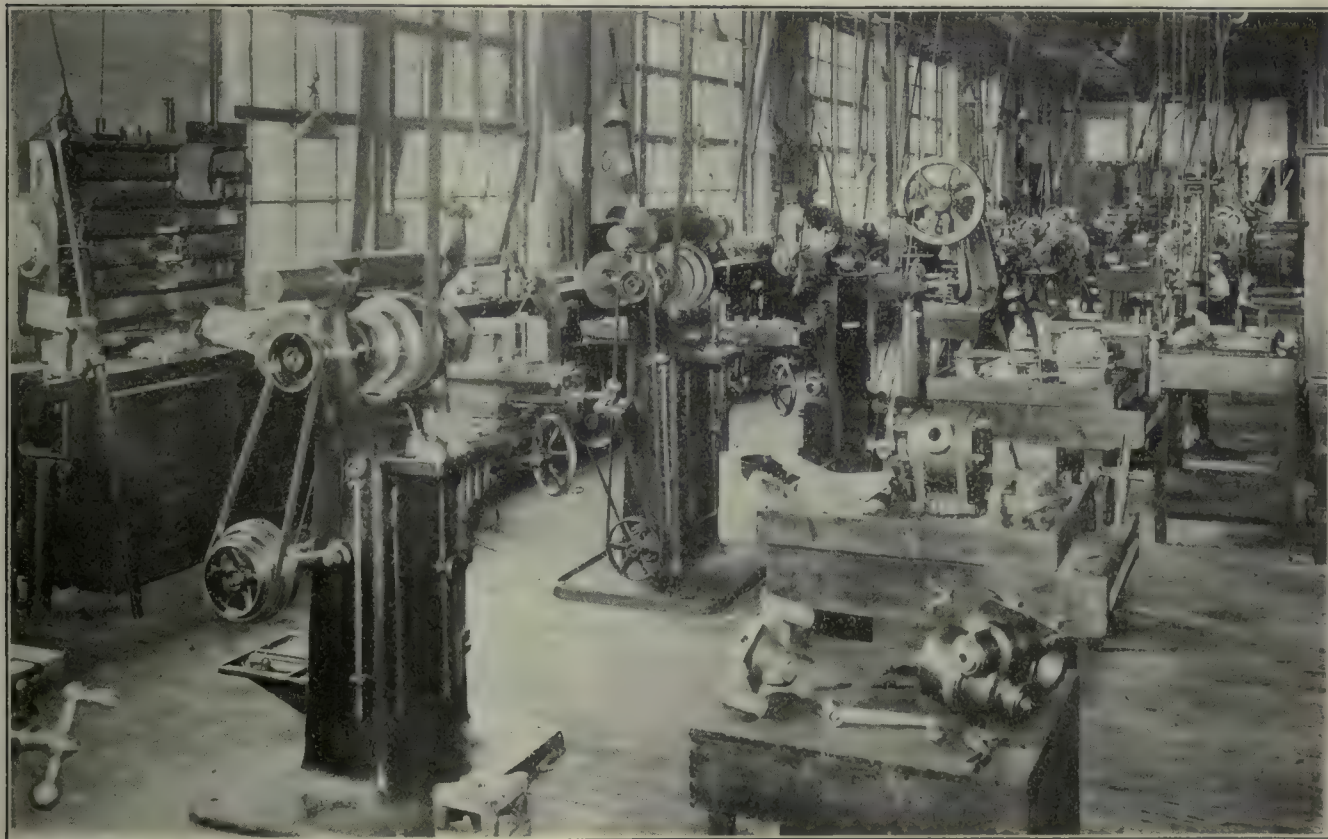


FIG. 1. GENERAL VIEW OF PART OF THE TOOLROOM

in separate departments, but in the most advantageous positions throughout the room.

The various types of tools in these nominal departments are divided into groups, also only nominally. For instance, universal millers, vertical millers, plain millers; chucking lathes, engine lathes, bench lathes and so forth. The divisions and subdivisions are necessary to facilitate the apportioning of work. The various departments, tools, product and so forth are symbolized in conformity with the efficiency system in use at the works. It may be mentioned here that every department, every tool, large and small, and each and every one of the nearly 10,000 items manufactured by the toolroom for use in the works is marked with and known by a symbol. This is merely

given more and more accurate work to perform—in short, they undergo a higher apprenticeship, and tool makers who graduate from this shop are apt to be highly skilled all-around men.

Besides grading the machines, the work they are capable of producing is also graded as to quality and these grades are also symbolized in conformity with the system. The tool makers, be they bench or machine hands, are also graded according to the quality of work with which they may be entrusted.

When a department requires a new tool or the replacement of one, the proper requisition is made out and forwarded with sketches and all necessary information to the engineering department. In the case of a new job,

or one which is somewhat complicated or unusual, those responsible for making and using the tool consult with a view to producing the best or simplest tool for the purpose. Having received the O. K. of the engineering department, the requisition and information are brought to the attention of the superintendent for his approval. His indorsement obtained, the manufacturing office makes out the necessary order and cost sheet. The engineering department then makes the necessary drawings and blueprints which go to the layout man.

The layout man is assistant to the toolroom superintendent. Both of these men are expert tool makers. The

the special job the machine must again be set up for standard work. This is a very sensible arrangement. No one is better qualified to dismantle a special rig than the man who constructs it, and it is always more or less annoying to take a job to a machine only to find it cluttered up with some special rig which must be dismantled before the machine can be used for the work in hand.

Each tool maker is to a certain extent an inspector not only of the operations which have preceded his own, but of the work which he has done; therefore, having completed an operation, he is required to inspect it with the same care and thoroughness that he would exercise in the



FIG. 2. TOOLROOM CLERK'S OFFICE

duty of the layout man is to determine how the piece shall be made. That is to say, the operations, the order in which they shall be performed, the kind and quality of the work, the estimated time necessary for each operation, the date when the job will be begun and the date when it will be finished are all plainly set forth on a form for this purpose.

Each job as it enters the toolroom is given a place according to the starting date marked on the form which goes with it, the classification of the initial operation as turning, planing, drilling and so forth, and also the quality grade of the work to be done on the piece in this, the first operation.

As each tool maker finishes the work he has in hand he returns it to the toolroom clerk who gives him the job which is at the outgoing end of the shelf devoted to the kind (lathe, shaper, miller, etc.) and quality of work he is competent to handle.

The machines in each group are set up and kept set up for the standard class of work. If, however, it becomes necessary to set them up for special work requiring a set-up different from the standard, then on completion of

inspection of work done by another. Should he discover faults in his work or should the work be spoiled by him he reports to the toolroom foreman. In some shops known to the writer, when a man has spoiled a job he does not wait to report but quits to avoid being fired. At the Smith Premier shops there is no fear of being fired for spoiling a job. The probability of having an occasional job spoiled is recognized and allowed for by the system. Of course, should a man habitually spoil work he would thereby prove his unfitness for that kind of work. Having inspected the work and found it satisfactory the job is returned to the toolroom clerk. The work undergoes a thorough inspection after its receipt by the toolroom clerk. Having passed this, it is placed at the rear of the line of work on the shelf devoted to the class of work called for in the next operation. It would seem by the foregoing that once started the work must go on from operation to operation to completion always taking its place at the rear of the line of jobs as it passes from one class of work to another. While this is in the main true, ample provision has been made for emergency or rush jobs. They take precedence over all others and

when, after an operation, they are returned to the toolroom clerk they are placed at the head of the line of jobs waiting for the next operation.

Of course, this procedure with rush jobs breaks the schedule of regular work and delays it. The office is however kept informed by the toolroom clerk, of the daily progress of the jobs in hand. All this is tabulated on forms supplied for the purpose and the probable date of

delivery of a job can be seen at a glance without the necessity of consulting the toolroom foreman, which is the method followed in so many shops and which is unsatisfactory in its results besides bothering an already too busy man.

In Fig. 1 is shown a part of the toolroom. This particular part of the toolroom was taken because the lighting at the time was favorable for photographing. One

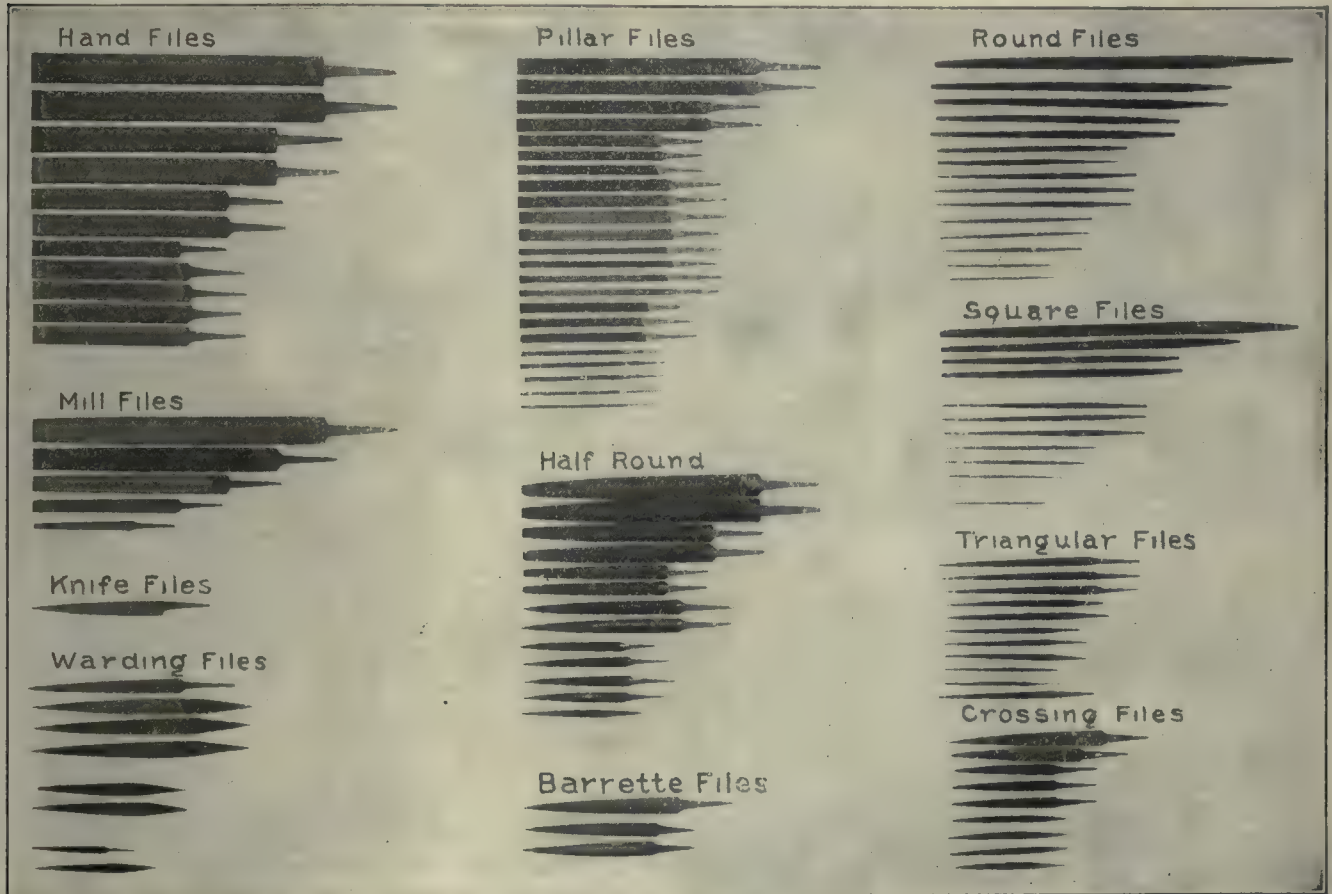


FIG. 3. STANDARD FILE BOARD

STANDARDIZED FILES USED IN SMITH PREMIER TOOLROOM

SQUARE FILES			HALF-ROUND FILES			HAND FILES			BARRETTE FILES		
Make	Size, In.	Cut	Make	Size, In.	Cut	Make	Size, In.	Cut	Make	Size, In.	Cut
Barnett.....	12	1	Barnett.....	10	1	Barnett.....	12	1	Grobet.....	6	2
	10	1		10	2		12	2		5	0
	8	1		8	1		10	1		5	4
Grobet.....	8	2		8	2		10	2			
	6	0		6	1		8	1			
	6	2		6	2		8	2			
	6	4		6	2		6	1			
	4	0	Grobet.....	6	2	Grobet.....	6	0			
	4	4		6	4		6	2	Barnett.....	10	1
	3	0		4	0		6	2		10	2
	3	2		4	2		6	4		8	1
	3	4		4	4		6	6		8	2
				4	6					6	1
				3	0					6	1
				3	4						Smooth
CROSSING FILES			ROUND FILES			MILL FILES			PILLAR FILES		
Make	Size, In.	Cut	Make	Size, In.	Cut	Make	Size, In.	Cut	Make	Size, In.	Cut
Grobet.....	6	2				Barnett.....	12	1			
	5	4					10	1		6	2
	4	0					8	1	Grobet.....	1/2x6	0
	4	2					6	1		1/2x6	2
	4	4					4	1		1/2x6	4
	3	0								1/2x6	6
	3	2								1/2x6	0
	3	4								1/2x6	2
	3	6								1/2x6	4
										1/2x6	6
TRIANGULAR FILES			KNIFE FILES			WARDING FILES			PILLAR FILES		
Make	Size, In.	Cut	Make	Size, In.	Cut	Make	Size, In.	Cut	Make	Size, In.	Cut
Grobet.....	6	0	Barnett.....	12	1	Grobet.....	5	0		1/2x6	0
	6	2		10	1					1/2x6	2
	6	4		10	2					1/2x6	4
	5	1		8	1					1/2x6	6
	5	2		8	2					1/2x6	0
	4 1/2	1		6	1					1/2x6	2
	4	0		6	2					1/2x6	4
	4	2		6	0					1/2x6	6
	4	4	Grobet.....	6	2					1/2x6	0
	4	2		6	0					1/2x5	2
	4	4		6	2					1/2x5	4
	3	2		6	4					1/2x4	0
	3	4		4	0					1/2x4	2
				4	2					1/2x4	4
				4	4					1/2x4	2
				3	2	Barnett.....	3	1		1/2x4	4
				3	4	Grobet.....	3	2		1/2x4	2
							3	4		1/2x4	4

familiar with machinery will be able to pick out lathes, millers, a drilling machine, a punch press, shapers and a planer, which bears out the statement that no special departmental arrangement of the tools has been made.

In Fig. 2 is shown a part of the toolroom clerk's office. This is the toolroom clearing house. The shelves *A* against the wall are occupied by bench work of the various classes. At *B* is work ready for assembly. At this point

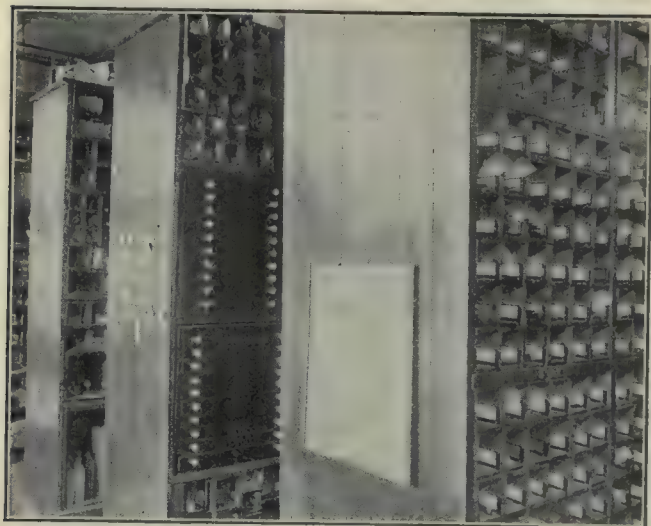


FIG. 4. SHELVES IN THE STOCKROOM



FIG. 5. DRAWER FROM A STOCK CABINET

it may not be out of place to mention the extremely sensible method of marking tools. A tool carries the same number as the part it is to produce. For instance, a punch and die are required to produce typewriter part No. 1,000. The punch and die will also bear the number, 1,000. If a tool consists of two or more principal parts—as for instance in this case, two, the punch holder and the die holder—then one of these is lettered *A* and the other *B*. Should there be one or more parts which are fastened to either or each of these members then these also are lettered *A* or *B* according to the part (punch or die) to which they are fastened and are also numbered 1, 2, 3, 4, etc., according to the order in which they are assembled to the main components *A* and *B*. For instance, we have a punch and die for perforating four different sizes of holes in and blanking typewriter part No. 1,000. The punch holder would be marked 1,000 *A*, and the die holder

1,000 *B*. The blanking and piercing punches would be marked 1,000 *A1*; 1,000 *A2*, and so forth, in the order in which they are assembled to the main component of the punch assembly. The same method of marking would be followed with the die and its components, but these would be marked 1,000 *B1*, etc. This method of marking must be of considerable value if only as a time saver when tools go to the toolroom for repairs, for by following the numbering in reverse the components are removed one by one in their proper order. How many of us have begun to disassemble an intricate piece of work only to find that we started at the wrong place?

At *C* in Fig. 2 are the shelves for grinder work arranged in order of precedence, type of machine and grade or quality of workmanship required. On the left at *D* are the shelves for work for the various other machines, lathes, millers, shapers, etc., also arranged in order of precedence, type, grade, etc. On top of the shelves at *E* are pans of work on which one or more operations have been completed. These await inspection, after which they will be sent to the next operation in the manner previously described.

The company has selected certain files for toolroom use and these they have standardized. There are of course in this as in other factories special files which are used for special jobs. Outside the delivery window of the store-room is a file board, Fig. 3, on which are all the standard files. Each kind of file, as "hand," "mill," "knife," etc., is grouped by itself. Above each group is the name of the group and to the left of each group is the symbol for each file and its location in the stockroom. Thus when the tool maker fills in a file order by copying these symbols from the stock board he not only informs the storekeeper what file he wants but where it is.

Two makes only of files are represented in the standard file list—Barnett, the Philadelphia file maker, and Grobet, the Swiss. The standard list of files is shown in the table.

To the right on the file board is a typewritten instruction sheet which shows the tool maker how to make out in symbol his file orders. The system of storekeeping is both simple and efficient. It is not the purpose of this article to go deeply into it, but a few of the outstanding meritorious features will probably be of interest. One element of storekeeping which probably causes much trouble and annoyance is running out of stock; in other words, failing to make out an order to replenish stock before the amount on hand is dangerously low or perhaps exhausted. According to the demand for the thousands of articles stocked, so are the ordering points of the various items determined; and also the minimum quantities for which replenishing orders shall be made out.

For instance, the article may be a special tap, reamer or what not, used perhaps once for a few minutes only in a year or more. The ordering quantity for such a tool would probably be one, and the ordering point reached only on the destruction of the tool. On the other hand, tools and so forth which are used more frequently, and are more readily broken, worn or eliminated from stock by being used in the assembly of other tools, are ordered in larger quantities and the ordering point will of course vary in proportion. Various ways have been devised to have the ordering point assert itself and bring itself to the attention of the storekeeper. With items which are kept loose in bins the minimum stock (the ordering point) is kept separate in a bag or other container and only when

all the rest of the stock is consumed is this opened and the contents used. When this minimum stock is broached, the storeroom clerk issues an order for the article. In the meantime, the demands of the shop are supplied from the minimum stock. On receipt of the new stock, any of the remaining pieces of the minimum stock are used before any of the new stock is touched. The minimum stock container is then replenished from the new stock.

Where the parts are kept in drawers, each partition has a false bottom as shown in Fig. 5 at *A*. The minimum stock is kept beneath this false bottom, which is made of tin, and when this is reached the stock clerk makes out his order. While waiting for delivery of the new stock the reserve minimum under the false bottom supplies the demands of the works. When an order is made out a special card bearing the date of the order and other necessary data is placed in the partition as shown at *B*, in Fig. 5. This is removed when the stock is replenished.

A large variety of sizes and kinds of steel are used in the works. Each bar of tool steel is painted from end to end with a distinguishing stripe of color so that no matter how small a piece of a bar may be left the make and brand are at a glance apparent. Besides this stripe of paint the minimum stock or ordering point is also marked on the last bar or bars of steel. This reminder takes the form of red, white and blue bands close together around the bar at the ordering point. When this varicolored band is reached, the storekeeper issues an order for the particular brand and size required.

The minimum stocks of oil and similar supplies are kept in padlocked tanks. The keys are kept in the storeroom. When application is made for a key, the storekeeper knows that the ordering point of that particular commodity has been reached.

And so on throughout the list of stores. The method of storing the minimum stock is made to fit the particular commodity. Having been reached, the minimum stock reserve impresses the storekeeper with the necessity of ordering, fills the needs of the shop till the new stock arrives and is entirely used up before the new stock is touched.

❧

An Adjustable Follow Rest

By C. D. PARKHURST

Having quite a number of long slender rods and screws to get out on a lathe with a rise and fall tool carriage, for which the ordinary follower did not work well, the adjustable follow rest shown in the illustration was devised.

This consisted of an upright frame fitted at the bottom with a slideway to fit upon the crossfeed slide of the tool carriage. At the front is the crossbar *B*, Fig. 1, to hold the jaws of the slide from spreading open when the gib screws are set up to hold the rest firmly in place.

The vertical frame has a vertical slideway at the back, as shown, and a long oval hole is in the vertical part, centrally with the slideway.

The slides *S* and *H*, Fig. 2, are cast solid and machined to fit the slideway with a gib, and has the hub *H* to receive the screw *A*.

The barrel *C*, Fig. 1, screws with the slide *S*, Fig. 2, through the oval hole in the frame; the barrel *C* and hub *H* are in effect one continuous piece, bored out to receive the steel arbor *D*, Fig. 1. This arbor has a keyway in it on its underside, and is moved in or out by the screw *A*,

Fig. 2, exactly the same as the arbor in the tailstock of the lathe. This arbor *D* is fitted with a standard taper hole for taper plugs of whatever form may be needed to form the rest *R*, Fig. 1.

The handle *E*, Fig. 1, actuates the screw which moves the slide *S* and its attachment up or down in the oval hole in the frame, and is long enough to give all the motion needed.

The rest operates as follows: It is placed upon the ways of the tool carriage and clamped in place by securing the bar *B* and setting up on the gib screw, there being room enough at the bottom for the rest to pass over the rise and fall adjusting screw of the tool carriage when the latter is raised to its highest position.

With the rest and work in place, and the tool set to its proper height for its cut, the rest *R* can now be advanced

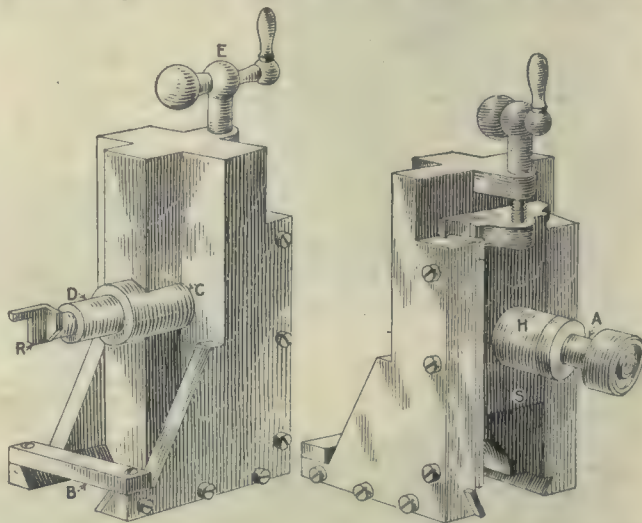


FIG. 1

FIG. 2

FOLLOW REST WITH RISE AND FALL ADJUSTMENT

and raised or lowered until it fits against the work, the rest *R* from the construction comes over the cutter of the tool-carriage slide, and the tool itself is set accordingly.

This rest has been found in practice to work admirably. Long, slender rods have been turned, and long slender screws have been cut that otherwise could not have been done. As the diameter of a long, slender rod is reduced it is evident that the rest can be quickly and accurately readjusted to fit this reduced diameter for any number of successive cuts, if these be necessary.

Again, if the tool has to be raised or lowered for any reason, the rest can be accurately and quickly adjusted to correspond, to hold the rod against the cut, and yet not spring it out of line.

❧

Wheels for Grinding Razors

Concerns that manufacture razors usually employ an 80 grade N or O alundum silicate wheel for the concaving operation, and cutlerers, who merely desire to repair or reconcave, use 80 grade I or J alundum vitrified on the same operation, according to *Grits and Grinds*.

This is usually followed by a leather-covered polishing wheel set-up with flour alundum grain or flour emery followed by a buffing wheel and rouge for the final finishing.

The blades are then honed on medium india oil-stones by hand, or in some cases by means of a medium india oil-stone grinding wheel revolving on a vertical spindle,

Machining Connecting-Rod and Piston for Aeroplane Engine

BY ROBERT MAWSON

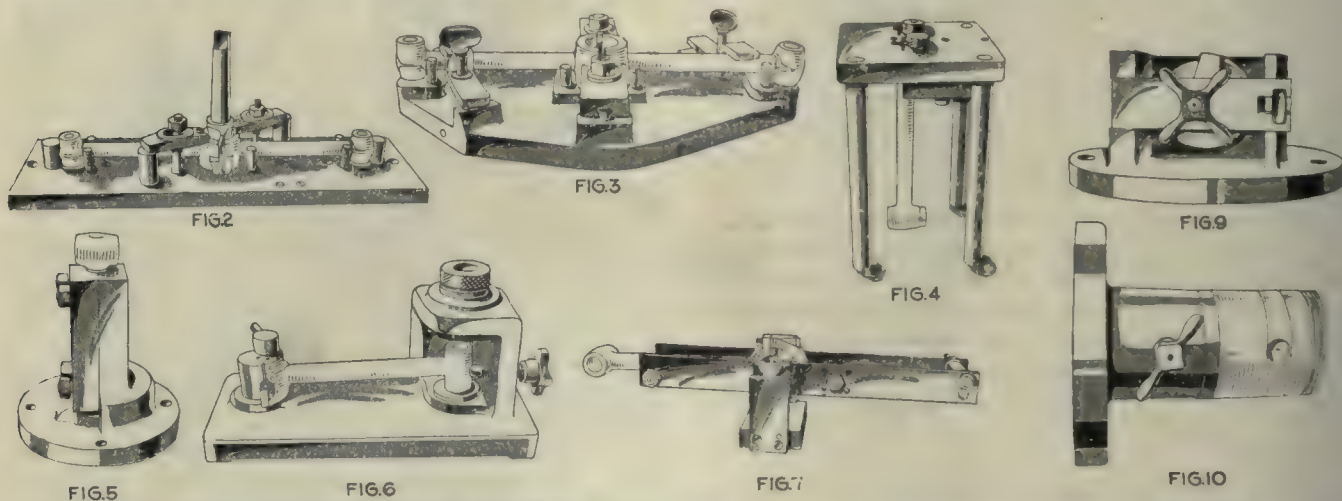
SYNOPSIS—The connecting-rod on this aeroplane engine is of the fork type. This is necessary, as the cylinders are opposed. The piston is of the conventional type, but fitted with only two rings. The boring fixtures used in machining the connecting-rod employ three pins inside of which the boss on the rod is located. A similar type of fixture is used in milling the connecting-rod. An interesting method of locating the piston for turning the outside is illustrated, for the fixture is provided with a crosspin that fits into the reamed wristpin hole.

On page 230 were shown some of the tools used by the Ashmussen Manufacturing Co., Providence, R. I., for machining the cylinder for an aeroplane engine. In this article are illustrated other tools for machining the connecting-rod and piston for the same engine. The fixture used in milling the connecting-rod employs pins that, coming against the edges of the bosses, locate the

forging. A similar arrangement locates the piece for boring the large hole in the rod. A box type of jig is used to drill the oil hole in the end of the rod, which is located by a turned recess. The jig that serves in drilling the bolt holes employs a turned semicircular plug as the locating medium.

This firm has developed an interesting way of testing the balance of the rods. The method used is to place a plug which fits into either the crank or wristpin hole according to the end being tested for balance. The plug is made with tool steel knife edges to reduce friction as much as possible. The rod is then placed as shown into the fixture and if the balance is correct the fixture will be in a horizontal position. If it is not so, metal is removed from the rod until a perfect balance is obtained.

The fixture for turning the outside of the piston employs a cross-shaped locating pin that fits into the previously reamed wristpin hole. Pressure applied to the knob-headed screw draws down the pin and holds the piston securely for the subsequent machining operation.



JIGS AND FIXTURES USED IN MACHINING CONNECTING-RODS AND PISTONS OF AEROPLANE ENGINES

FIGS. 2 AND 2-A

Operation—Boring large hole in connecting-rod, Fig. 1. The forgings are located by pins at the wristpin end and against other pins at the large end. Straps are tightened to hold the forgings down.

Hole Machined—One hole rough- and finish-bored 1.813 in.

FIGS. 3 AND 3-A

Operation—Milling connecting-rod bosses. The two forgings are located by pins that fit outside the rod at the small and large ends. Straps tightened down with thumb-screws hold the parts firmly.

Surfaces Machined—Bosses on rods.

FIGS. 4 AND 4-A

Operation—Drilling and reaming bolt holes in connecting-rod. The forging is located by a semicircular plug that fits into the bored hole at the crankshaft end. A strap holds the forging in position.

Holes Machined—Two $\frac{1}{8}$ -in. drilled and reamed.

FIGS. 5 AND 5-A

Operation—Drilling hole for lubricant in end of connecting-rod. The forging is located in the jig by the turned shank. After the part has been placed in position, four bolts hold the cover of the jig, thus securing the connecting-rod in position.

Hole Machined—One $\frac{1}{8}$ -in. drilled.

FIGS. 6 AND 6-A

Operation—Drilling and boring hole for wristpin in connecting-rod. The forging is located by a plug that fits into

the bored hole at the large end. The knob-headed setscrew shown forces the rod back into the jig.

Hole Machined—One $\frac{3}{16}$ -in. drilled, and reamed 1 in.

FIG. 7

The fixture used in balancing the finish-machined connecting-rods has a steel plug provided with knife-edges and placed in the hole. The rod is allowed to swing on the tool-steel block, as shown. If the rod be properly balanced, it will hang horizontally. For balancing the small end, a similar procedure is observed, a pin being fitted into the small end and the rod swung in the reversed manner.

FIGS. 9 AND 9-A

Operation—Boring wristpin hole in piston, Fig. 8. The casting is located on a turned plug and held down with a clamp after the fixture cover has been fastened down. The fixture is attached to the faceplate of the lathe with three bolts.

Holes Machined—Two $\frac{1}{8}$ -in. holes rough- and finish-bored.

FIGS. 10 AND 10-A

Operation—Machining outside surface of piston. The casting is located by a turned shoulder set inside the bored surface and held with a steel pin that fits into the bored wristpin hole. The knob-headed screw draws down the steel pin, thus forcing the piston onto the turned shoulder and holding the part.

Surfaces Machined—Outside turned to 3.75 in. diameter and base end faced.

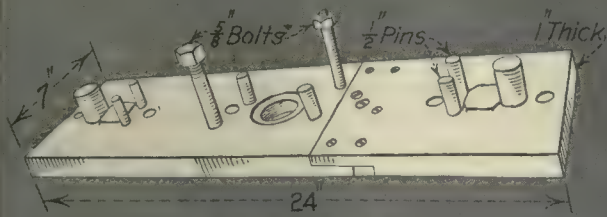


FIG 2-A

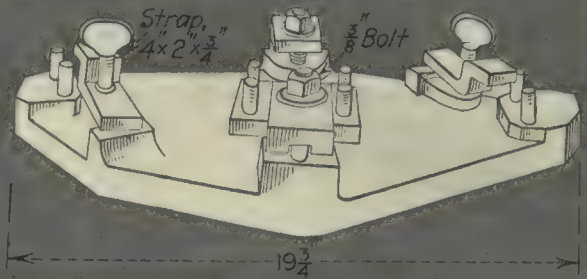
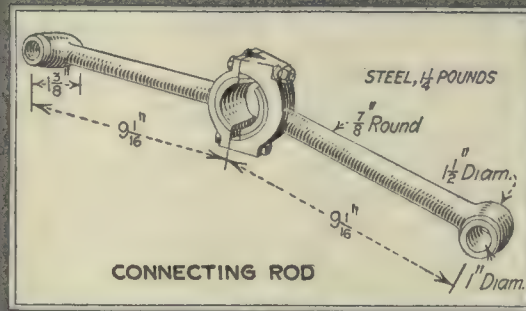


FIG 3-A



CONNECTING ROD

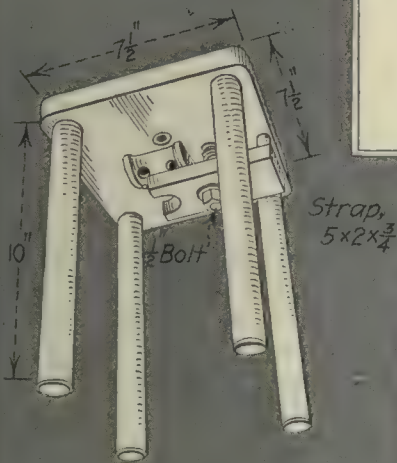


FIG 4-A

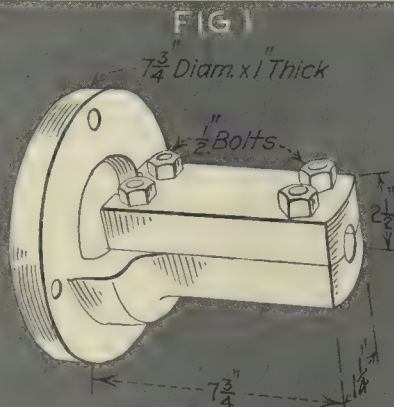


FIG 5-A

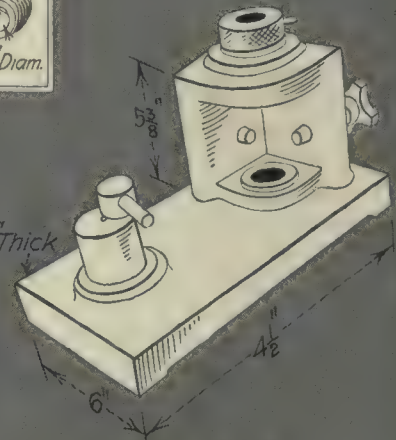


FIG 6-A

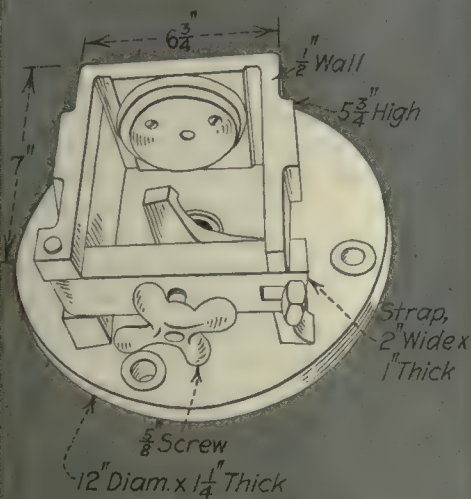


FIG 9-A



FIG 8

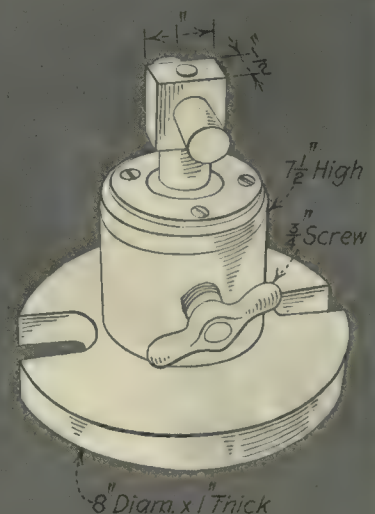


FIG 10-A

ALL BUSHINGS USED FOR GUIDING TOOLS ARE BLACKENED. ALL JIG AND FIXTURE BODIES ARE CAST IRON, STRAPS AND FASTENINGS, MACHINERY STEEL; GUIDE BUSHINGS ARE TOOL STEEL, HARDENED AND GROUND

Electric Ovens and Furnaces*

BY W. ROCKWOOD CONOVER†

The value of electric ovens and furnaces for the processes of baking enamel finishes, annealing and hardening cutting tools and tool steels and smelting foundry steels is becoming more generally recognized.

In the field of enameling processes the electrified oven of the metallic-resistor type has proved of marked advantage. Not only is the time required for baking the successive coats greatly reduced, thereby increasing productive output, but a noticeable improvement in the quality of the process itself is obtained, resulting in a brighter and smoother finish and in a more perfect degree of hardness than have previously been possible of attainment with the gas-heated ovens. This improvement in the quality of product is due in a large measure to the fact that in the electric-heated oven the material is acted upon by radiant heat instead of by convected heat, as is the case with the gas oven. In the gas oven, air currents are created by the increased amount of ventilation required, and these air currents are loaded to some extent with fine particles of dust that affect the polished surfaces of the baking enamel adversely and modify the smoothness and evenness of gloss so much desired in this class of product. In the electric oven the amount of ventilation required is comparatively little. The air currents carrying dust are almost wholly eliminated, and an even polished gloss on the surfaces of the material being treated is secured. The improved appearance of the enamel is due, also, in a large measure to the great uniformity of the radiated electric heat, while it is found that the enamel reaches the proper degree of hardness with equal uniformity during the process of cooling.

The gain in operating time and productive output of the electric enameling oven over the gas oven is a distinct advantage and establishes a new basis of cost on these processes. This increase in some cases has reached more than 60 per cent. and is estimated to average as much as 40 per cent. It is also to be mentioned that when an attempt is made to speed up production in the gas oven the quality of the process is interfered with and the enamel shows a tendency to shrivel on the surface of the metal. Notwithstanding the greater output secured in the electric oven, the quality of the product is not only maintained, but greatly improved through the radically different method of heat introduction and application.

COST OF ELECTRIC HEATING

The cost of heating the electric-operated oven is somewhat in excess of the cost of heating with gas fuel, but this difference in favor of the gas oven is more than compensated for in the greatly increased product and quality of finish obtained by the electric process.

The question of fire hazard must also be considered, and here the electric oven possesses superior advantages. The danger from explosions and leaks and the cost of constant inspection and repairs are practically eliminated. Electric ovens may be located in various parts of the factory in convenient proximity to the mechanical processes without increasing the fire hazard, while at the same time the labor of handling materials is greatly reduced.

The method of installation is simple, and old gas ovens may be equipped with electric-heating units with a relatively low expenditure when compared with the advantages to be gained through the change. The heating units may be placed on the floor along the sidewalls and in the center line, while the main bus conductors can be mounted on the walls near the ceiling. In this manner all of the electrical equipment can be so installed as not to interfere with space required for enameling processes or the free movement of the operator in handling the product.

With the improvements that have been made in the method of construction of enameling ovens in conjunction with the installation of electric equipment, still greater gains in productive output will doubtless be made possible within the next few years.

ELECTRIC ANNEALING AND FORGING FURNACES

Resistance annealing and hardening furnaces and resistance forging furnaces are destined to come into use increasingly in the large factory as their economic efficiency becomes better known. They are adapted to the processes of annealing and hardening of tools and to the treatment of high-speed steel and high-carbon steels for forging.

In outward appearance these furnaces resemble the usual type of gas or oil-fed furnace. They are constructed of iron framework and firebrick, the interior lining being composed of brick of high refractory properties. This interior construction is designed to withstand high temperatures for any period of time desired. The furnace equipment includes a control panel, main and auxiliary carbon electrodes and regulating transformer. A layer of several inches of foundry coke (reduced to the proper size) upon the refractory floor constitutes the main resistor. Special refractory material built into the arch roof of the furnace composes the auxiliary resistor. This auxiliary resistor develops the properties of conductivity when acted upon by the heat radiated from the main resistor.

High heating efficiency is secured through the method of construction. Current reaches the coke resistor through the carbon electrodes at each side of the furnace, which are located in chambers or pockets filled with pulverized carbon, and enters the coke mass on the refractory floor. A high resistance arc is prevented by the pulverized carbon, and the life of the electrodes becomes practically indefinite because of the absence of oxidation. Nearly all the heat is generated in the main and auxiliary resistors, the resistance to the passage of current through the carbon electrodes being negligible. The temperature of the coke resistor is raised but little higher than that of the heating chamber, which results in preserving the refractory lining of the furnace for long periods.

With this type of furnace a reducing, neutral or oxidizing atmosphere may be obtained, owing to the fact that the carbon resistor, at the proper operating temperature, eliminates the oxygen by combination—the furnace doors being closed and the ventilation controlled in accordance with the kind of atmosphere desired. The efficiency of control of the electric furnace is a factor that must be recognized as of great value. This control is practically automatic, maintaining a uniform temperature throughout the process and for an indefinite period.

*Prepared for the author's forthcoming book on "Industrial Economics." Copyright, 1916, Hill Publishing Co.
†Factory economist, General Electric Co.

This is accomplished by the arrangement of the controlling panel, which provides for throwing the furnace onto either of two voltages, depending on whether the temperature of the resistor is above or below that required in the chamber. The high- and low-voltage circuits are connected and disconnected automatically, thus alternating the heat load in such manner as to hold the temperature practically constant.

In the treatment of shop cutting tools, dies, high-speed steels, etc., uniform temperatures are specially desirable. The atmospheric conditions are more uniform in the electric furnace and the ventilation under better control; as a result the factor of oxidation is practically eliminated and the treatment is carried on without the material becoming coated with scale. With other types of furnace the operator must give more or less constant attention. Care must be taken in the introduction of atmosphere or drafts into the heating chamber, and there is always danger of overheating or of a reduction in temperature if the furnace is left at night or for any considerable period without supervision.

This type of carbon-resistance furnace is adapted to operation at voltages ranging from 110 to 550 volts. By adjusting the instruments on the controlling panel the maximum and minimum volume of current entering the resistor can be regulated at any limits desired, according to the working conditions. A wide range in operating temperatures, running from 550 deg. to 1,400 deg. C. (1,022 to 2,552 deg. F.), is secured by means of the flexibility of the system of control constituting a part of each equipment.

ELECTRIC SMELTING FURNACES

The commercial value of electric furnaces for the smelting of foundry metals appears to be established. Within the past decade they have been in successful operation in Europe and in some parts of Canada and the United States. Most of the developmental work of real value has been done during the past 10 or 15 years. Previous to that period little had been accomplished toward demonstrating their practical utility in constant operation, the efforts being chiefly of an experimental nature. In countries where there is a scarcity of coal and where abundant supplies of water power exist, their utility appears to be specially indicated, as there the cost of heat generated by electric energy in comparison with the cost of heat produced by other fuels would obviously favor their adoption, when due consideration is given to the important factor of efficiency.

In general, electric furnaces designed for the production of iron and steel and for the smelting of these metals are constructed of high-refractory materials such as fire-clay bricks, silica bricks, magnesia, etc. It is essential that the furnace materials contain as little as possible of fluxing properties, such as iron oxides, potassic oxides, etc., and that the interior lining of the chamber be sufficiently refractory to withstand the highest temperatures required in the processes of reduction or smelting without being affected by the metallic slag or charge. It is also important that all the heat possible be retained in the smelting chamber, and for this reason it is desirable that the outer wall of the furnace be constructed of heat-retaining materials having low conductivity properties. In the continuous electric smelting furnace, where the heat can be introduced into the center of a large charge,

the outer portions of the charge remaining cooler, the walls are better preserved and last for indefinite periods, and the exterior layer can be built of material having less refractory properties.

Heat is developed in electric smelting furnaces either by passing current through arc electrodes, using the heated gases of the arc as a resistor; by passing the current through the charge, the molten slag acting as conductor and heat being generated as the current passes through the molten mass; or by passing the current through a carbon resistor composed of retort carbon or coke. In either type of furnace the arrangement and dimensions of electrodes will be governed by the amount of electric current to be supplied, the temperature required in the smelting chamber, the conductivity of the material of which the electrode is composed and the character and construction of the furnace itself.

In the operation of electric furnaces the current supplied is usually alternating. By means of the transformer the high-voltage current is changed to one of greater volume and lower voltage or such voltage as is required to obtain the desired temperature in the smelting chamber.

EFFICIENCY OF ELECTRIC SMELTING FURNACES

The efficiency of the electric smelting furnace in comparison with furnaces using coal or coke as a fuel is worthy of consideration. In the electric furnace the greater portion of the heat generated is used in the process of smelting, while in the coal- or coke-fired furnace a large percentage of the heat often goes to waste. This loss is emphasized in the furnaces where the process requires very high degrees of temperature. The results obtained within the past several years indicate the efficiency of the electric furnace to be from two to thirty times that of the usual type of metallurgical furnace. The factor of efficiency may range as high as 60 to 85 per cent., while in foundry furnaces and cupolas it is generally much lower; and in openhearth steel furnaces it is sometimes as low as 20 to 30 per cent. The range of available temperatures has been materially increased, running from 1,800 deg. C. (3,270 deg. F.) to approximately 3,600 deg. C. (6,520 deg. F.), which was not possible in the fuel-fired type of furnace, while the elimination of air or injurious gases increases the efficiency and renders it adaptable to the production of certain metallic substances and products, such as zinc, phosphorus, graphite and carbon oxides and bisulphides.

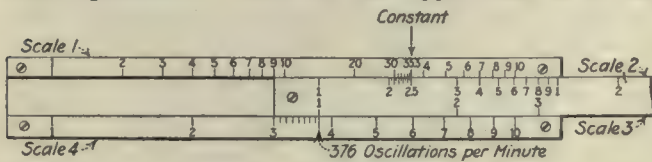
The cost of heat generated by electricity is in general in excess of that produced by either coal or coke, but in sections somewhat remote from the coal fields or in localities where transportation rates are high and where water power is abundant and relatively low in development cost the electric furnace presents distinct economic advantages when we consider its high rate of efficiency. Under certain conditions the cost of heat generated by electric energy may be somewhat less than double that of heat generated by the combustion of coal, and in other cases it may be approximately equal to heat produced by coke. The cost per electrical horsepower of electric energy, as well as the cost per ton of coal or coke, varies sufficiently in different localities to render any comparison of the two methods of heating in a given locality of only relative value. The economic advantages of the electric furnace in general seem apparent.

Free Oscillations of Springs

By N. W. AKIMOFF

It is not a hard task, in general, to calculate the free period of oscillation of a loaded spring, but I wish to submit a short-cut method whereby this can be done in one setting of the slide rule. I have never seen this method used or published, although it is not unlikely that it may have been used by the readers of the *American Machinist* long before this.

The method applies to any flat or coil spring, of which the deflection under its load is known, and is not inconsistent with the capacity of the spring as allowed by ordinary practice. The method can be explained in three operations: First, on the upper scale 1 of the



A SLIDE-RULE EXAMPLE

slide rule mark a new constant, 35.3. (See the illustration.) Second, divide this constant by the deflection. Third, extract the square root of the result, which will give the number of complete (double) oscillations per minute.

Note that, in dividing, scale 2 will not mean inches but tenths of one inch; also that the result on scale 4 will be in hundredths of revolutions. For instance, let the deflection of a certain spring under a certain load be $\frac{1}{4}$ in. What will be the rate of its natural vibration under that load? Under the constant 35.3 of the scale 1 set 2.5 (that is two and one-half tenths) of the scale 2. Under 1 of scale 3 will be found the answer, 376 complete oscillations per minute. In the same way the rate corresponding to the deflection of $\frac{1}{2}$ in. will be 266, and that due to the deflection of 1 in. will be 188 complete oscillations per minute.

These results will be found to be only roughly approximate, owing to certain imperfections of the spring itself. To begin with, it has a certain mass of its own; and then its unit elongation may or may not be constant, which would at once introduce an element of uncertainty in the differential equation governing the motion of such a spring.

How Would You Produce This Casting?

By M. E. DUGGAN

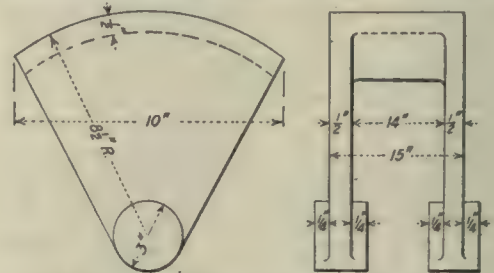
Frequently, articles appear in technical journals illustrating and describing the making and molding of difficult patterns such as gears, propellers or pipe bends—all of them patterns with which the majority of pattern makers seldom have anything to do, except to make an occasional change or repair.

It is true that every pattern maker should know how to construct these patterns. But why do these articles appear so often, when there are so many simple things in connection with the pattern-making and foundry trades that the practical pattern maker must know—practical details that come up, not once in a year, or once a lifetime, but in everyday practice? The strangest part of

it all is that many of us try so hard to do the simple things in a difficult way, without success, when they could be quickly done if we but knew the simple way.

A short time ago I was called upon to make a pattern like the one shown in the illustration. To the great majority of pattern makers this will look so simple as to be hardly deserving of notice. Nevertheless I made it. How I made it I am not going to say, but I will ask the pattern-maker readers of the *American Machinist*, How would you make it? Would it be possible to make this pattern so that it would make either more or less work for the molder?

I made this piece contrary to good foundry practice. Let us see what the results were. Twelve castings were wanted to take the place of twelve that were worn out. These were to be cast, delivered and installed within



THE CASTING REQUIRED IN A HURRY

36 hours. In other words, these twelve castings must be made in one day. Instead of twelve, only seven castings were made; two of these were bad. The foundryman figured his loss at about \$2 and the factory a delay of 24 hours and a production loss in proportion.

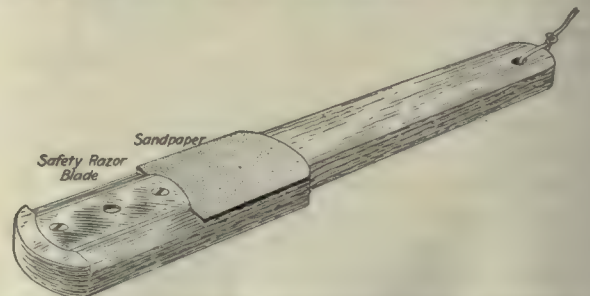
Desiring to know where I had made a mistake, I called at the foundry and had a talk—not with the boss, but with the molder who made the job. It took him but a few minutes to show me where I was wrong. He also explained how to make the pattern so that the molder could, without any unnecessary trouble, make in one day the twelve castings wanted.

Brother pattern maker, can you figure out how the molder wanted this very simple little job made?

Novel Drawing Office Tool

By G. WEBER

The illustration shows a handy pencil sharpener and sandpaper grinder for the draftsman. The advantage



PENCIL SHARPENER AND SANDPAPER GRINDER

afforded by this combination is that the two things needed are combined in one.

The apparatus is easy to construct. The handle is made of wood and a razor blade is fastened to it with screws. The blade is easily removed when dull and another as easily attached.

Making the 18-Lb. Cartridge Case--I*

BY ROBERT MAWSON

SYNOPSIS—In this article are described the successive operations performed in the manufacture of the 18-lb. cartridge case. Illustrations are shown of the various machines set up for the operations. The special tools, such as punches and dies, gages and other equipment, are also included. Rates of production, annealing temperatures, times, and the pickling solutions used are given in detail.

The manufacture of the 18-lb. cartridge case furnishes a problem in metal-drawing work that requires great skill and much experimenting, even of the plants that

- | | |
|------------------------------|---------------------------|
| 15. Fifth draw | 24. Second taper |
| 16. First trim | 25. Machine head |
| 17. Anneal and wash | 26. First inspection |
| 18. Sixth draw | 27. Stamp and wash |
| 19. Second trim | 28. Hand-tap for primer |
| 20. Wash | 29. Final inspection |
| 21. First and second heading | 30. Government inspection |
| 22. Flash anneal | 31. Stamp, box and ship |
| 23. First taper | |

Samples taken from each operation from the blank to the finished cartridge cases are shown in Fig. 2. The blanks which are purchased measure 6.375 in. in diameter by 0.380 in. thick.

The composition of the metal is

Copper 67 to 72 per cent. Lead under..... 0.10 per cent.
Zinc 33 to 28 per cent. Iron under..... 0.10 per cent.

The physical properties of the metal are—ultimate tensile strength, 48,000 lb. per sq.in.; elastic limit, 17,-

X=18 Thds. per In., R.H., British Std. Whitworth

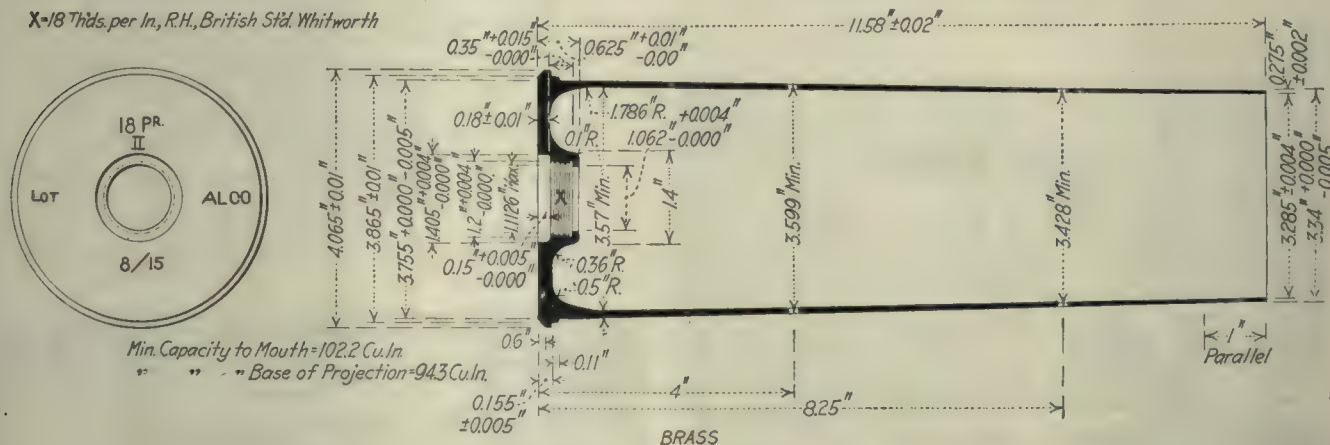


FIG. 1. DETAILED ILLUSTRATION OF THE CARTRIDGE CASE

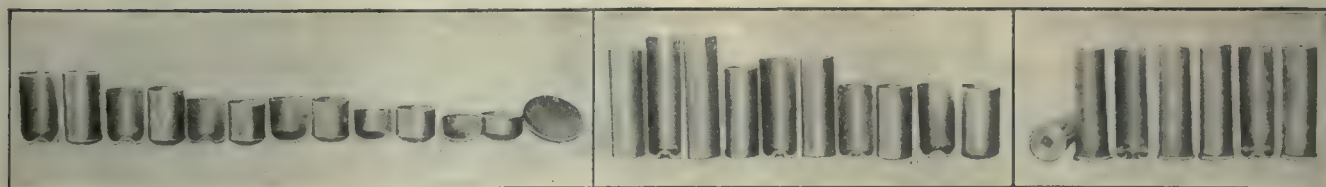


FIG. 2. PROGRESSIVE STAGES IN THE MANUFACTURE OF THE 18-LB. CARTRIDGE CASE

are experienced in the production of munitions. When, however, this work is undertaken by a firm previously engaged in some other industry, the task is more difficult. The American Locomotive Co., Richmond, Va., which was formerly engaged in the building of locomotives, is an instance of a plant of the latter type that has successfully solved the problem. With radical changes in equipment and methods the company is now producing 18-lb. cartridge cases at the rate of 18,000 per day.

A detailed illustration of the cartridge case is shown in Fig. 2. The operations followed in the manufacture of the case are:

- | | |
|----------------------------|-----------------------|
| 1. Blank | 8. First indent |
| 2. Mark for identification | 9. Anneal and pickle |
| 3. Cupping | 10. Third draw |
| 4. Anneal and pickle | 11. Anneal and pickle |
| 5. First draw | 12. Fourth draw |
| 6. Anneal and pickle | 13. Second indent |
| 7. Second draw | 14. Anneal and pickle |

000 lb. per sq.in.; elongation, 71 per cent. As the blanks are procured from three different concerns it is found advisable to mark them with a distinguishing symbol. The blanks are therefore marked with a letter, number or character so that the cases may be traced should any defect arise during the machining operations. This operation is shown in diagrammatical form in the illustration, Fig. 3.

The next operation is cupping; the machine set up for performing this operation is shown in Fig. 4. The punch and die are shown in detail in Fig. 5. The operation is also illustrated in diagrammatical form in Fig. 6. The cupped blanks are then taken to the oil furnaces for annealing; one of these furnaces is shown in Fig. 7. The temperature of the furnace for the annealing operations is kept at from 1,180 to 1,200 deg. F. The average consumption of oil is 15 gal. per hr. per furnace.

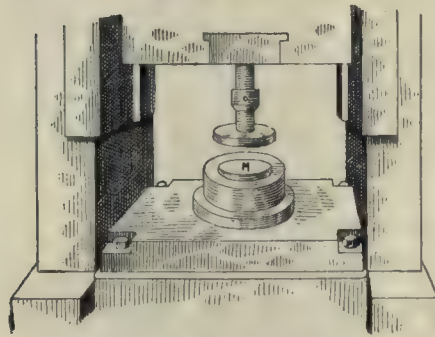
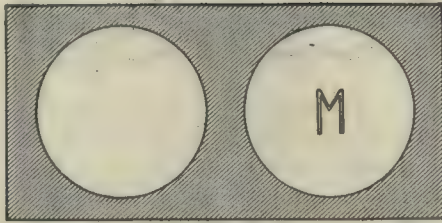


FIG. 3. MARKING THE BLANKS

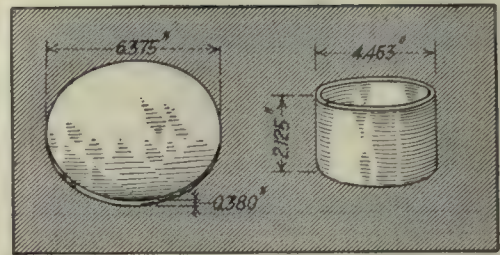


FIG. 6. OPERATION 3: CUPPING
 Machine Used—Bliss No. 77½, 12-in. stroke; press operating at 13½ r.p.m.
 Production—800 per hr.
 Lubricant Used—Lub-a-tone.
 Pressure Required—120 tons.
 References—Figs. 4 and 5.

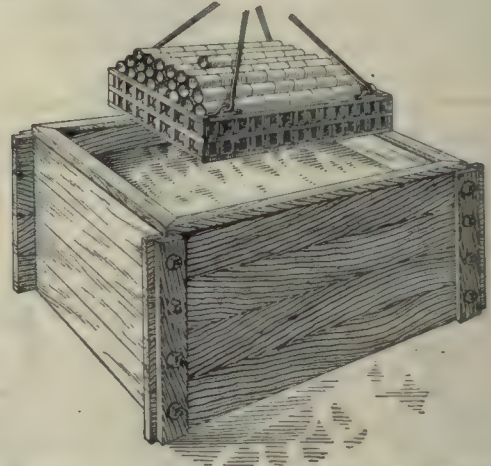


FIG. 9. OPERATION 4: ANNEALING AND PICKLING

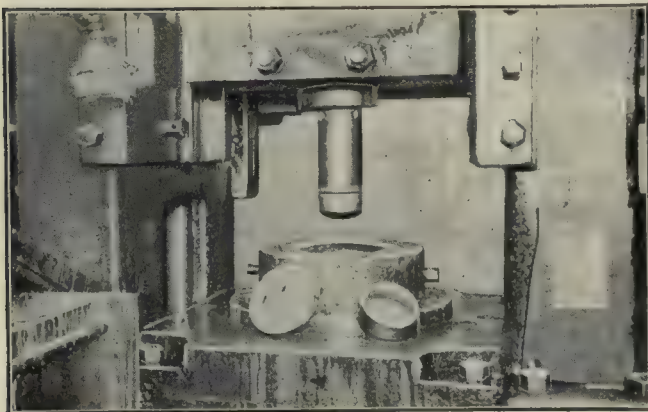


FIG. 4. THE CUPPING OPERATION

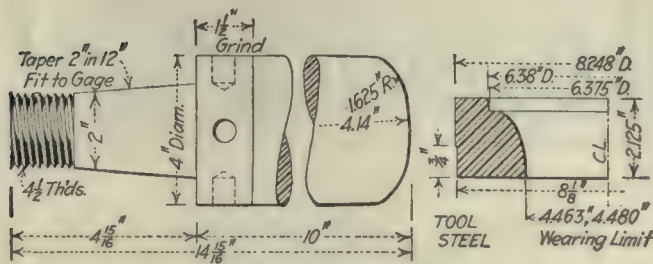


FIG. 5. DETAILS OF CUPPING PUNCH AND DIE

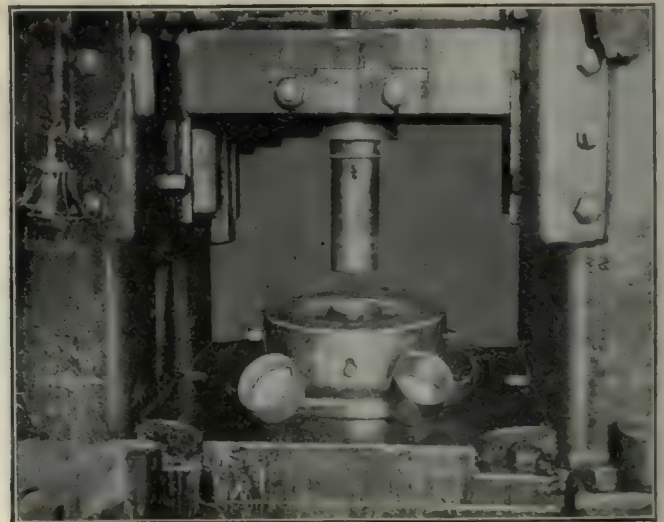


FIG. 10. FIRST DRAWING OPERATION

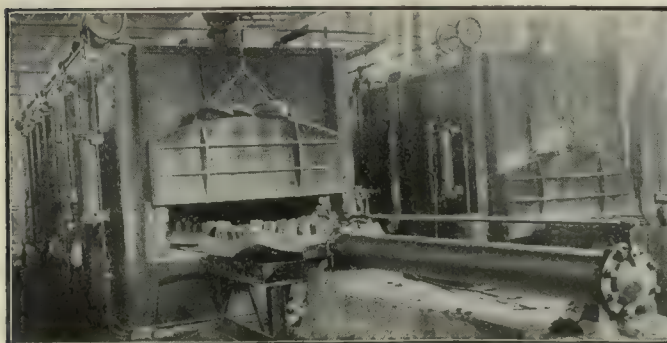


FIG. 7. VIEW OF ONE OF THE FURNACES



FIG. 8. ONE OF THE PICKLING TANKS

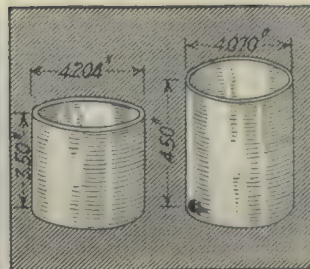
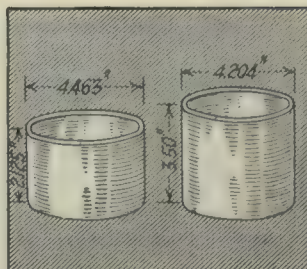
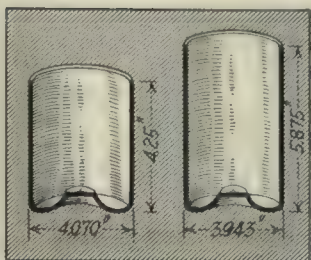
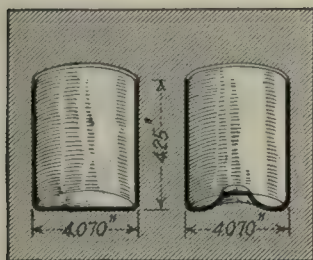


FIG. 12. OPERATION 5: FIRST DRAW

Machine Used—Bliss No. 77½, 10-in. stroke; press operating at 13½ r.p.m.
Production—800 per hr.
Lubricant Used—Lub-a-tone.
Pressure Required—75 tons.
References—Figs. 10 and 11.

FIG. 15. OPERATION 7: SECOND DRAW

Machine Used—Bliss No. 77½, 12-in. stroke; operating at 13½ r.p.m.
Production—800 per hr.
Lubricant Used—Lub-a-tone.
References—Figs. 13 and 14.

FIG. 19. OPERATION 8: FIRST INDENT

Machine Used—Bliss No. 78½, 10-in. stroke; operating at 12 r.p.m.
Production—700 per hr.
Lubricant Used—None.
Pressure Required—150 tons.
References—Figs. 16, 17 and 18.

FIG. 22. OPERATION 10: THIRD DRAW

Machine Used—Bliss No. 77½, 10-in. stroke; press operating at 13½ r.p.m.
Production—800 per hr.
Lubricant Used—Lub-a-tone.
References—Figs. 20 and 21.

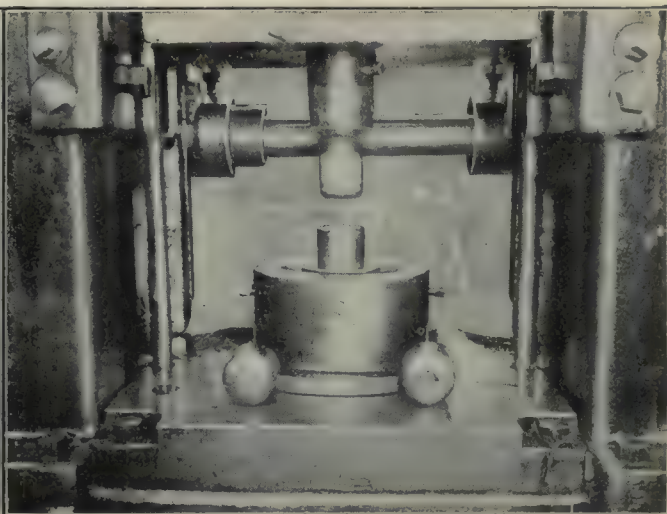
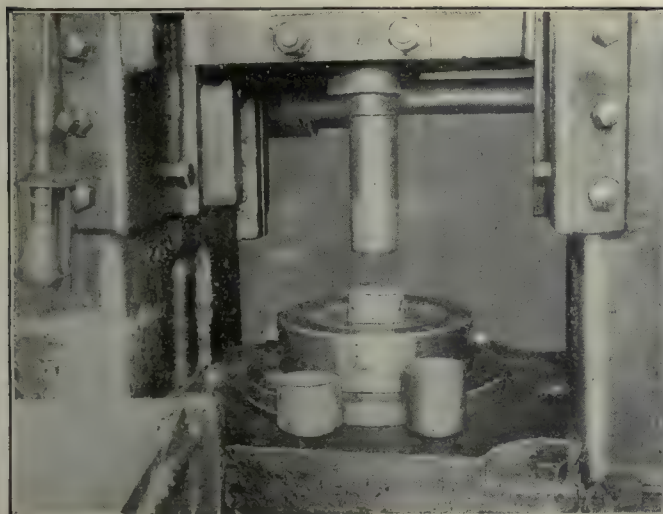
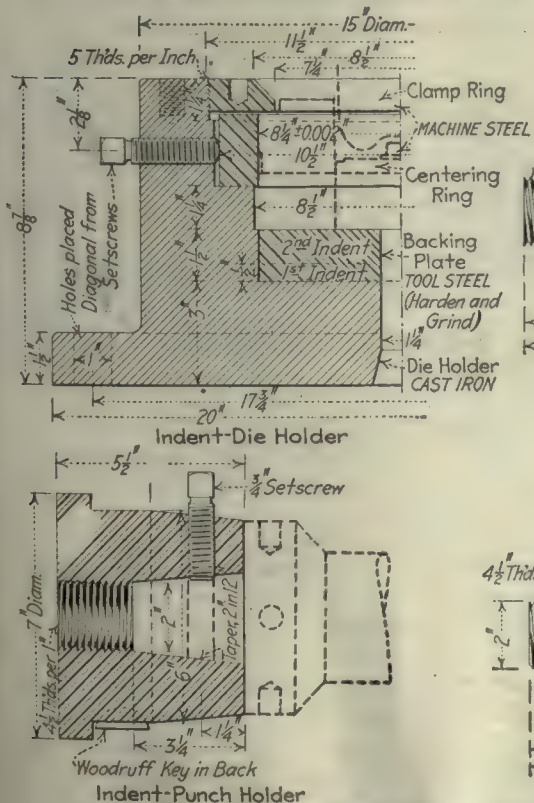


FIG. 13. SECOND DRAWING OPERATION

FIG. 16. FIRST INDENTING OPERATION



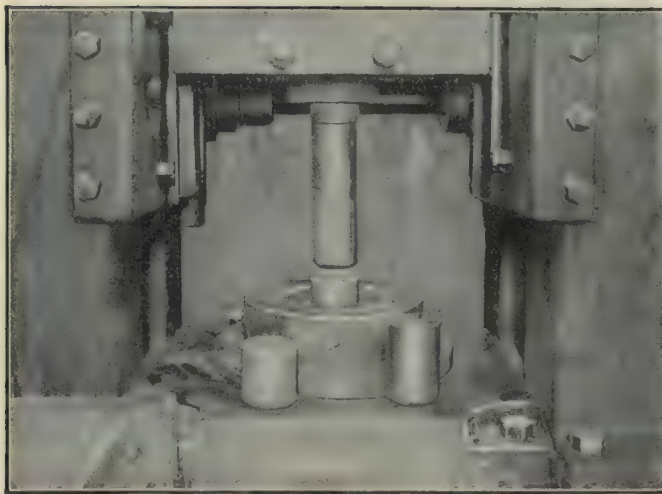


FIG. 20. THIRD DRAWING OPERATION

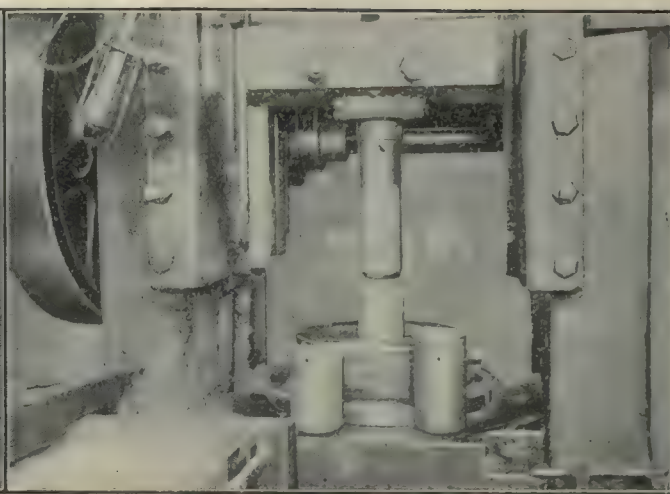


FIG. 23. FOURTH DRAWING OPERATION

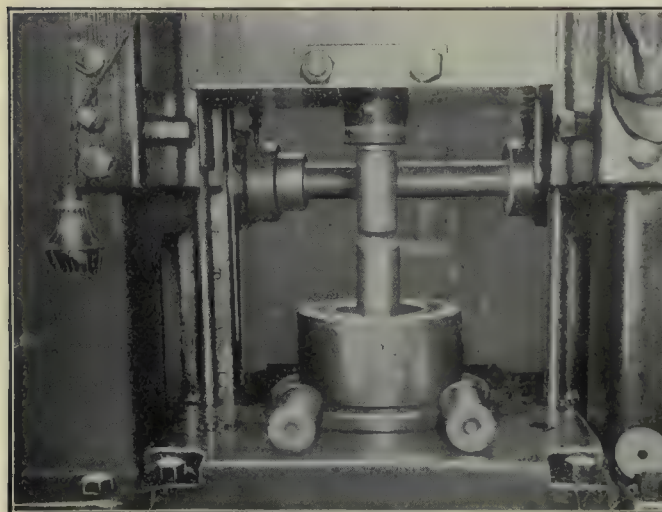


FIG. 26. SECOND INDENTING OPERATION

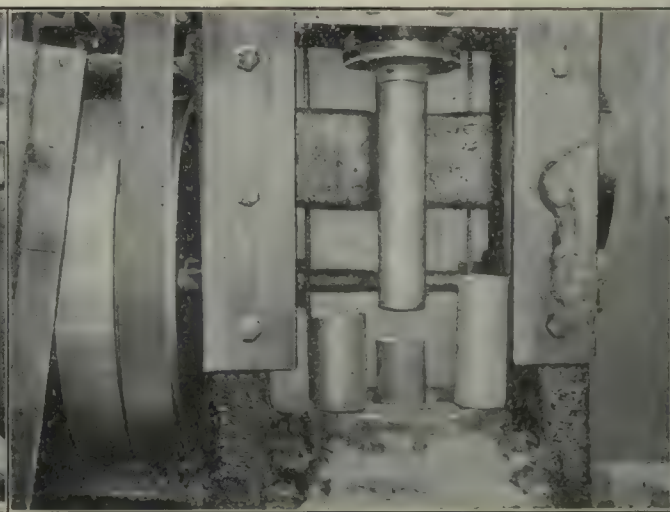


FIG. 29. FIFTH DRAWING OPERATION

When annealing, two men load the trays. The furnace holds nine, one tray accommodating about 150 blanks. Every 6 min. one of these is pushed in, using the air-operated plunger shown in front of the furnace. The cartridge cases are left in the furnace for approximately 45 min. Two men are stationed at the furnace who draw out the trays according to the time noted and lower them by an air hoist into the water tank.

Three furnaces are attended to by another man who watches the pyrometers and regulates the heat. The pickling is done in a bath of "Edis" compound made from 1 lb. of the compound and 1 gal. of water. This mixture is kept at a temperature of from 180 to 210 deg. F. The blanks are allowed to remain in the pickling tank for approximately 8 min. A view of one of the pickling tanks is shown in Fig. 8.

The cases are then washed in hot water in a separate tank. The baskets that are used during this operation are made from copper so as to prevent any discoloration of the cases. The pickling operation is shown in diagrammatical form in Fig. 9.

The next operation is the first drawing; the press used for this operation is shown in Fig. 10. The punch and die used for the first drawing operation are shown in Fig. 11. The operation is also shown in diagrammatical form in Fig. 12.

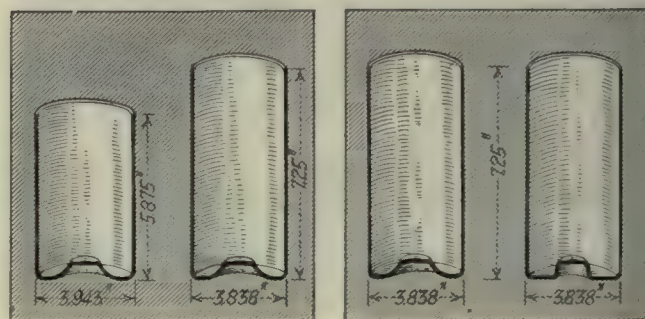


FIG. 25. OPERATION 12: FOURTH DRAW
Machine Used—Bliss No. 87, 16-in. stroke; operating at 133 r.p.m.
Production—750 per hr.
Lubricant Used—Lub-a-tone.
References—Figs. 23 and 24.

FIG. 28. OPERATION 13: SECOND INDENT
Machine Used—Bliss No. 78½, 10-in. stroke; operating at 12 r.p.m.
Production—700 per hr.
Lubricant Used—None.
References—Figs. 18, 26 and 27.

The cases are again annealed and pickled after which they are ready for the second drawing operation, which is performed on the press shown in Fig. 13. Details of the punch and die used for the second drawing are shown in Fig. 14. A diagrammatical illustration of the operation is also shown in Fig. 15.

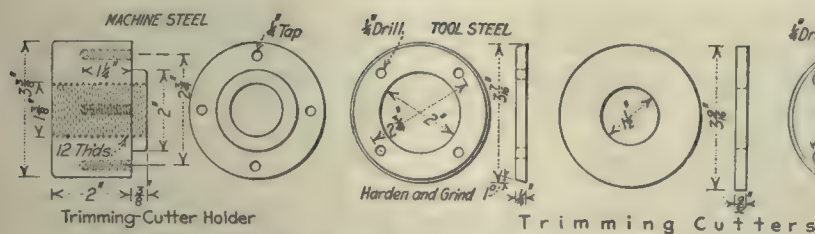


FIG. 33. DETAILS OF TRIMMING CUTTER

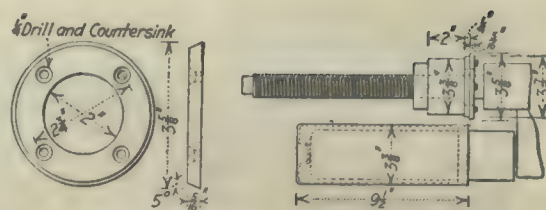
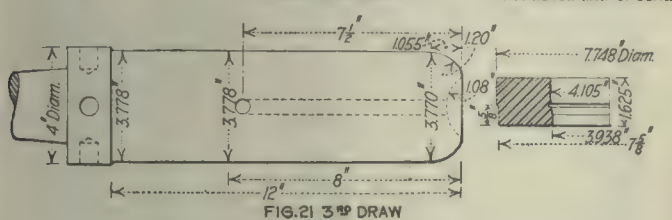
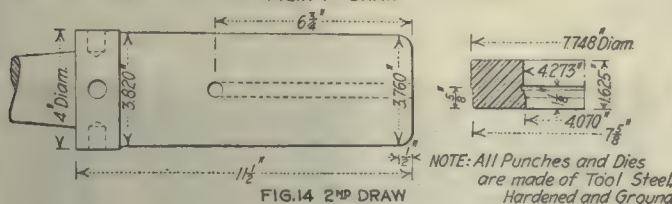
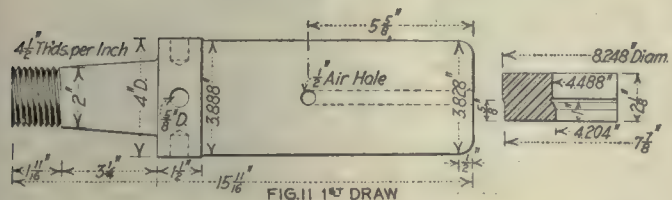
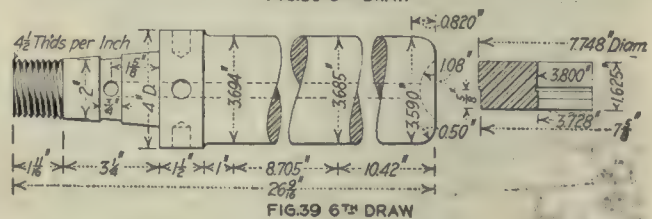
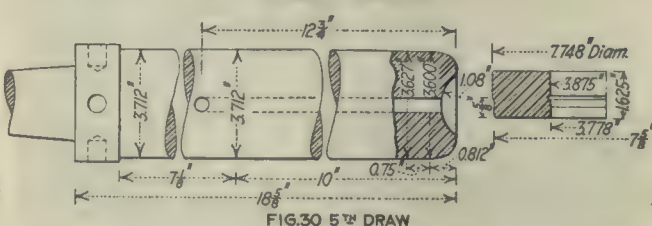
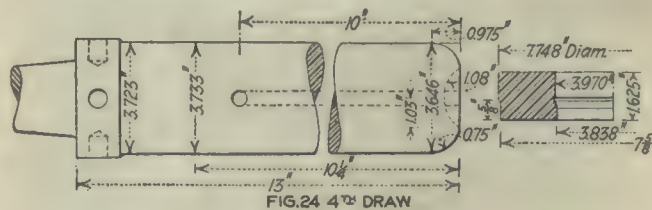


FIG. 34. DETAILS OF TRIMMING CUTTER HOLDER



FIGS. 11, 14 AND 21. DETAILS OF PUNCH AND DIE FOR FIRST, SECOND AND THIRD DRAWING OPERATIONS



FIGS. 24, 30 AND 39. DETAILS OF PUNCH AND DIE, FOR FOURTH, FIFTH AND SIXTH DRAWING OPERATIONS

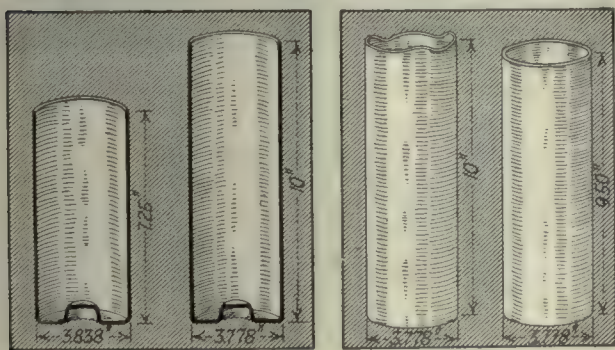


FIG. 31. OPERATION 15: FIFTH DRAW
Machine Used—Bliss No. 60½ reducing press.
Production—250 per hr.
Lubricant Used—Lub-a-tone.
References—Figs. 29 and 30.

FIG. 35. OPERATION 16: FIRST TRIMMING
Machine Used—Bliss trimmer, speed of spindle 585 r.p.m.
Production—300 per hr.
Note—Case trimmed dry to 9½ in.
References—Figs. 32, 33 and 34.

The cases are then taken to the press, Fig. 16, for the first indenting operation. Details of the punch, die and center post used for the first indenting are shown in Fig. 17; details of the die holder and punch holder are shown in Fig. 18. The operation is also shown in diagrammatical form in Fig. 19. The cases are again annealed and pickled.

The next operation is the third drawing, which is performed in the press shown in Fig. 20. Details of the punch and die used for the third drawing are shown in Fig. 21. The operation is also shown in diagrammatical

form in Fig. 22. The cases are again annealed and pickled as before.

The next operation is the fourth drawing; the press set up for his work is shown in Fig. 23. The punch and die used for the drawing operation are shown in detail in Fig. 24. A diagrammatical illustration of the work performed is also shown in Fig. 25.

The case is now ready for the second indenting, which is performed in the press shown in Fig. 26. Details of the die and punch holders used in this operation are shown in Fig. 18. The punch and die are also shown in detail in Fig. 27. The operation is also shown in diagrammatical form in Fig. 28. The cases are then annealed as described and pickled by dipping in a bath made in the proportion of 1 part sulphuric acid to 10 parts water, and kept at a temperature of 120 deg. F.

The next operation on the case is the fifth drawing; a press set up for this operation is shown in Fig. 29. Details of the punch and die used for this drawing are shown in Fig. 30. The operation is also shown in diagrammatical form in Fig. 31. The case is then trimmed to 9½ in. long in the lathe shown in Fig. 32. Details of the trimming cutter and holder are shown in detail in Figs. 33 and 34. The operation is also shown in diagrammatical form in Fig. 35.

The cases are then annealed as before, after which they are dipped in the sulphuric acid bath. The contents of the bath are made up of 300 gal. water, 30 gal. sulphuric acid and 40 lb. bichromate of soda. The mixture is kept at a temperature of 100 to 120 deg. F.

A detail of the tongs used to dip the cases in the bath is shown in Fig. 36. It will be noted that this time the cases are only dipped into the bath, whereas before they were allowed to remain in the bath suspended in a basket. It will be observed also that the bath mixture is different. After being removed from the bath they are plunged into water at a temperature of 210 deg. F.

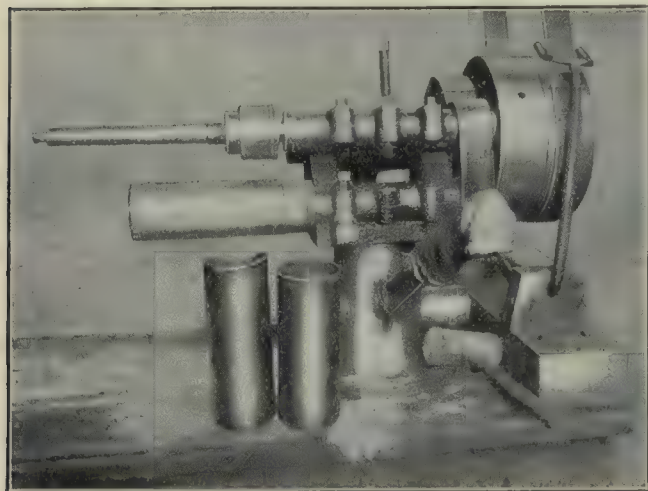


FIG. 32. CASE-TRIMMING LATHE

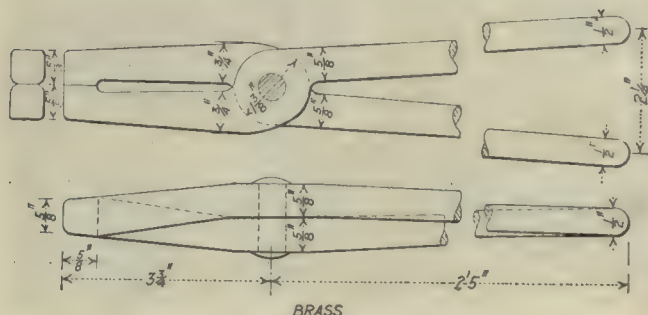


FIG. 36. DETAILS OF TONGS

and then quickly transferred to the air dry. The operation is also illustrated in a diagrammatical form in Fig. 37.

The next operation is the sixth drawing, which is performed in the press shown in Fig. 38. Details of the punch and die used for this final drawing are shown in Fig. 39. The operation is also shown in diagrammatical form in Fig. 40.

When the American Locomotive Co. started to make cartridge cases tool steel was at a premium and a sufficient quantity for making the tools could not be obtained.

It will be observed that many of the tools, as shown by the details, were made from an 0.40 to 0.50 carbon billet steel.

In making the tools the steel was treated in the following manner: First it was heated for 18 hours in an oil furnace at a temperature of 1,750 to 1,800 deg. F. Then the steel was removed and allowed to cool in air, after which it was reheated to 1,550 deg. F. and quenched in brine and water. Then it was again reheated to 1,425 deg. F. and quenched in cold water. The first indent die and first and second center sections were made from Cyclops XXX tool steel and were treated in the manner recommended by the makers of the steel.

Another interesting feature of the tools used in the manufacture of the cartridge case is the fact that no

mechanical stripper is used. The only stripper needed is an air stripper, used for the sixth draw. The air is admitted to the inside of the punch by the moving ele-

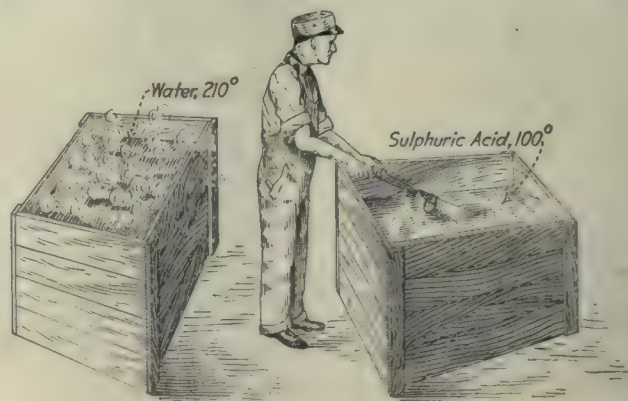


FIG. 37. OPERATION 17: WASHING

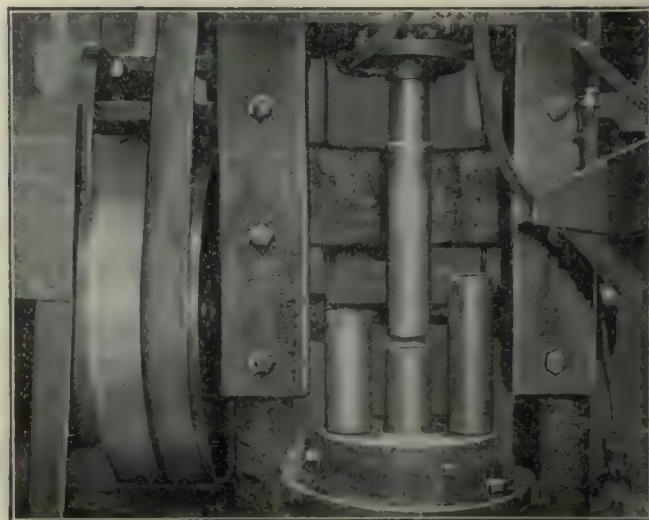


FIG. 38. SIXTH DRAWING OPERATION

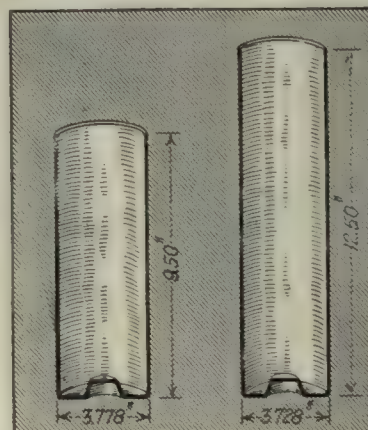


FIG. 40. OPERATION 18: SIXTH DRAW

Machine Used—Bliss reducing press No. 60 1/2.
Production—230 per hr.
Lubricant Used—Lub-a-tone.
References—Figs. 38 and 39.

ment of the press opening and closing a valve. The 1/4-in. pipe through which the air enters is screwed into the top of the punch, a hole being machined through the punch, as may be seen by the detail. The air enters as the punch reaches the bottom of the stroke and coming in contact with the end of the case on the inside strips it from the punch.

(To be continued)

Manufacture of a Five-Piece Typewriter Frame--II*

BY FRANK A. STANLEY

SYNOPSIS—Profiling fixture and piece jigs are used for finishing various surfaces after the frame parts have been assembled, and then the web is handled exactly as if it were a one-piece casting.

Figs. 15 and 16 illustrate the use of a profiling fixture in the finishing of certain surfaces on the rear brace for the frame and also on certain seats on the frame sides. This fixture carries the assembled typewriter frame supported from its lower edges, where it rests upon accurately finished stops. The fixture is equipped near the center with a double-ended support, which is carried by a plunger and is free to rock vertically so that both points come directly in contact with the under surface of the light web across the body of the rear-frame

It will be seen upon inspection of Figs. 15 and 16 that the work-holding fixture carries a set of hook bolts for drawing the typewriter frame down into position, these bolts being operated by conveniently placed thumb-screws controlling the simultaneous movements of a pair of bolts, the connection being such that a uniform gripping effect is secured by the bolts. At each side of the assembled typewriter frame in the fixture is a thin steel plate serving as an outer brace or support for the thin frame sides, to prevent them from springing under the cut, these stops being merely pressed against the casting lightly by the hand while the clamp handles are operated to secure them.

In this fixture, as in all others used on the work, ample provision is made in the general arrangement of stops and clamps to obviate any tendency toward distor-

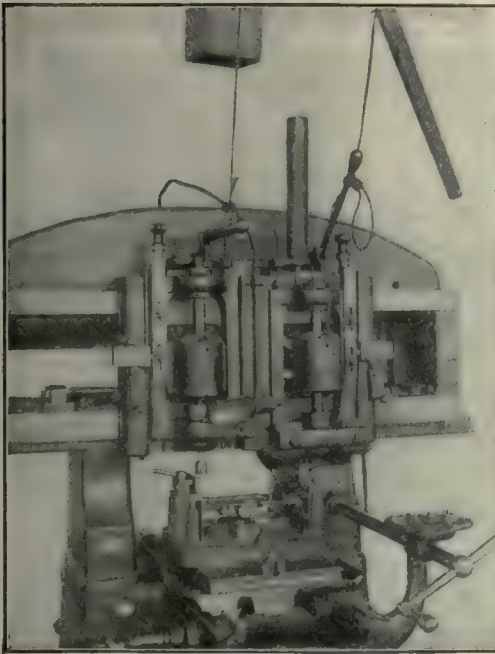


FIG. 15. PROFILING LUGS

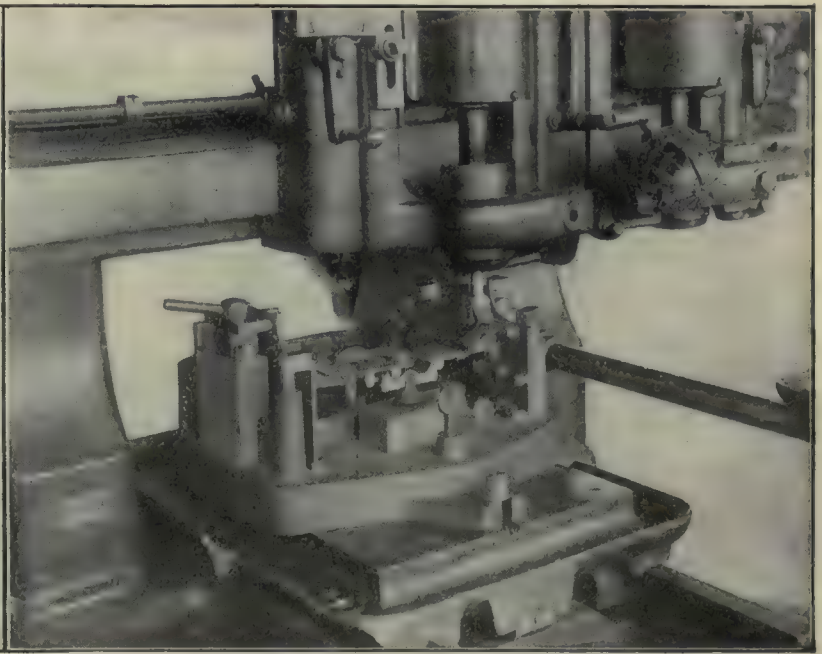


FIG. 16. PROFILING BEARING SURFACES

brace. This support is similar in construction to the one already referred to in connection with Fig. 10.

Cuts are taken on the work in this fixture at several different heights, and the stop bar for the profiler cutting head, as shown at the left of the left-hand saddle, is provided with stop notches by means of which the cutter position is accurately set for the respective surfacing processes. It will be seen that the action of the counter-weight suspended from the core attached to the operating handle of the cutter spindle for the cutter head holds the head upward, always in positive contact with the indexing detent or stop at the left-hand side of the saddle.

In Fig. 15 the profiling cutter is shown in operation on lugs at the left-hand end of the work, while in Fig. 16 the bearing surface at the opposite end of the brace is shown under the machining cut.

tion or springing of the work during the cutting process, as well as to make it impossible to locate the work improperly in the fixture. The construction of the fixture is such that it is readily kept clean, and it is a simple matter to remove the finished casting and replace it with a rough one for machining.

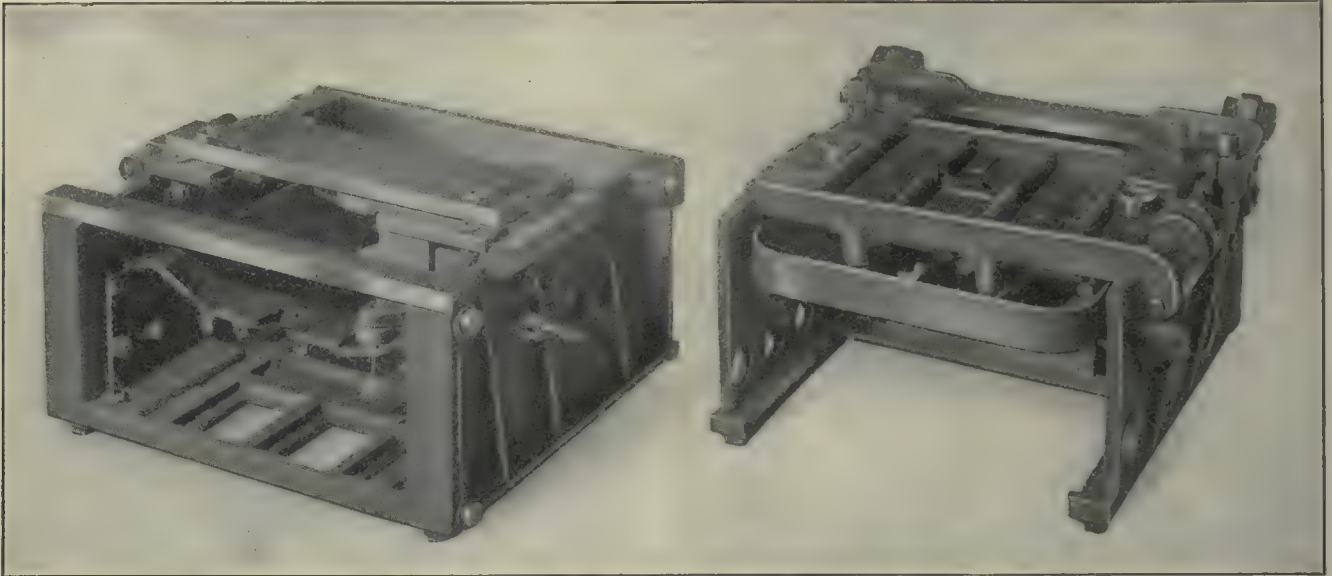
SOME ASSEMBLED-FRAME JIGS

Figs. 17, 18, 19 and 20 illustrate jigs for drilling certain holes in the frame parts after they are assembled. In Fig. 17 the typewriter frame is seen in place in the jig, where it is positioned sideways by a hardened-steel roller *A*, clearly shown at the open end of the jig, this roller fitting in the finished groove or seat for forming the guide for the center tie of the typewriter. The longitudinal position of the work in the jig is fixed by knurled-head hardened plugs, one of which is shown

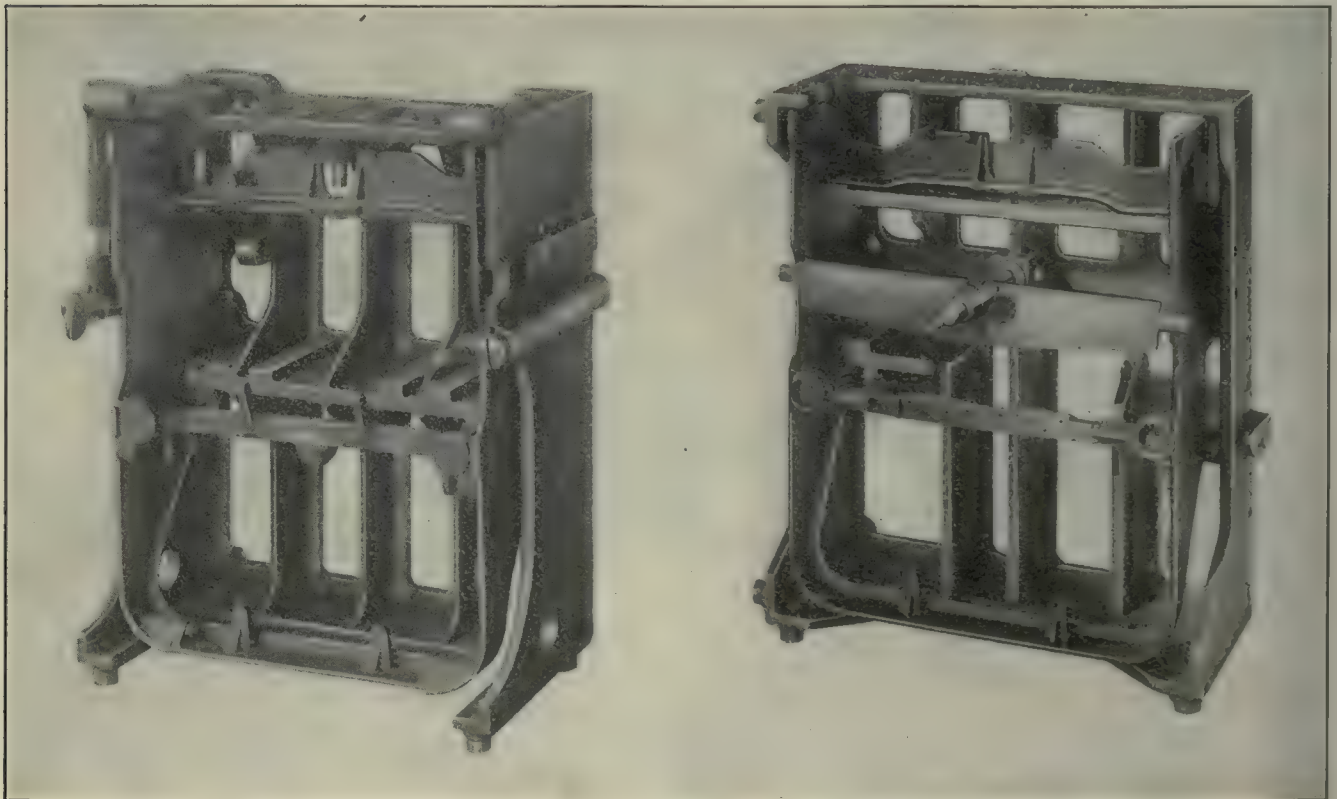
*Previous installment appeared on page 273.

at the right-hand side. The plugs fit nicely in steel bushings secured in the jig wall, and the inner ends of the plugs are pushed into holes in the side of the work drilled and sized in a previous operation. With the work

from correct results in previous operations will here be detected by the roll and plug. It may be stated here that care is taken in the preceding processes to make sure that all cuts are correct and that consequently the



FIGS. 17 AND 18. FRAME PART DRILLING JIGS



FIGS. 19 AND 20. DRILLING JIGS USED FOR VARIOUS FRAME PARTS

thus located in two directions, it is easily clamped for holding for the following drilling operations. This jig is also an accurate testing device for determining whether the assembled frame is correct in respect to all important surfaces, bearings, holes and the like.

Thus it must rest on the bottom of the frame on hardened studs in the jig corners, and at the same time the setting roll and hardened plugs must enter nicely in their respective locations in the work. Any deviation

assembled frame will locate properly in the jig in which it must later be drilled for final operations.

The jig in Fig. 19 is for drilling a series of holes in lugs and bosses, and the one in Fig. 20 is for counter-boring holes drilled in other jigs. Fig. 20 holds the work by a long strap with some extensions or trunnions at the end, forming a point contact with the lower edge of the typewriter frame, while the strap is easily removed or replaced owing to its being slotted from the outside

to admit a stud, upon which is placed an ordinary wing nut for tightening purposes. The work is located in this jig from the finished seat, which forms the guide for the center tie, the guide fitting over a locating piece in the central rib of the jig.

All of these jigs are simple in construction. Several of them have swinging leaves for carrying bushings, and in each instance the method of locating and clamping the work is such as to facilitate rapidity of movement.

The shape of the center tie, which is adapted to slide in its guiding seat in the top of the rear brace in the typewriter frame, is shown in Fig. 21, where it will be seen to be in the form of an angle with long wings at each side, this center tie being fitted properly to the guiding seat in the rear brace and adapted to control the adjustment of the carriage forward or away from the front of the machine to allow for any given number of sheets of paper between printing bar and type. In the shifting of the carriage up and down, the back of the carriage is supported against the vertical guide on the center ties. This guiding surface must be made exactly at right angles in both directions to the guide by which the center tie itself is supported and adjusted forward or back in

stop pins are carried by the jig plate for positioning the plate correctly upon the work. In this case the work carries the jig itself instead of being placed in a box structure or other holding form of tool.

Another small jig is shown in Fig. 23, carried by the typewriter frame. The purpose of this is to drill a very small hole in the lug near the bottom of the side wall. This jig body is merely a narrow steel plate with a block doweled and secured by screws near one end, this block being adapted to rest against the guiding surface inside of the work. It is held in position against the guiding surface by a flat bent spring at the outer end, imme-

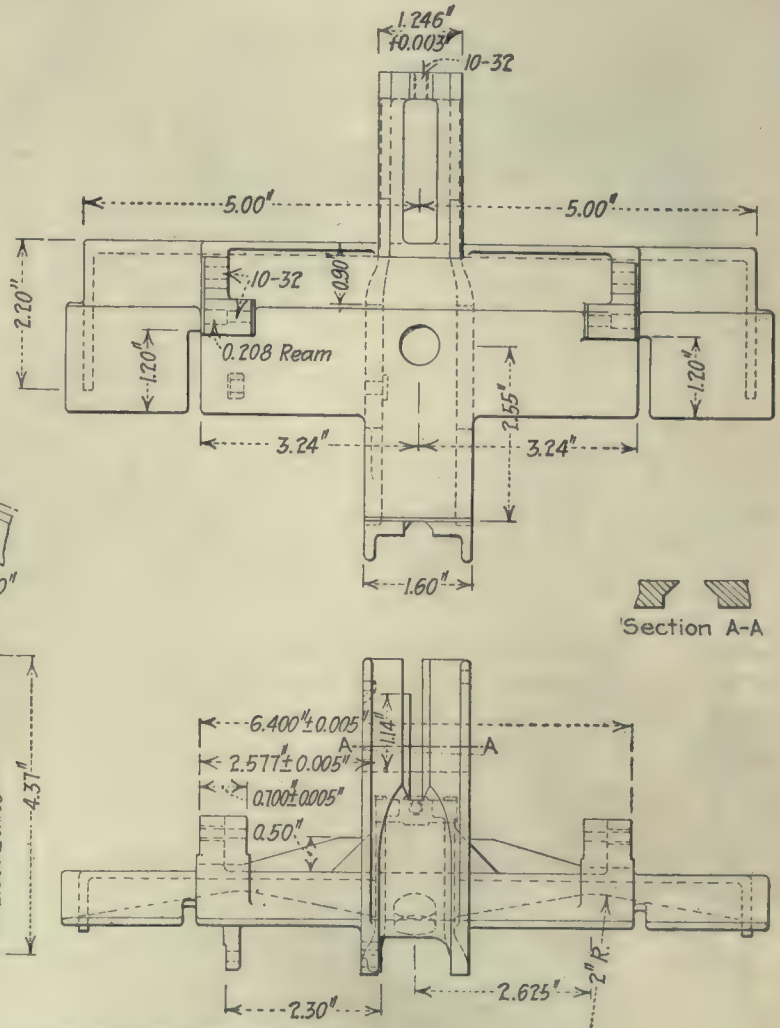
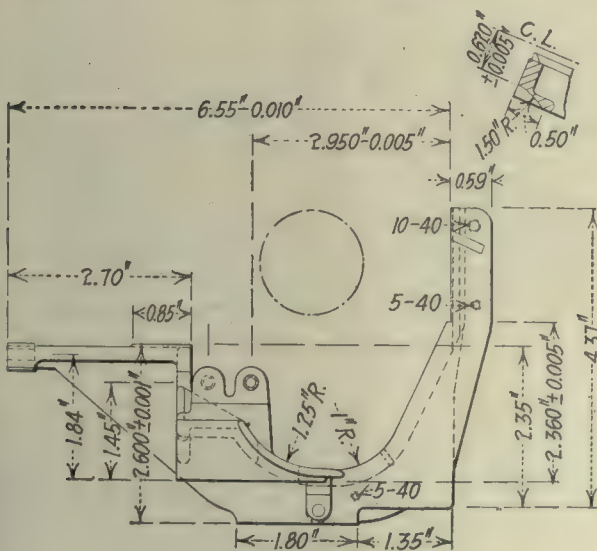


FIG. 21. DETAILS OF THE FRAME CENTER TIE

the rear brace of the typewriter frame. The methods of machining this piece are interesting and will be taken up in another article. The drawing of the center tie is shown at this point to indicate the character of the work necessary in machining the rear brace in which it fits.

TWO SIMPLE HANDY FRAME JIGS

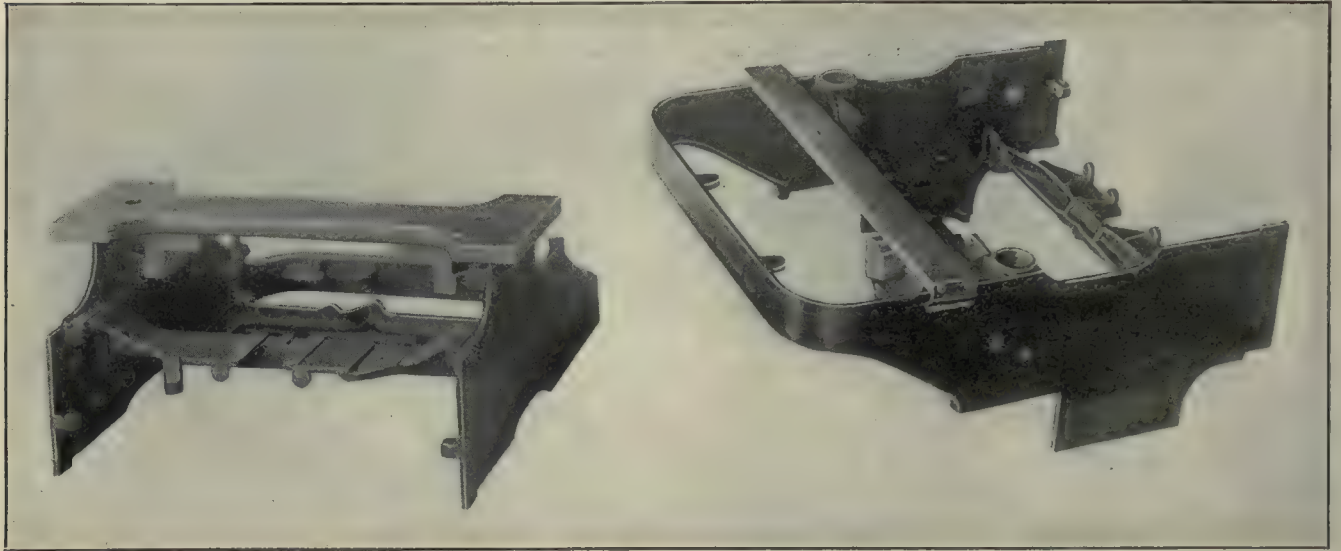
Fig. 22 shows a simple type of jig for drilling holes in two important inner lugs cast on the walls of the side plates of the frame. This jig consists of a flat plate set to rest upon the finished upper edges of the side frames, with two depending brackets in which are placed the drill bushings. A clearance hole is made through the top of the plate to allow a drill to run down freely and enter the guide bushing properly. Suitable

diately in front of the observer, so that it is controlled entirely by the friction between the guiding surfaces. This type of jig is readily applied and removed, is located with absolutely no possibility of spring and is a cheap form of tool to make and maintain.

Another member that is later attached to the typewriter frame is known as the shift shaft bracket and is represented by Fig. 24. A drill jig for machining this part is shown in Fig. 25. In this jig it will be seen that the work, after it has been faced on the bottom bearing surfaces, is held by means of two small knurled-head screws which are brought up lightly against the projecting bosses on the work while the spring pins under the bosses are let up into position where the springs can be properly secured by the thumb-screws shown. The jig bushings used for guiding the drills working down-

ward from the top are carried in swinging leaves that are quickly fixed in proper position by the swinging levers *AA*, each of which carries a crosspin bearing upon a cam-shaped upper surface on the jig leaf. These leaves are provided with hardened and ground stop pins, so that when closed for operation they are brought to an

Each of these gage sides is on the tandem principle, giving two dimensions for the maximum and minimum limits. The tolerance is allowed at one end, the opposite end being a plane surface. The male gage *D* is also a limit tool, used similarly, and the test gage *E* at the bottom of the group is a limit device for testing the



FIGS. 22 AND 23. SIMPLE DRILLING JIGS USED ON FRAME PARTS

accurate position, in which they are positively fixed by the clamping movement of the swinging arm and pin *A* directly above. The function of the two large knurled-head screws, bearing directly upon the top of the work to hold it down upon the supporting feet underneath, is clearly shown in the drawing.

SOME GAGING APPLIANCES

At all important stages in the machining of members of the typewriter frame, accurate gaging tests are applied to check up the different surfaces as to their

length of the front member *F* of the typewriter frame. At *G* is a block height gage for testing the height across bosses at the ends of the frame brace.

The gages at the right of Fig. 26 are used in connection with the rear brace for the typewriter frame. Of these the one at *H* gages the overall length of the main piece, while the narrow opening at the left-hand end of the gage measures the distance between the end of the work and the guide shoulder for the seat in which the center tie is carried. Both of these gage openings are made on the limit principle. The height gage *I*

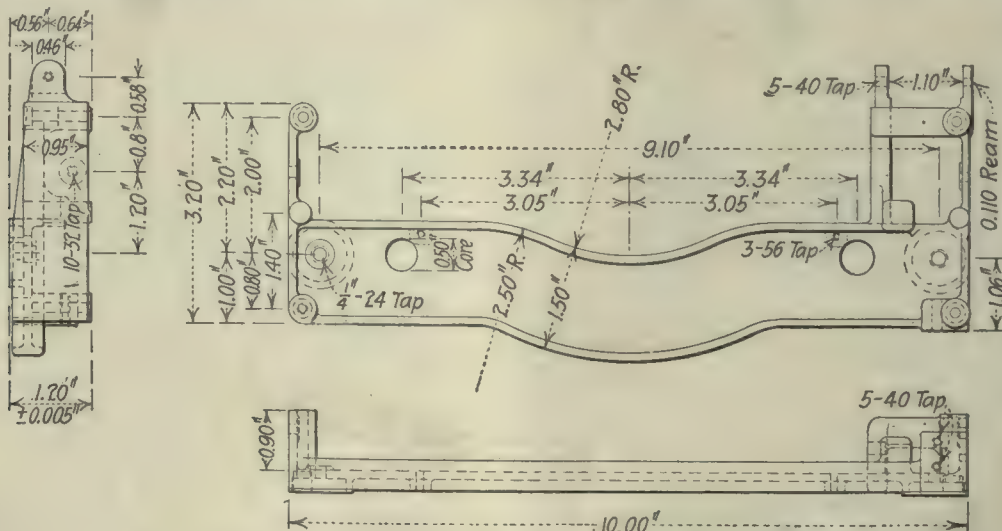


FIG. 24. DETAILS OF THE SHIFT SHAFT BRACKET

dimensions and correct relation to one another. Some of the gages are illustrated at Fig. 26. At the left in this view the upper part shown is the front-frame brace, and the long gage directly below this answers the double purpose of testing the overall length of 9.90 in. and the distance across the two inner lugs *CC*, measuring 8.16 in.

in the lower right-hand corner is used in the manner indicated by the photograph, for testing the accuracy of the overall dimensions across two important surfaces on bosses at the right-hand end of the work. This is also a limit gage, and its permanency as an accurate tool is maintained by lapping or grinding off the lower face

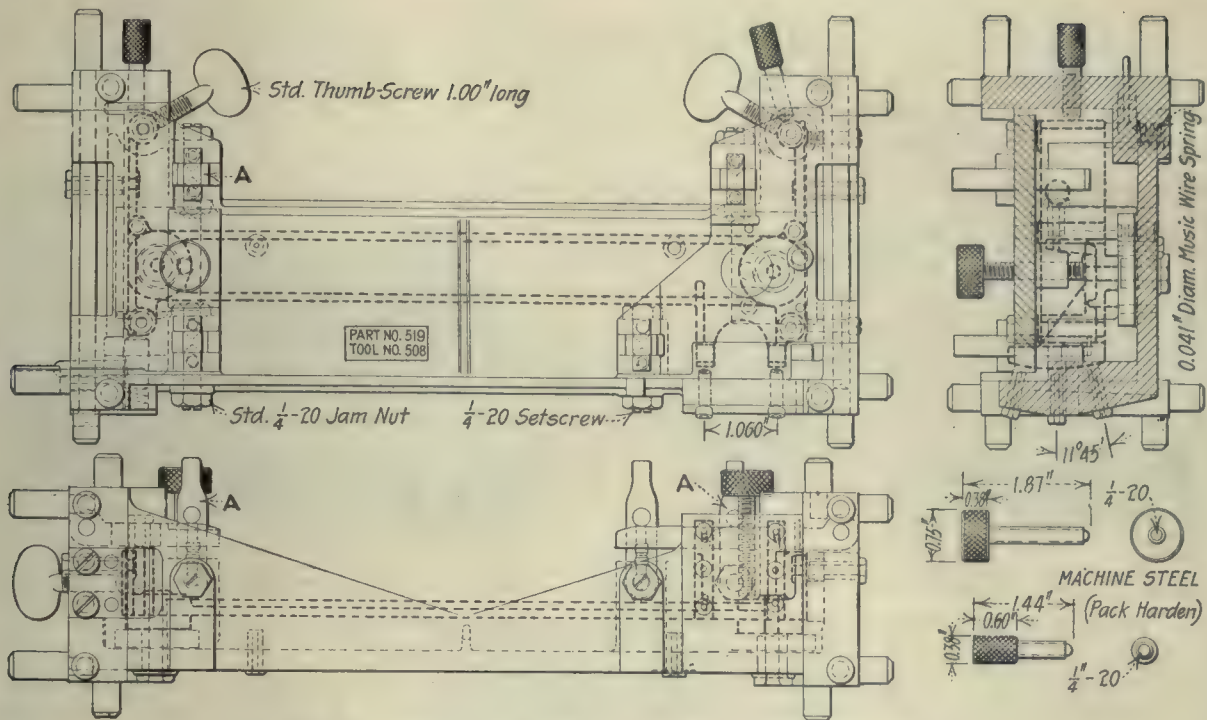


FIG. 25. DRILLING JIG FOR THE SHIFT SHAFT BRACKET

as fast as the outer maximum gaging end becomes worn. The main face of the top plate forms the minimum limit; and when this is ground off, the whole gaging member drops accordingly to hold to its original size.

Gage *J* at the top of the group carries four spring gaging points and is an extension of the fairly well-known flush-pin principle.

The large-head gaging plunger at the left of this lot is to test the height of seat *K*, as compared with the locating edge on the end of the casting itself; the two conical plungers at *L* test the correctness of the height of the seat *M* for supporting the center tie in the typewriter; the spherical counter plunger *N* tests the upper

face of the body of the casting for general accuracy of dimension below the finished bushing surface. As in the usual flush-pin construction, the top ends of these plungers are ground flat, so that they are flush with the top of the finished gage when the bottom ends are in contact with a correctly machined series of surfaces. The very slightest departure from the perfectly flush position, either high or low, in either one of these plungers is discovered easily by passing the thumb nail across the flat surfaces.

After the typewriter frame has been put together, the surfaces on the rear-frame brace for the center-tie feet are given a final test with the apparatus seen in Figs.

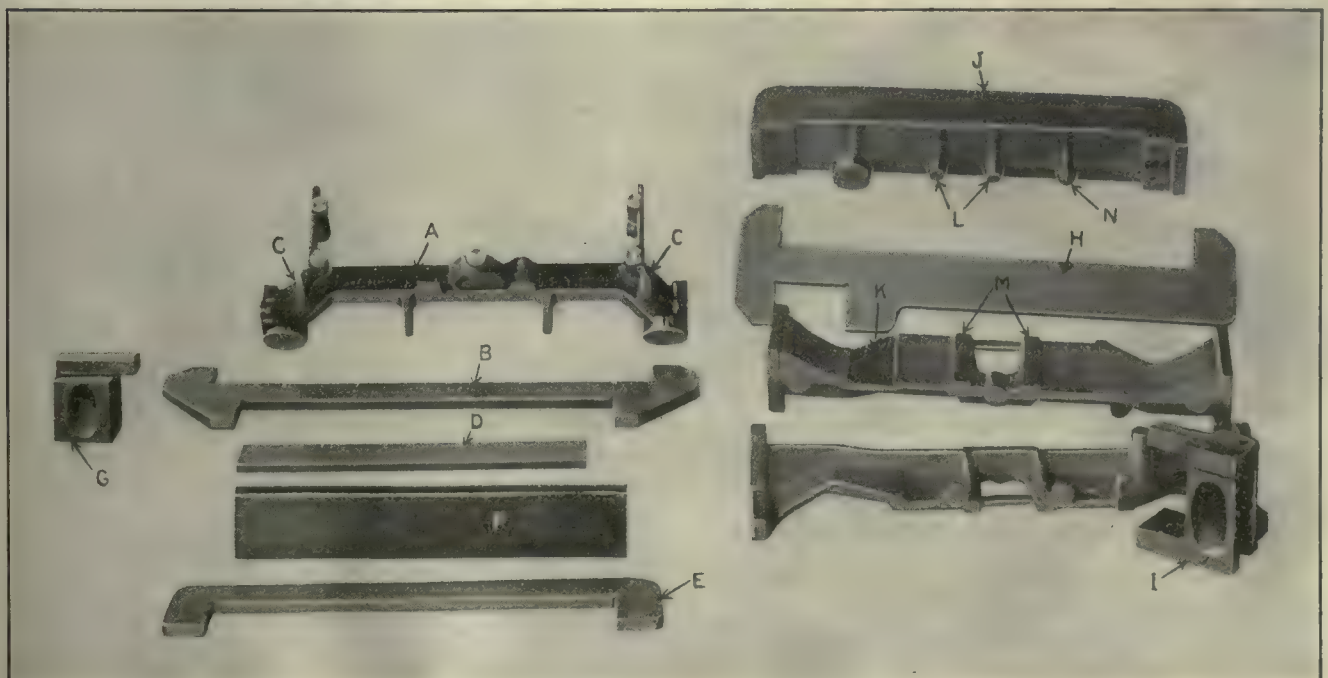
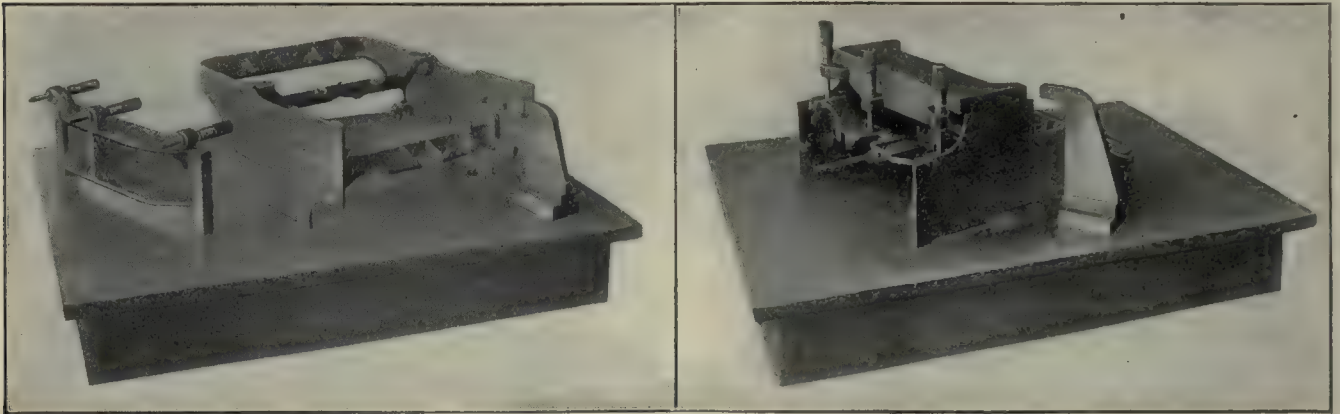


FIG. 26. GAGES USED ON FRAME PARTS

27, 28 and 29. In the first of these the gage at the left is shown with three micrometer spindles in position, while the typewriter frame is shown at the right, bottom side up, for the application of a height gage to the surface of an important bearing seat. When the frame is turned

and the National Association of Box Manufacturers has been carried on during the past year to determine the strength of boxes of various woods and of different construction. Over four and a half billion feet of lumber is used for box-making every year, and on this account the



FIGS. 27 AND 28. TESTS FOR THE ASSEMBLED FRAME

over and the micrometer gage applied, it appears as in Fig. 28, where the three micrometer spindles are shown in contact with the surfaces to be tested.

The construction of this micrometer block is best shown by Fig. 29, a drawing that is practically self-explanatory. The lugs on the cast block are bored accurately to receive the micrometer spindles, and the latter, when in position, are truly perpendicular to the locating surfaces and edges on the under side of the gage body proper. The gage is sufficiently heavy to rest properly and securely upon

tests are considered important. Moreover, big losses are caused by the breakage of boxes in transit, and all parties concerned are said to be anxious to determine the best kind of box.

The machine consists of a hexagonal drum with 3½-ft. sides, which is lined with thin steel sheets. Pieces of scantling bolted to the bottom form what are known as "hazards."

In making the tests boxes filled with cans containing water are placed in the drum, which is then rotated. For

convenience in observing the results of the tests, the sides and ends of the box are numbered with large figures, and in addition other numbers are placed at specified points on each side. The hazards cause the boxes to be carried part way around and then dropped back to the lower level of the drum. Each fall of this sort is a pretty fair imitation of the probable treatment it would receive in shipment. The boxes are watched carefully, and notes are taken on the manner in which they give way and the number of falls required to break them in pieces. In this way, say the officials who have conducted the tests, it is possible to determine what kinds of woods are best suited for boxes.

The tests showed a decided need

for a standard classification of box woods, and three groups have been made, based on the data which were obtained.

The tests also show the best methods of box construction. The experts say that one of the most striking things brought out was the inadequacy of the ordinary methods of nailing up boxes. The number of nails used and the way they are put in are important. One nail more to the side of a box will give it a great deal more strength than might be thought. The nails should not be driven too deep into the wood. In many cases, it is said, proper nailing will allow a reduction of the amount of lumber used without any decrease in the value of the box.

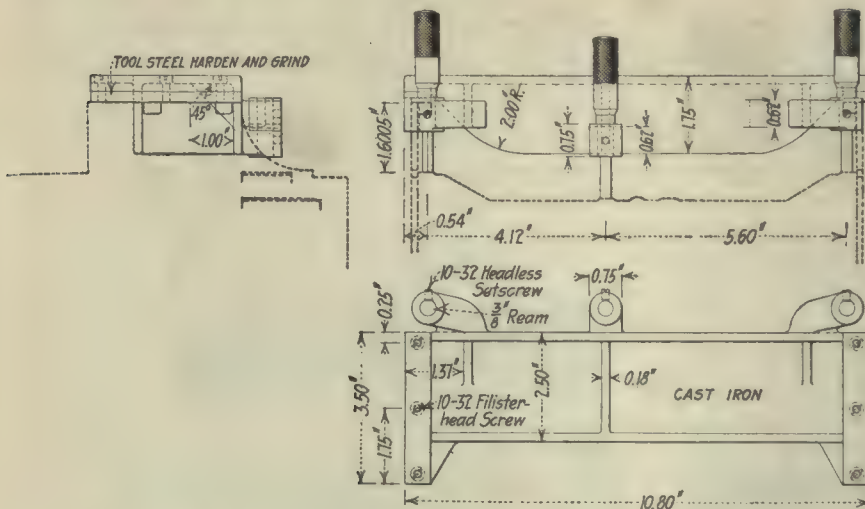


FIG. 29. DETAILS OF THE MICROMETER BLOCK

the finished upper edges of the typewriter-frame side, and this test in conjunction with the others referred to gives assurance that the machine parts are assembled properly and work correctly.

Box-Testing Machine

A machine for testing the strength of boxes has been devised by engineers of the Forest Service and is in use at the Forest Products Laboratory at Madison, Wis. The machine is the result of experiments made to determine a fair test for all types of boxes. A series of tests in coöperation with the American Society for Testing Materials

and the sticking end of the bar may not be so thick as some part of the bar following. The breaking point should be close to the rolls and for this purpose special coupling boxes of reduced cross-section may be used. Another device is a special breaking block beneath each main adjusting screw of the roll stand. These are supposed to break under the excessive thrust when the rolls are overloaded. The breaking blocks should be surrounded by a protecting shield to prevent injury from flying pieces of the block.

The rolls should be set upon a heavy concrete foundation suitably reinforced, with special attention to tying together the foundations for the roll-stand rails and the

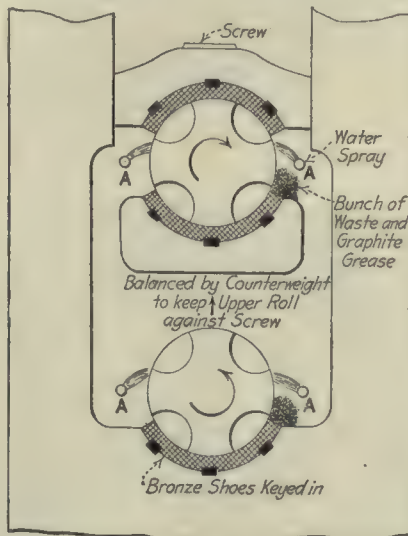


FIG. 3. METHOD OF KEEPING THE BEARINGS COOL

gear base. The foundations should be separate from all other concrete work and an open joint made with the floor so that as little vibration as possible will be transmitted to surrounding structures. The height of the rolls should be such that the workmen will be able to lift the bars from the wagons to the guides and stick them with minimum effort. Under usual conditions this height is about 34 in., measured from the floor to the opening between the rolls.

With well-designed bearings there should be no trouble with hot necks on the rolls. All the pinion and roll bearings should have bronze liners. Lubrication of the rolls is accomplished by laying a swab of waste covered with heavy graphite grease against the necks of the rolls. In addition, a cold-water spray is turned against the necks from each side as shown in Fig. 3. Heavy machine oil has worked satisfactorily in the pinion stand bearings.

In the first rolling operation, breaking down, the reduction should be as great as possible without making the bar too long for the table of the overhauling machine. For this reason a gage stick for the maximum allowable length of bar is kept at the rolls and the reduction varied, so that the full-length sheared bar will not come too long and all bars of the same nominal thickness are given the same reduction. In sticking, the bottom end of the bar is entered first as it will be square, clean and free from oil, which is not the case with the sheared or top end of the bar. The presence of oil will prevent the rolls biting on the bar and occasionally it is necessary to dust charcoal on the sticking end of the bar in order to make it enter.

A dab of kerosene oil is placed on the upper side of the bar a few inches from the sticking end. This serves to lubricate the rolls and tends to keep the metal from turning up. After breaking down the bars are ready for overhauling.

A phrase much used by brass rollers is "the metal does (or does not) behave well," and assuredly there is good reason for the use of such a verb in describing the rolling of brass. There are so many curious variations in product under apparently identical operating conditions, owing to obscure and perhaps unknown causes, that the workman may well be excused for unconsciously attributing his troubles to the vagaries of an animate spirit in the metal. Of course, under the directions of a skilled roller these difficulties are quickly remedied. However, at times bars will come curved and bent in some direction, will gage unevenly or not finish smoothly, and patience must be exercised in finding the cause. Some of the troubles may be owing to bars being cast in old or improperly made molds, and therefore be of uneven thickness; to a difference in diameter of the rolls; to the heating of the necks of the rolls; to incorrect height of the bottom guide above the center of the rolls; to the kind of lubricant used on the metal; to dust and dirt in the atmosphere; to uneven annealing; to improper pickling; to unusual variation in chemical composition of different bars or within the same bar, or other causes.

The fundamental principles to be remembered in any consideration of the action of the rolls on brass bars of uniform thickness are that the rolls spring apart in proportion to the total pressure exerted on the metal; that the amount the metal flows or the bar elongates at any

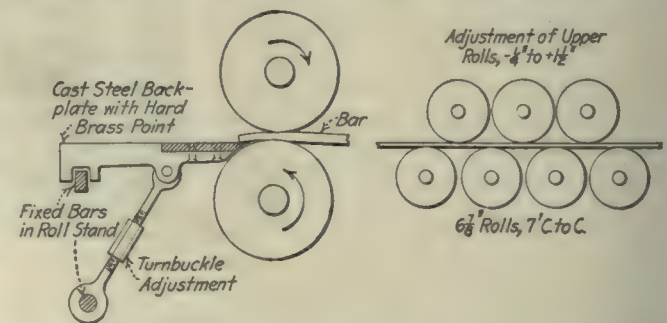


FIG. 4. POSITION OF BACK PLATE

FIG. 5. DIAGRAM OF ROLL POSITIONS

point depends upon the pressure the rolls exert and the hardness of the metal; that the metal may vary in hardness owing to chemical composition and inequality in annealing or previous working; and that, theoretically, the peripheral velocity of both upper and lower rolls should be the same. In addition, a further consideration is that bars are not always of uniform thickness and that variations in thickness may occur in the same bar. From these facts it is evident that unless the metal is uniform and homogeneous in every particular, bars will tend to turn up or down in the rolls, hoop, curve or bend, and it is in handling the metal with usual mill variations from uniformity that the skill of the roller is brought into play.

If there is a small difference in the diameter of the rolls, the larger roll should be placed on the top as this will tend to turn the bar down. In breaking down it is difficult to set the guides so that all the bars will come straight as they are rolled from the rough, and therefore

it is the usual practice to make the bars turn down. The curve in the sticking end of the bar will be determined by the setting of the back plate as shown in Fig 4. The back plate is set up as far as possible, care being taken that the rolled bar does not catch and tear out the plate. This back plate should have a hard brass wearing plate or point. The front guides should have adjustable bottom guides of bronze so that the metal will not seize or

satisfactory, but several passes are needed to bring the bars flat. The principle of straightening is to curve the bar in one direction on the first pass, turn it upside down and remove the curve in the further successive passes required. Obviously, a five or seven-roll machine is simply a combination of three-roll straighteners in series, and the operation may be done in one pass in such a machine. The rolls are set to remove the greatest kink in the bars,

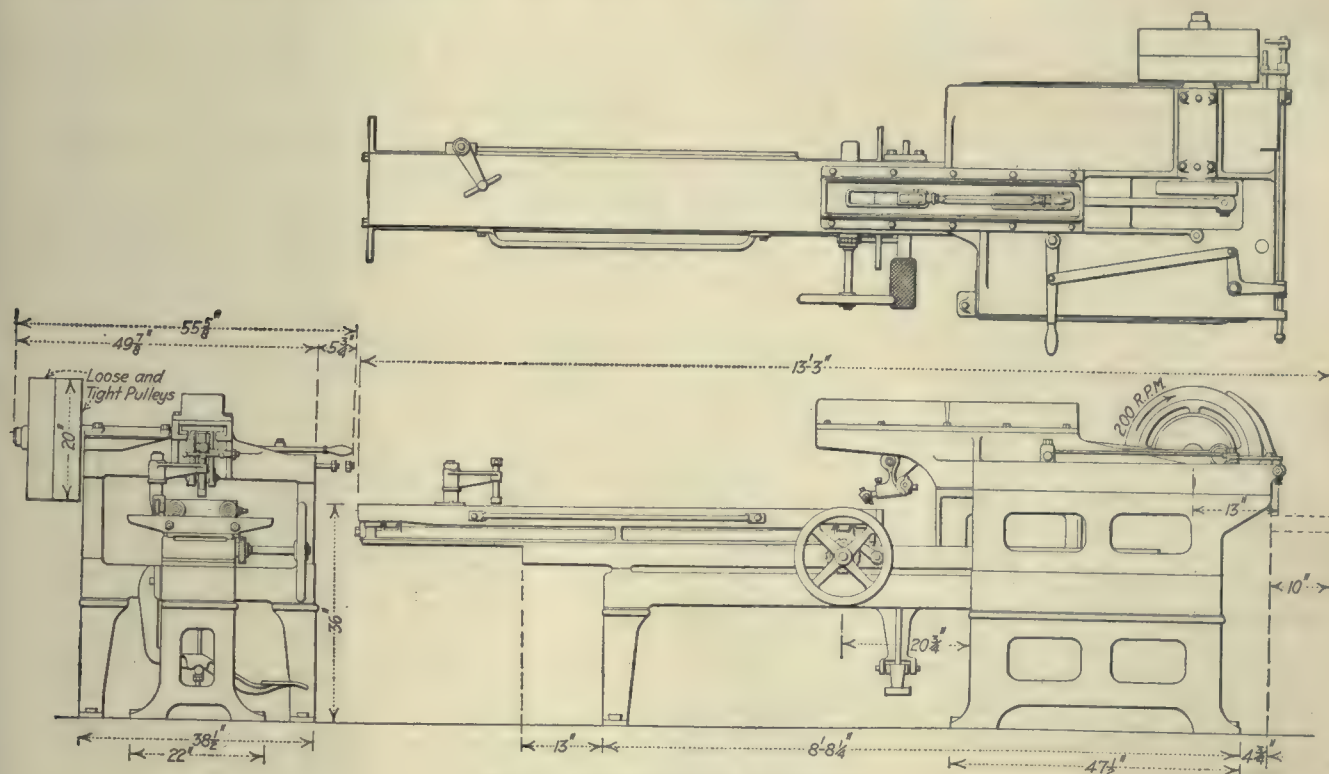


FIG. 6. OVERHAULING MACHINE

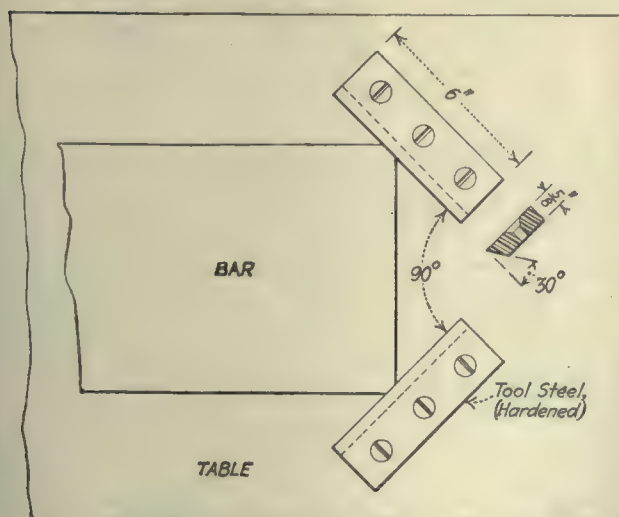


FIG. 7. TYPE OF CLAMPS USED

tear. The side guides may be of cast iron or steel with hard steel wearing plates.

Preliminary to overhauling, the bars must be straightened so that they will lie flat on the table of the overhauling machine. The straightening is done with a set of rolls, the upper and lower rolls being staggered as shown in Fig. 5. The number of rolls required depends on the thickness of the metal and degree of flatness required. For many purposes a three-roll straightener is

and small variations in thickness have no effect other than increasing the driving power required. Derived from some experience with two different types of machines, the following points should be considered in selecting a straightener. All rolls should be driven—that is, no idler rolls; rolls should be as small in diameter as possible consistent with strength for the work to be done, rolls should be set on close centers horizontally—that is, within $\frac{1}{8}$ in. of the diameter; the housings should be such that a broken roll may be removed and replaced without tearing down the machine; a parallel adjusting device should be attached to the adjusting screws so that the rolls may be set parallel, quickly and accurately; and the power should be ample. On a seven-roll machine with rolls $6\frac{7}{8}$ in. in diameter on 7-in. centers about 20 hp. was required. The speed of the rolls varies from 40 to 70 ft. per min.

After straightening, the bars are stacked in front of the overhauling machines. One of the latter is shown in Fig. 6. It is simply a light, high-speed, draw-cut shaping machine adapted to the special requirements of removing the surface metal from the sides of the bars. The tool is provided with a cam lift for the reverse stroke. The machines described run at 200 r.p.m. and have a 9-in. stroke of which about $7\frac{3}{4}$ in. is effective, the loss being due to the cam action. The table slides in both directions horizontally on rollers, and is moved by hand. The entire table and rails are raised, and the work fed to the tool,

by a foot lever that enables the operator to vary the pressure against a stop and thus obtain a slight variation in depth of cut. The metal removed is from 0.020 in. to 0.040 in. in thickness. The tools are of high-speed steel $\frac{3}{8} \times 1\frac{1}{4}$ in. in section, and are held in a special holder.

The bars should be overhauled all over, and for this reason the method of holding them on the table of the machine is important. The clamps provided with the machines described would not permit the tool to pass over the end of the bar, therefore a special device shown in Fig. 7 was designed. In this the pull of the tool makes the jaws bite into the brass and holds them more firmly. The bars are then turned end for end to clean up the portion covered by the front clamp. Just now we are making a new style of front clamp so that the metal not overhauled will be less than $\frac{1}{2}$ in. in length and thus make the reversing of the bars unnecessary. The tool could not pass over the front end of the bar without danger of tearing it loose from the table or wrecking the machine.

After overhauling, the bars are inspected, after which they may be returned to the operator for proper machining, rejected as scrap, or passed to the running-down rolls. The operators are provided with gage chisels for removing defects deeper than the average cut of the tool. As the bars are marked plainly on the ends with the number of the caster, it is a simple matter to keep a record of the scrap of each caster. In many instances it is necessary to cut off only an end of a bar as scrap.

The overhauling-machine operators are paid on a piece-rate basis of from $2\frac{1}{2}$ to 4c. per bar, depending upon material and size of bar, irrespective of mill variations from nominal length. The output per machine should average ten to fourteen bars per hour, overhauling all over.

After inspection, the bars are taken to the rolls for running down, which reduction is accomplished in three or four passes, reducing the metal to a suitable thickness for finishing. This work is done on the first set of rolls, known as the breaking-down rolls. The bars are sorted out into wagon loads of sixty bars, which load is used as a unit quantity of metal until it has reached the finished stage.

The run-down bars gage within about 0.020 in. of the same size, but vary somewhat in temper or hardness. Therefore in order to facilitate finishing the bars are annealed. In this case the annealing is done to bring all the metal into the same condition as regards temper and not because the metal is too hard to allow further reduction without splitting or cracking. For it is evident from previous discussion of rolling, that if the bars are of the same degree of hardness or softness and about the same thickness, they can be finished to dimension without sorting and with the least number of passes. After annealing the bars are pickled to remove scale and are then ready for the finishing rolls. The annealing and pickling will be discussed later. The finishing roll stand is practically the same as the breaking-down roll stand with the exception that the rolls run at a higher speed, as previously mentioned. The rolls are ground once or twice a week as required, the smooth surface being obtained by traversing the rolls with a stick fitted to the curve of the upper and lower rolls, using a mixture of No. 60 emery and oil. This operation usually requires three or four hours.

A scheme of reduction for one grade of cartridge brass is as follows:

	Inches
Cast bar	1.000 $\pm$ 0.020
Breaking down	0.750 $\pm$ 0.015
Running down	0.650 $\pm$ 0.012
Running down	0.550 $\pm$ 0.010
Running down	0.450 $\pm$ 0.008
Anneal	
Finishing	0.384 $\pm$ 0.005
Finishing	0.374 $\pm$ 0.003
Finishing	0.368 $\pm$ 0.001
Anneal	

In the last pass on finishing, the bars are sorted into lots of the same size covering a range of variation of not more than 0.002 in. Each lot is then rolled to finish gage at one setting of the rolls, a different setting being determined for each lot.

Commercial brass is usually listed under grades of temper or hardness as follows:

Dead soft	Soaked after annealing
Soft	Annealed
Half hard	Rolled from soft—2 to $2\frac{1}{2}$ numbers
Hard	Rolled from soft—4 numbers
Spring	Rolled from soft—6 numbers
Hard spring	Rolled from soft—8 numbers

The notation added indicates the method by which the different tempers are produced. The soaking is holding

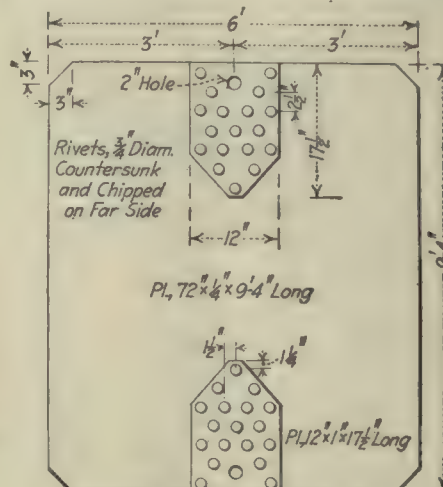


FIG. 8. BAR-ANNEALING PAN

the metal at the temperature of annealing for about eight to ten hours. The majority of flat brass used is under $\frac{1}{2}$ in. in thickness and usually comes within the range of the Brown & Sharpe gage. To produce the tempers listed, a reduction from soft metal by the number of gage sizes or numbers given starting at any size is required.

As is well known, working brass by rolling, hammering, etc., hardens it, increasing its tensile strength and decreasing its ductility. This condition is removed by annealing or heating the brass to a definite temperature that produces changes in the crystalline structure of the metal and a condition of softness, depending upon the temperature reached. Microscopic examination shows that the fine crystallization of the hard metal is changed to a coarse crystalline structure. The term "temper" is used to describe the varying conditions of hardness of the metal. As mentioned before, brass is annealed in many cases to facilitate rolling to gage and not because the metal is too brittle.

As proper annealing depends mainly upon the temperature reached, it follows that the furnace must have an even temperature; that the metal must be so disposed as to absorb heat and increase in temperature at the same rate in all the bars, and that there should be a

reliable method for determining the temperature in all parts of the furnace.

The furnaces generally used are of the muffle type, using gas, coal or oil as fuel. A usual size is about 6 ft. 6 in. wide, 32 ft. long and 3 ft. high, so that three pans 6x10 ft. may be used in tandem. The annealing pan used is shown in Fig. 8. These are coupled together by pan hooks shown in Fig. 9. The metal is loaded on the pans in the rear of the furnace and pulled in by a motor-driven winch placed in front of the furnace. This winch also is used to pull out the loads. In ordinary work the bars are piled flat on the pans, but as the specifications for cartridge brass require close limits in tensile strength and elongation, the annealing must be more than usually accurate, and in order to secure even heating the bars are set on edge on a fixture shown in Fig. 10. For annealing 67 to 33 per cent. brass to secure a minimum tensile strength of 43,500 lb. and a minimum elongation of 57 per cent. in four inches, a temperature of about 1,250 deg. is sufficient, keeping the metal in the furnace for the time required to bring the metal to an even heat all

This is especially objectionable when pickling the finished metal after final annealing.

Metal is rarely handled in bar form longer than 18 ft. as greater lengths are coiled. Tanks about 4 ft. wide, 20 ft. long and 2 ft. 6 in. deep are standard. Timber such as cedar, yellow pine, etc., in finished planks 3 in. thick mortised and bolted together with $\frac{1}{2}$ in. iron stud bolts is usual construction. The acid tank is lined with $\frac{1}{8}$ in. sheet lead.

The method of dipping the bars varies with the crane facilities. Excellent work has been done by pickling each load of sixty bars in slings made of brass bars bent up for this purpose. A ten-ton crane picks up the load from the furnace front and carries it directly to the acid tub. An immersion of ten or fifteen minutes should be sufficient to clean the bars to a bright yellow, free from scale or discoloration. Afterward the load is rinsed in two tubs of clear water—the latter preferably hot to assist in drying. The water from the second tub is led through an overflow into the first. The bars are dried by covering with sawdust that is then removed by brushes. Machines, with power-feed rolls, can dry the bars quickly and far more cheaply than any other method. The metal is now loaded on a wagon and taken to the pressroom for blanking.

In general, good results may be obtained if the general foreman, rollers and furnace foreman are of the type of skilled workmen, the rest of the help required being common unskilled labor broken into the nature of the work. A breaking-down mill requires a roller and three helpers; a finishing mill, a roller and four helpers; the furnaces, two furnacemen and necessary helpers, depending upon the volume of the work and facilities for handling it; pickling tubs, foreman and necessary laborers; overhauling machines, one operator per machine.

As regards production, no data of value can be given as the quantity of work required to produce each of the numerous standard sizes and grades of flat brass varies greatly and does not permit of generalization here. With the equipment described, it is possible to finish 1,500,000 lb. of cartridge metal per month, working sixty hours per week with smooth operation.

In conclusion, the field for the investigation of rolled copper-zinc alloys to determine accurately the properties of each permutation of such factors as chemical composition, kind of impurities, percentage of impurities, total percentage of reduction, number of passes to obtain given reduction, temperature of annealing, time of annealing, temperature gradient in annealing, manner of cooling, etc., seems almost limitless and the results of such investigations are of inestimable value to the general fund of engineering knowledge.

Precautions in Casting Metal Patterns

Patterns cast in metal are required to have a good surface. To secure this care must be taken not to have the metal too hot. The molds can be of green sand lightly rammed, but should be as dry as possible for proper working. If such a mold is poured with metal too hot, one or other face will be bad. The metals usually employed for patterns can be cast at a relatively low temperature, and in fact should be so cast in order to get the best results.—*Brass World*.

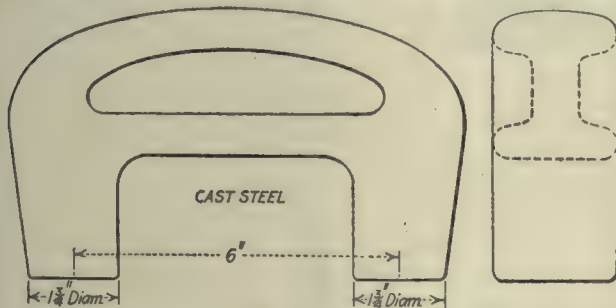


Fig. 9

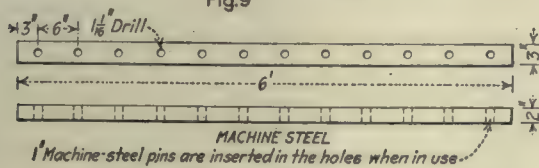


Fig. 10

FIG. 9. PAN HOOK. FIG. 10. FIXTURE FOR HOLDING BARS

over. This is best determined directly by the color or by a pyrometer working on the radiation principle. The points of thermo-couple pyrometers are not always the same temperature as the metal and each may be affected differently by currents of gases in the furnace. The length of time the metal is exposed to a constant temperature does not seem materially to affect the strength of the metal, at least for small differences of an hour or two. Usually, however, the temperature continues to run up after the firing of the furnace has stopped and thus the condition of constant temperature is not realized. Quenching or cooling slowly does not seem appreciably to affect the strength of the metal.

The annealed metal has a slight scale on it that must be removed before finishing. This is done by dipping the bars in a pickle solution of 10 to 15 per cent. sulphuric acid. Acid and water are added each day to make up the strength of the solution and to replace the drip loss on each bar. The acid acts more quickly and effectively if heated by a steam coil to about 150 deg. F.

The concentration of copper sulphite in the solution should be checked frequently, for when it is high a large amount of acid will be required and there is a tendency under certain conditions to plate out copper on the bars.

A Small Louisiana Repair Shop

If anyone doubts the existence of the all-around machinist of the older day, he has only to visit a few such shops as that illustrated herewith. The work handled varies from sewing machines to the steam



A SMALL LOUISIANA REPAIR SHOP

tractors shown, with automobiles and centrifugal pumps stuck in between.

The equipment consists for the most part of a small lathe, a vertical drilling machine and the usual equipment of drills, taps and reamers of all sizes likely to be needed. The shop is in Jennings, La., and the man who handles any job that comes along is Harry H. Eaton, whose name appears on the sign.

❧

Foreign-Trade Suggestions

BY P. C. LITTLE

It is generally concluded that the American machine industry will enter considerably into the economic up-building of Europe after the war. Therefore, manufacturers would do well to become fully conversant with what European buyers require, at the same time realizing what criticism the machines are subject to in the eyes of the buyers.

The writer during the past two years has inspected an enormous quantity of material for foreign governments and is familiar with manufacturing conditions in this country and in Europe. Therefore, knowing the opinions of many European buyers regarding American products, it is desired in this article to set forth a few defects covering chiefly the finish and appearance of the machine, defects that the American manufacturer desiring export business would do well to avoid and correct.

European engineers admire the efficient quick-production methods in force at our plants and also our designs, but candidly detest the carelessness of the workmen which is prevalent in many factories. This carelessness at present is unfortunately greater because of capacity business, which has meant breaking in numbers of "green hands."

Very few makers seem to realize the importance of having bolts of sufficient length to protrude beyond the outside of the nuts, or even of having them flush. At the plants where the writer has visited it is an exception to find this point free from criticism. It is no more ex-

pensive to make and fit up bolts of correct lengths; and manufacturers should realize that this defect, which, it is surprising to find, is considered only trivial by many, is almost a cardinal sin to a European engineer.

Extreme care should be taken to see that grease cups and oil cups are well threaded in place and that cotter pins are opened. Riveting, especially in the automobile industry, is not done according to European standards. The writer has been surprised to find how many concerns are riveting cold the rivets as large as $\frac{1}{2}$ in. in diameter, which can only result in a poorly finished head. It is admitted that in many cases the above defects do not prevent the machine from giving entirely satisfactory service and in many cases only affect the appearance of the machine; but surely it is worth while correcting such details, which certainly entail no extra expense. To sell goods and keep them satisfactorily sold, a manufacturer must give the purchaser what he requires or even demands, and it is a certain fact

that the European purchaser considers the clean finish and appearance of a machine to be absolute requirements.

One word about packing material: Do not let a machine or part leave the factory with even a suspicion of rust. If parts do rust during production, do not try to cover this up by coating with heavy oil, but clean thoroughly and then oil. Heavy oil and grease are cheap and should be used liberally in the shipping room. Some time ago the writer received instructions from Russia which translated literally said, "Grease must be applied more than sufficiently."

Rigid inspection will do much to insure a clean-looking machine, if the inspection starts in the foundry and ends when the machine is crated.

❧

Machinist or Draftsman?

BY A. D. MUNDY

Whenever this subject comes up for discussion, I feel compelled to ask this question, Would the average machinist be any more successful than the average draftsman if he should enter that field of endeavor? Does the average machinist use any better judgment than the average draftsman? I am of the opinion that he does not, and good judgment is one of the chief essentials.

Now there are expert mechanics who can lay out a complete set of cams and tools for the automatic screw machines, or a set of dies for the manufacture of some article, or who, when given the requirements, can develop a special machine. These no doubt would make excellent draftsmen; but these men are too scarce to be spared from the shop, and they command salaries that compare favorably with those paid in the drafting office. They also enjoy a freedom of design which would not be allowed in many drafting offices. The main thing that is requested of them is results.

One thing which I have observed is that when one is devoting all of one's energy to produce a machine that will give certain movements or series of movements he is apt to overlook certain elements of construction.

Foreign Trade in Machine Tools During Fiscal Year, 1915

BY LUDWIG W. SCHMIDT

SYNOPSIS—A group analysis of American machine-tool exports, according to value, absorbed by the various markets. Compared with preceding years, there has been a great rearrangement of the different countries. In general, the change outside of Europe has not been at all satisfactory.

The value of statistics as an aid to industrial development lies in the help given by compiled figures to estimate the present and future tendencies of the markets. Most statistics compiled by governmental agencies unfortunately fail to give the necessary aid, either by attempting too much or by being published too late to be of any material use to the manufacturer or dealer. So the publication in the middle of June, 1916, of the export and import figures of the United States for the fiscal year 1915, covering the period July 1, 1914, to June 30, 1915, is much too late to be of any assistance or value to a manufacturer who needs more than the few facts given in the monthly statements. To offset this deficiency I made for the *American Machinist* during the last year an estimate of the actual trade in machine tools with several of the most important markets. While this estimate was out a few thousand dollars of the actual values exported, nevertheless the figures gave to all those interested a fairly correct statement of the trade done.

The figures then obtained are given below beside the actual amounts now shown by the official report of the Bureau of Foreign and Domestic Commerce.

	Estimated Values	Corrected Values
France.....	\$ 8,695,826	Official, taken from monthly statements
England.....	12,294,801	
Germany.....	121,756	\$2,123,195
Russia in Europe.....	2,113,000	
Italy.....	515,000	511,134
Austria-Hungary.....	25,000	24,256
Denmark.....	245,000	247,244
Netherlands.....	80,000	79,403
Norway.....	210,000	211,640
Sweden.....	625,000	621,458
Spain.....	105,000	98,693

Even with the handicap, however, of having to deal with such stale figures many matters of interest may be read out of the full statement now published. Naturally a considerable change in the trade relations between this country and other markets could have been expected, and the results have shown how correct these expectations have been. A close study of the export figures for the year 1914-1915, which is practically the first year since the outbreak of the European War, also brings out very clearly a peculiar steadiness in the demand for American-made machine tools that possibly may astonish those who thought that these machines had been regarded by the world's market as something like a luxury. It is therefore well worth while to deal with a few of the facts brought out by the Government statistics, and also to draw from them such conclusions as may be of general interest.

Naturally, in contemplating figures that have been produced by so elementary an event as the European War, one feels inclined to draw comparisons with former years.

Such comparisons, when made for each individual market or country, are often astonishing and make interesting reading; but they tend also to give an entirely wrong picture of the actual economic movement that has taken place. One or the other country began to buy under the pressure of economic necessity larger quantities than usual, a thing that, of course, has happened to a great extent since the outbreak of the war. But it is the economic movements in the great groups of foreign buyers that finally must instruct the reader as to the real force of events. In dealing therefore with the exports of American machine tools during the first year of the war, and the changes that have taken place, the method of grouping the markets according to their buying power has been taken and Table 1 was prepared.

FACTS BROUGHT OUT BY THE GROUPING IN TABLE 1

This grouping at once brings out an outstanding fact. For the first time since America has started to export machine tools there have been two markets, each able to consume more than \$4,000,000 worth of these machines. England has moved to that high mark from her former solitary position in the group of countries buying between \$3,000,000 to \$4,000,000 worth. France has made even a larger jump, coming up from those countries buying from \$1,000,000 to \$2,000,000 worth. On the other hand, Germany, which formerly belonged among the leading customers for American machine tools, has dropped to those buying less than \$200,000 worth. Russia moved up one grade, from \$1,333,644 to \$2,123,195. Canada, while buying more, remained among those markets buying machine tools to the value of \$1,000,000 to \$2,000,000, while Australia, another British dependency, dropped from that group to the one buying from \$200,000 to \$500,000 worth.

The change in the position of Germany and Belgium, the latter dropping to the group of \$20,000 to \$50,000, can be explained by the fact that the changes were brought about by the war. But there is a less satisfactory explanation for the sudden decline from Australia. A loss of business of more than \$1,000,000 in what was practically a peace market gives reason for thought. An early knowledge of this state of affairs might have induced an interested American manufacturer to try his luck in that market. Especially as it was a time when manufacturing in Australia should have been good owing to lack of competition from abroad.

Both Sweden and Italy have risen from the \$200,000 to \$500,000 group to the \$500,000 to \$1,000,000 group, while Austria-Hungary, which had belonged formerly to the same group, has gone with those countries buying from \$20,000 to \$50,000 worth.

Great and unsatisfactory changes took place in that group of countries buying American machine tools to the value of \$100,000 to \$200,000 yearly. Nearly all the countries formerly belonging to that group have gone out of it and, unfortunately, have dropped below. Only Cuba remains, losing roughly \$46,000. The Netherlands is

now among those countries buying from \$50,000 to \$100,000 worth, as also are Spain, Brazil and Japan, while Argentine has dropped still lower. How much the war has disarranged our former business connections is best realized when we see Germany now classed with the countries just mentioned.

With the exception of the great progress made in the sales to Denmark, little of real importance seems to have

TABLE 1. EXPORTS OF AMERICAN MACHINE TOOLS ACCORDING TO BUYING CAPACITY OF MARKETS

1913-1914		1914-1915	
Over \$4,000,000 worth:			
None		England	\$12,294,801
		France	8,659,826
Less than \$4,000,000 and over \$3,000,000 worth:			
England	\$3,178,630	None	
Less than \$3,000,000 and over \$2,000,000 worth:			
Germany	\$2,167,240	European Russia	\$2,123,195
Less than \$2,000,000 and over \$1,000,000 worth:			
France	\$1,771,525	Canada	\$1,813,188
European Russia	1,333,644		
Canada	1,199,356		
Australia	1,316,952		
Less than \$1,000,000 and over \$500,000 worth:			
Belgium	\$552,531	Italy	\$511,134
		Sweden	621,458
Less than \$500,000 and over \$200,000 worth:			
Austria-Hungary	\$268,010	Denmark	\$247,244
Italy	421,603	Norway	211,640
Sweden	310,613	Russia in Asia	365,389
		Australia	282,480
Less than \$200,000 and over \$100,000 worth:			
Netherlands	\$186,756	Germany	\$121,756
Spain	111,636	Cuba	100,507
Cuba	146,596		
Argentina	109,836		
Brazil	115,974		
Japan	120,166		
Less than \$100,000 and over \$50,000 worth:			
Norway	\$92,729	Netherlands	\$79,403
Mexico	74,706	Spain	98,693
Chile	85,168	Switzerland	57,403
		Brazil	55,106
		Japan	86,166
Less than \$50,000 and over \$20,000 worth:			
Denmark	\$48,204	Austria-Hungary	\$24,256
Finland	35,934	Belgium	34,416
Switzerland	22,627	Mexico	37,530
Panama	35,210	Argentina	25,700
Peru	35,294	Chile	28,430
Uruguay	20,612	Peru	31,631
Dutch East India	20,216	China	25,321
New Zealand	36,260	British India	23,700
British South Africa	28,822	New Zealand	21,679
		South Africa	29,917
Less than \$20,000 and over \$10,000 worth:			
Colombia	\$16,838	Colombia	\$11,572
China	17,668	Philippines	13,640
British India	17,953		
Straits Settlements	18,930		
Philippines	10,266		
Less than \$10,000 and over \$5,000 worth:			
Bulgaria	\$8,173	Honduras	\$5,418
Portugal	8,903	Venezuela	6,975
Bolivia	9,896	Japanese China	6,559
Ecuador	5,077	Portuguese Africa	8,072
Japanese China	6,909		
Less than \$5,000 worth:			
Roumania	\$3,329	Roumania	\$1,200
Azores	416	Azores	272
Gibraltar	10	Gibraltar	200
Greece	548	Greece	779
Malta	965	European Turkey	210
European Turkey	1,911	Bermuda	50
Bermuda	131	British Honduras	273
British Honduras	435	Costa Rica	48
Costa Rica	2,602	Guatemala	294
Guatemala	4,312	Nicaragua	449
Honduras	110	Salvador	36
Nicaragua	1,104	Newfoundland	519
Salvador	2,108	Jamaica	333
Newfoundland	958	Trinidad and Tobago	300
Jamaica	755	Dominica	4,515
Trinidad and Tobago	1,445	Dutch West Indies	15
Dominica	2,990	British Guiana	163
Dutch West Indies	31	Small British Indies Possessions	450
Haiti	125	Siam	354
British Guiana	61	Turkey in Asia	4,529
Paraguay	237	British Oceania	205
Venezuela	4,950	British West Africa	2,153
Small British Indies Possessions	589	Egypt	69
Hong Kong	680	German Africa	860
Russia in Asia	1,381	Finland	2,784
Siam	1,449	Portugal	1,612
Turkey in Asia	1,468	Danish West Indies	12
British Oceania	309	French West Indies	250
British West Africa	557	Bolivia	291
British East Africa	300	Ecuador	3,567
Egypt	2,839	Uruguay	1,845
German Africa	308	Aden	125
Portuguese Africa	4,523	Straits Settlements	3,514
		French Africa	500

happened among the lesser customers of American machine tools. As an unpleasant feature must be mentioned the addition of many countries to that group of markets buying below \$5,000 worth each, among which are Finland, Portugal, Ecuador, Uruguay and the Straits Settlements.

The trade with individual countries, however, cannot be regarded as the only guide for a study of the business of the machine-tool industry as indicated by the exports. The conditions of the different groups also will have to be taken into consideration. In this respect the following figures, showing the development of the exports to the different larger units of the world, may be of interest:

	1913 to 1914	1914 to 1915
Europe	\$10,525,897	\$25,129,282
North America	1,472,994	1,969,858
South America	403,943	165,280
Asia	207,389	538,946
Oceania	1,363,787	318,011
Africa	37,349	41,571

The great advance in the sale to Europe has been no surprise to those who know the trend of business; but the loss of business to those markets, which by the nature of things could not be affected much by the war, although no surprise to those who have watched the market during that first year of the war, seems to have been avoidable. Viewed in buying groups, according to the amount of the orders, the first year of the war has increased the predominance of the large buying group over the group buying below \$200,000 worth. The dropping out of Germany from among the large buyers has had no influence at all, as it has been offset by the increasing orders that came from England and France. Viewing the groups with a buying power below \$500,000 we find that the orders secured in the group from \$200,000 to \$500,000 show in its total only a small change. On the other hand, that group ranging from \$100,000 to \$200,000 shows a heavy loss. As already explained, this results from a reduction in the orders coming from certain countries that now help to swell the group of markets buying between \$50,000 to \$100,000 worth.

So the fact that the exports of machine tools during the first year of the war rose from \$14,011,359 to \$28,162,968 unfortunately is not all a cause for joy, quite apart from the fact that 50 per cent. of the increase at least has to be set down as the result of unhealthy economic conditions.

IMPORT OF MACHINE TOOLS INTO THE UNITED STATES

Turning to the import side, figures are given for the first time for the year 1914 to 1915. No comparison with former years is possible. Also the year is one badly suited to the purpose of studying the sources of supply for foreign-built machine tools used in this country. Germany, Belgium, England and Canada are given as the most prominent sources.

Following are the specified figures:

Imported from	1914-1915	Imported from	1914-1915
Austria-Hungary	\$ 1,829	Scotland	\$1,790
Belgium	31,633	Canada	13,470
France	2,902	Honduras	25
Germany	84,211	Mexico	45
Greece	17	Cuba	89
Netherlands	422	Japan	100
Switzerland	2,380	Australia	262
England	21,250	British South Africa	61

Of the countries represented in the foregoing tabulation only Germany, England, Belgium, Canada, and possibly France, can be called sources of supply. The total amount was only \$160,486. One naturally wonders what it will be after the war, and what it might have been if the war had not interrupted the trade.

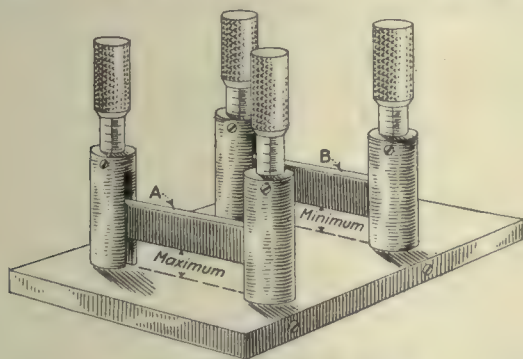
Letters from Practical Men

Adjustable Limit Gage for Munitions Parts

Shrapnel fuses and the like are extremely exacting as regards the dimensions of their component parts. In many cases the quantities to be handled run into the millions, and the usual types of snap gages, though well suited for set-ups and periodical checking of the product at the machines, prove extremely slow in handling the final inspection.

In order to gage the overall dimensions, both maximum and minimum, of quite an assortment of small parts I have found the gage here illustrated most satisfactory. For want of a better title we will call it a "bridge" gage. To the best of my knowledge it is new in general shop use, though I believe the principle is old.

A small surface plate or any true-surfaced steel or cast-iron slab may be used as a platen. Inserted in this are



ADJUSTABLE LIMIT GAGE

two pairs of hollow pillars, slotted to receive a pair of thin parallel-sided straight-edges. The distance between the surface plate and the straight-edge is controlled by the micrometer plugs, the straight-edges being held against the plugs by springs.

It is quite obvious that if the straight edge *A* is set to the maximum and *B* to the minimum, any part that will pass under *A* and refuse to pass under *B* will be within the limits.

It is not necessary to go to the refinement of design here shown to gain the same ends, as like results can be obtained by using merely parallels and size blocks, clamping these to the surface plate with C-clamps; but as we had a variety of parts, all well within the scope of the micrometer plugs, the added expense was more than offset by the ease and accuracy of the setting.

By arranging the device on a slight incline the parts may be rolled or slid down to the "bridges," and the gaging will prove to be extremely accurate.

Woonsocket, R. I.

JOHN R. ANDERSON.

Method of Chucking Work in the Dividing Head

It was required to mill a tongue on 50 turned pieces, as shown at *A*, Fig. 1. The pieces were first turned in the

lathe to dimensions *B*, *C*, *D*, *E* and then secured in the chucking device seen in Fig. 2. This consists of a tapered collet to fit the index head and of a nut bored out to fit the pieces.

A pair of gang or straddle mills was employed for the milling operation. The packing between the cutters was 0.099 in., a thousandth more than the dimension *A*. The

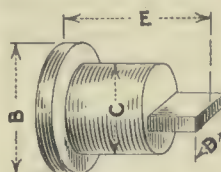


FIG. 1

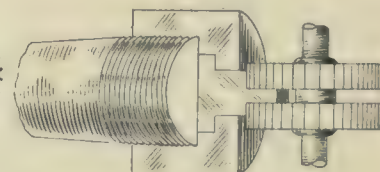


FIG. 2

CHUCKING WORK IN THE DIVIDING HEAD

table of the miller was adjusted transversely so as to mill off one side of the piece to the required depth with the outer side of one cutter. Then the piece was run in to its proper position between the cutters, the finished side just clearing the first-mentioned cutter.

The graduation on the dial of the feed screw was noted to facilitate the operation. This lot of 50 was turned out in about the same time, including the making of the device, as a previous lot of 10, which had been milled after much difficulty, due to the pieces jumping out of the vise while being milled.

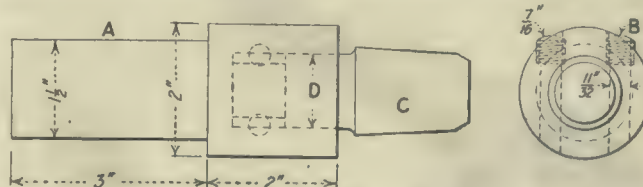
WALTER GABRIEL.

Newark, N. J.

Pipe-Tap Holder

The illustrations show a 1-in. solid pipe-tap holder we recently designed and made in various sizes. The holder is shown at *A* with the tap *C*. In the section the tap has, for clearness, been removed.

Our work is such that the taps are required to do very heavy duty, and therefore a frequent renewal of the tap



PIPE-TAP HOLDER

is necessary. The tap holder was designed to give a positive drive, prevent the tap from pulling out at reversal and afford a rapid means of renewal when worn.

The body *A*, of machine steel, is first turned all over to fit a magic chuck or hole in a turret. Two $\frac{1}{2}$ -in. holes are drilled through for the drive pins *B*. These holes are so located as to bring the body of the pin *B* about $\frac{1}{8}$ in. into the squared shank of the tap *C*. The holder is then returned to the lathe and the hole *D* drilled and the bottom squared. The two holes for the drive pins *B* are tapped at one end. The pins *B* are made of drill rod,

hardened and drawn to a dark brown. The tap has two grooves ground across opposite flats of the shanks for the pins *B*.

With this type of holder various makes of commercial pipe taps may be used in one holder, as ordinarily the hole *D* may be made sufficiently large to accommodate small variations of size in the shanks of the taps.

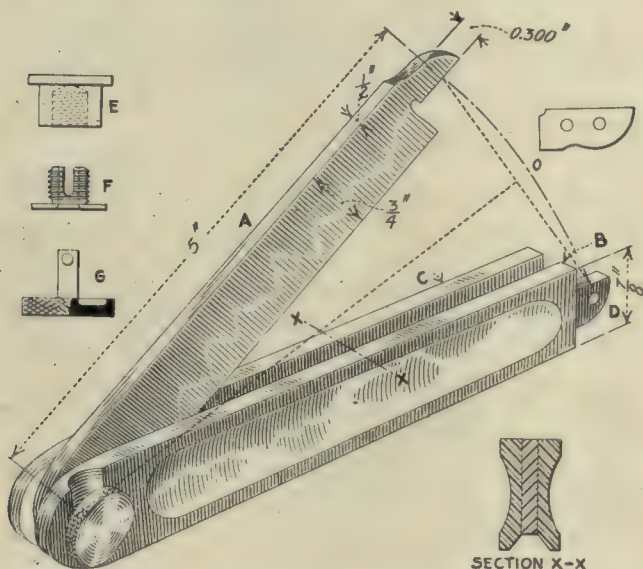
Springfield, Mass.

CHARLES F. ROGERS.

A Sine Protractor

The illustration shows a sine protractor that combines the accuracy of the sine bar and the usefulness of the bevel protractor.

The checking of an angle with the sine bar requires angle and surface plates, height gage and an abundance of patience in adjusting correctly. A micrometer is the



A HANDY COMBINATION OF THE SINE BAR AND BEVEL PROTRACTOR

only requisite for setting the sine protractor. The reading would be $\sin \frac{1}{2} \text{ angle} \times \text{diameter of circle } O + \text{diameter of rounded measuring ends}$. By making the radius 5 in. calculation can be done mentally from a sine table. The protractor may be set with the height gage, but in this case the calculation would differ, being the same as setting sine bar.

The base consists of the plates *B* and *C* with a spacer *D* of a thickness to allow the blade *A* to move freely. The hinge pin *E* is tapped to receive the clamping screw *F* with handle *G* loosely mounted, allowing it to be set flush when desired. A *V* in the base adds much to its usefulness and stability.

The sine protractor is especially suited for setting lathes, grinding and milling machines or work thereon to the proper angle before starting. For setting adjustable plate taper gages it makes expensive master-plug gages unnecessary. The fact that an angle of 0 deg. 1 min. in 5 in. would be 0.0014 in. + diameter of ends shows that minutes may be accurately split if desirable. The micrometer itself furnishes amply fine adjustment for closing the blade in the downward direction.

In order to secure accurate angles on the protractor the workmanship must be above reproach.

Detroit, Mich.

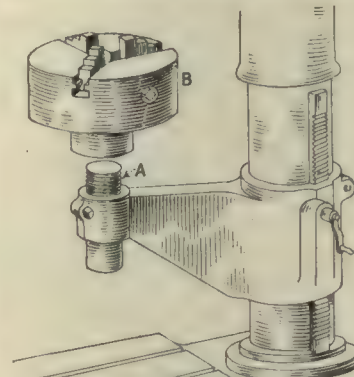
LOWELL C. BLOMSTROM.

Drill-Press Attachment

The illustration shows an attachment for a small drill press. A steel stud *A* is machined with one end threaded the same as the end of the lathe spindle and with a similar flange, while the

body is turned to fit the table arm of the press. A hole is also drilled the same size as the hole through the lathe spindle.

The drill table can then be removed, the stud clamped in place of it and a universal chuck *B* screwed on. This attachment is a convenient means for holding such things as washers for drilling



DRILL-PRESS ATTACHMENT

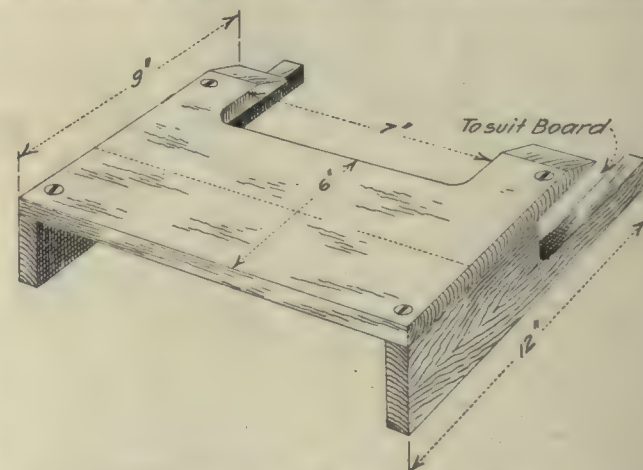
out, short pieces of shafting for center drilling and the like. Long slender rods can also be held for drilling by allowing them to extend through the hole in the stud.

Oakland, Calif.

H. H. PARKER.

Extension for Drawing Board

Having seen a number of suggestions for arm rests and drawing-table extensions for use when doing work up to or beyond the capacity of the drawing board, I am sending



EXTENSION FOR DRAWING BOARD

another one. It is interchangeable on every table, so that only a few are needed to accommodate the entire force.

Elmira, N. Y.

R. G. DICKENS.

Lubricating the Screw

There are many mechanics that fail to realize the amount of friction that occurs when a screw is driven in a machine or a tool. Even when it is essential that the screw be placed home as tightly as possible, lubricant is rarely used, and much of the energy employed is claimed by the friction that occurs at certain portions of the thread.

If the screw is free-fitting in the hole and a little lubricant is put on the thread and under the head if there is one, the thrust of the screw will get the major portion of the energy used in driving it home.

Newark, N. J.

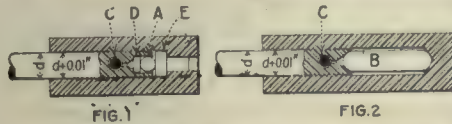
GUSTAVE A. REMACLE.

Discussion of Previous Question

Compound Float for Reamer

J. B. Murphy's letter on p. 866, Vol. 44, prompts me to offer two other somewhat simpler methods of accomplishing the same result.

It is evident from the sketches that the commercial steel ball *A*, Fig. 1, and the round-end column *B*, Fig. 2, take



COMPOUND FLOAT FOR REAMERS

the thrust, thus preventing the driving pins *C* from springing the reamer in any direction. The thrust buttons *D* and *E*, Fig. 1, should be made of drill rod, hardened; *D* should be a free fit in the end of the reamer shank, so that it will drop out easily, giving access to the center for grinding purposes.

R. K. ROWELL.

Bridgeport, Conn.

Avoiding Costly Errors in Indexing Work

Your editorial on page 785, Vol. 44, discussing errors in indexing work, calls to mind an indexing fixture that I designed, which is in constant use at the present time. As will be seen in Fig. 1, it is of sturdy construction,

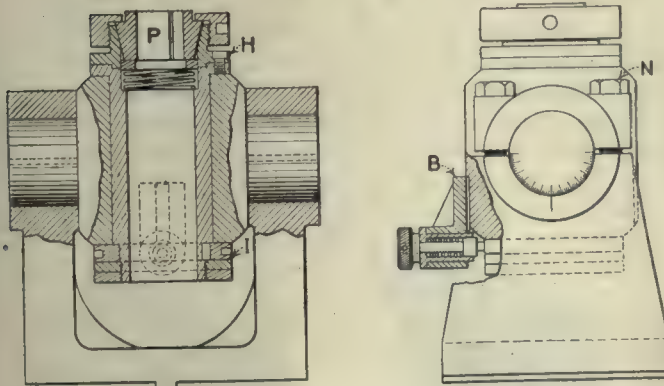


FIG. 1

SPECIAL INDEXING FIXTURES

and it has proved very useful. If these fixtures are made with indexing plates *I*, having the number of indexing holes to suit the work, it is impossible for the operator to make the mistakes mentioned in the editorial note.

The main body is made to swivel to any angle, one end being graduated. It can be locked at the desired angle by the nuts *N*, thus greatly increasing the range of work that can be milled on the fixture. Many engineers will

take exception to the hole and plunger index, as it is not so easy to manufacture accurately, nor does it produce so accurate work as the tooth type generally employed. While the hole and plunger gave satisfaction in this instance, Fig. 2 shows an index that is preferable.

The head *H* is secured in the hollow spindle, but is removable so that other heads, for special work such as that shown in Fig. 3, can be substituted. The collets *P*, Fig. 1, are of course made to suit the work and are kept up in position when the work is removed by the spring and washer shown. These collets, or jaws, are turned in a ring and afterward split into three loose sections.

If necessary to remove and replace the work, the indexing plate should not be keyed on as shown, but would have to be fixed in the spindle in such a manner that the work, when replaced, could be set correct in the collet and the indexing plate locked afterward.

Surrey, England.

P. J. TOMKINS.

The Purchasing Agent as a Safety Valve

I have read the communication by H. W. Wolff on page 1022, Vol. 44, and I am afraid he is attempting to spring a sort of nightmare on us poor machinists, who are somewhat bothered by purchasing agents. I must admit quite candidly that I have never met a purchasing agent who was a highly qualified draftsman, designer,

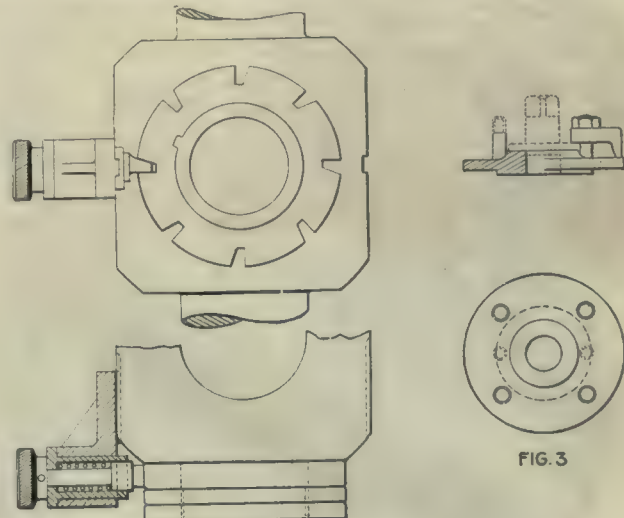


FIG. 3

FIG. 2

screw-machine expert, brass molder, die-casting expert, pattern maker, iron molder, metallurgist and foundry chemist, accountant and safety valve. Speaking for the machine shop, if such a type could be trained and tamed (otherwise he would have a business of his own), it would be necessary to be a heavyweight in more ways than one, as there would be other obstacles besides hanging on to the valve lever.

During the past 20 years I have requisitioned thousands of dollars' worth of machine-shop necessities, and the best purchasing agent I have met, from the point of a well-managed shop and the dividends earned, knew very little about the shop and the plant, but could tell you at any time, from memory, the state of the metal markets of the world. There was no interference with him when raw material was required. He neither looked up to nor down at any salesman, and personally I never appreciated his real value until contrasted with my next shop and purchasing agent.

In this shop, some time previous to my arrival, a great deal of graft had been practiced. Upon its discovery, after a hot few minutes when several individuals were unemployed, the proprietor, to protect himself, took in a partner whose sole duties consisted of purchasing everything required in the works, from twine to platinum wire. He had hardly warmed his seat when I arrived to assist the firm in making up a decent machine shop, and shopmen, if not purchasing agents, can easily understand my position. I had no trouble in getting the machines I wanted, as these were dealt with by the directors acting on my advice and the purchasing agent got his instructions direct, but with the furnishings I had a very exciting time.

The first incident occurred when I got my Landis grinder. On its arrival I requisitioned 22 ft. 6 in. of high-grade special belting for driving the grinding wheel, naming a particular make I could rely on. A few days later I received 68 ft. of the lowest-type belting I had ever seen. On referring the matter back, I was told it was a good job for the firm that they had someone who could buy three belts and save money, against my solitary one belt. I then gave a lecture on "Belting, What It Is and What It Isn't," and in the end got my special brand ordered.

Matters went on in this way for a few months, during which time I had collected nine different makes of milling cutters with three different sizes of keyways; five different makes of $\frac{1}{2}$ -in. taps requiring four different sizes of tap wrenches, and six different makes of twist drills, none of which were of the brand I had specified. One morning I visited the board room with an armful of these specimens and respectfully asked for a rearrangement of my salary—the fixed monthly one to be increased, and the quarterly one, which fluctuated according to output, dropped altogether. I used many arguments, but my winning point was the fact that I wanted the toolroom attendant to give out a set of taps and a wrench without the necessity of looking at them.

The head of the firm appreciated my view of the matter, and from that date until I left, a firm's name on a requisition form of mine was quite sufficient to insure the order going through, except in very special circumstances. Many instances of this sort could be given to show the different views of the machine-shop superintendent and the purchasing agent. It may be a safety valve on cash expended to buy taps in the cheapest market; but if it means inferior quality and another size of tap wrench, it is more correctly described as a leaky "blowoff cock."

The most valuable asset to any firm is honesty and loyalty. If the purchasing agent and the shop superintendent have these points well developed, the type suggested by Mr. Wolff is quite unnecessary. To come nosing around the shop would, as suggested by Mr. Wolff,

undoubtedly create friction, however delicately handled, and would operate to the firm's disadvantage.

Quite recently I had an experience with a purchasing agent which was new to me. Having a small patented tool of my own, I wrote a large local firm offering to send one on free trial, and in due course the offer was accepted and my tool sent. A few days later the purchasing agent sent me a curious kind of letter pointing out that the device was a failure, but that a slight alteration might make it useful. I asked to be allowed to call, and an appointment was made and fulfilled. The purchasing agent immediately and quite frankly admitted that he knew nothing about the device or what it was supposed to do, a confession which made me more anxious to serve him if at all possible. I was escorted to the works manager, with instructions to report again at the agent's office. To cut the story short, I found that my device, which was intended to shorten the machine stoppages, could not in this case be applied. But the manager pointed out that if the handle was shifted it would be the very thing wanted. I explained that I could make the alteration, and I estimated the machine stop at four minutes against the thirty-five then occurring, but it would add somewhat to the cost. The manager replied, "You must talk that over with Mr. Buyer; I'm saving time in here, not money."

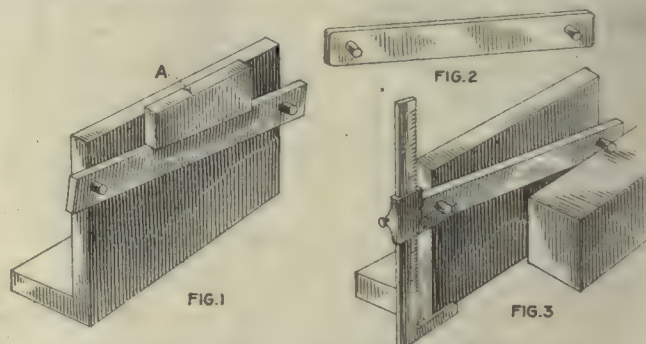
I returned to the purchasing agent and explained matters, making a strong point of saving thirty-one minutes, before introducing the extra cost, but the same feeling permeated this office: Save time, go ahead. My alteration proved successful, I got a letter saying it was all right and inclosing check against my invoice. This transaction impressed me with the idea that with the right man in the stokehold we need not bother much about the safety valve.

F. P. TERRY.

Belfast, Ireland.

Improved Type of Sine Bar

I have read with interest W. G. Grocock's comment on the sine bar on page 77; but I fear he is mistaken about the sine bar and its merits being well known, at least in this part of the world. Judging from the merits of the tool and the publicity it has received in handbooks and



IMPROVED TYPE OF SINE BAR

periodicals, it is surprising that the sine bar and its uses are a mystery to the majority of the tool makers I have come in contact with. To date I have never worked in a shop nor met a tool maker possessing a sine bar.

The design of the angle plate and sine bar shown on page 77 is very good for such work as may come within

the range of the tool. That range is quite limited, however, and this fact will militate against such design for use on general precision-tool work. Tool makers may be called upon to machine or grind angles on pieces of all imaginable shapes; therefore the sine bar should be of such construction that it can be used universally.

A piece shaped like A, Fig. 1, could not be located and held very readily on Mr. Groocock's device unless the angle plate were turned upside down. And if holes are drilled for clamping different jobs, the angle plate will soon lose its initial accuracy.

I employ a plain bar, Fig. 2, with $\frac{1}{4}$ -in. buttons 3 in. from center to center. With this bar, having the buttons on one side only, I may employ any size of angle plate that may be desired for a certain job, or the bar may be placed upon any part of the angle plate best suited for the work at hand.

When setting the bar, Fig. 3, I first determine which size of parallel block will raise the first button to about the right height and place it under the button. Knowing the dimension of this block, I set my plain slide gage to the other required dimension and place it under the other button of the bar. With the bar thus located, I can easily clamp to the angleplate and proceed with further operations.

GUSTAVE A. REMACLE.

Newark, N. J.

✱

Taper-Shank Drills

I have read with interest the articles on pages 554, 870 and 1090, Vol. 44, in regard to taper-shank drills.

I quite agree with S. H. Cox that the twist-drill manufacturers have been progressive. I remember drills with large taper shanks, made by an American manufacturer, which were in use in a shop near here about six years ago. These drills were a standard production and were purchased on account of the continual breakage of tangs on drills having small taper shanks.

I do not see, with A. P. Moore, that the extra steel is turned to waste, but he mentions only the larger-size drills. I do not think there is so much trouble with these as there is with drills usually supplied with the No. 1 taper shank.

It would perhaps be interesting to hear some experience with this difficulty. I am well aware that many devices have been brought out to use up broken tang drills, some being very effective too. I think that on drills having No. 1 taper shanks, even with well-fitted sockets, there is likely to be trouble. On drills $\frac{3}{8}$ in. in diameter and under I prefer the larger shanks.

J. H. DAVIS.

Wembley, England.

✱

Using Dynamite

There was an inquiry recently concerning the use of dynamite to remove die keys in drop-hammers. While I have never used dynamite for that particular job, I have often used it to remove broken shafts from gears and other similar work.

We sometimes have large steel gears or drums come into the shop with the shafts broken. We first try to remove the shaft with the hydraulic press, but if it does not start after one or two attempts, we resort to powder. The whole thing is rolled out into the vacant space in

front of the shop and far enough from any building so that the concussion will not break windows, and the gear blocked up if possible so that the charge can be put on the end of the shaft and blow downward. Then the sticks of dynamite are broken up so that they can easily be piled on the shaft and covered with a piece of wet burlap. About 2 ft. of ordinary fuse is attached and the charge fired.

One type that we often start this way is a large cast-steel gear with a 5-in. shaft that usually breaks close to the hub. As it is necessary to shrink this gear on the shaft with more than the ordinary allowance, it is hardly ever possible to remove the broken piece with the hydraulic press. So we block the gear up as solidly as possible with timbers, and use four sticks of 40 per cent. powder on the end of the shaft. Occasionally a second shot is necessary, but usually the first explosion moves the shaft about $\frac{1}{4}$ in. in the hub and it is pushed easily the rest of the way with the press.

It must be remembered that the force of the blow probably will crush the shaft a little and cause it to bulge slightly 1 in. or $1\frac{1}{2}$ in. from the point of contact. If the shaft happens to be the same size for its whole length, this bulging part will have to be reduced before it can pass through the hub. Another thing to remember, if the gear is keyed, is which way the key tapers, so that it will not be forced the wrong way and the gear consequently broken.

E. W. WRIGLEY.

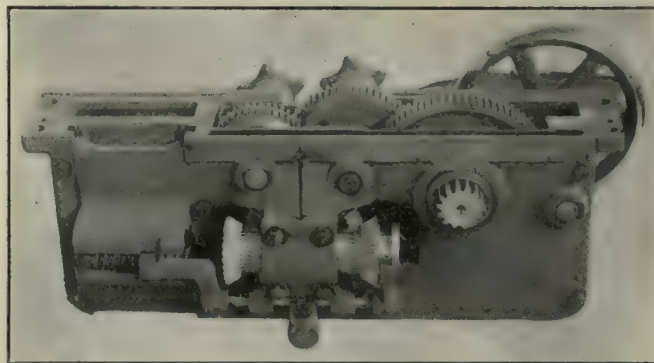
Seattle, Wash.

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Oiling the Lathe Apron

Mr. Davis' suggestion on page 120, Vol. 45, to put an oil-distributing reservoir in the carriage of the lathe, is quite similar to the oiling plan that has been used by the Lodge & Shipley Machine Tool Co. for a number of years.

The accompanying illustration shows the Lodge & Shipley apron. The oil reservoir is in the top of the back plate on the apron instead of in the carriage. A



LATHE OPEN, SHOWING ARRANGEMENT OF OIL RESERVOIR

single oil hole in the top of the carriage communicates with this reservoir, and through it the reservoir is filled. From the reservoir five oil tubes lead to the bearings in the back plate of the apron. Thus the one central oiling station distributes oil to all bearings in the back plate of the double-walled apron. The bearings in the front are oiled from oil tubes on the outside.

Cincinnati, Ohio.

HENRY M. WOOD.

Limits in Cylinder Boring

To answer the question asked by Robert Newcomb on page 206, I would state that the limits in cylinder boring are influenced by three factors—moulding, design and the machining process. These will be taken up separately.

It is well known that the more nearly true and straight the cored hole is, the less the distortion and springing of metal due to cutting of tools. To get a true, straight core, a cast-iron core box should be used. This box should be made to proper dimensions as to allowance for machining. Next, a substantial core barrel that fits its flask and also cast-iron flasks should be provided. The flasks should be bored to fit the core barrels, and the core-barrel ends should be machined to fit the flask. This may seem superfluous and expensive, but practical experience has shown otherwise. If good core materials are selected and properly baked, a first-class foundry job is the result.

Regarding the design, all clamping surfaces should have clamping bosses or be provided with them. The object of this is to prevent turning and lateral movement due to pressure of cutting tools. This matter is very important.

Now as to the machining process: Cylinders are bored by three methods, depending on the quantity—lathe, boring and turning mills, and boring machine with boring bar having cutter heads. It is the latter to which reference is made.

The cylinder should be placed in a massive fixture that will not show any distortion from clamping or tool pressure, care being taken that its clampings or bosses perform the duty intended. Two cuts should be taken through the cylinder, one roughing and one finishing. The cutter heads should be heavy, so as to prevent any springing, and should also be ground on an arbor to roughing and finishing dimensions. For best results with the finishing cutter the blades should be set at an angle of 5 deg., cutting right-hand spiral in feeding. One thing must not be forgotten, and that is that when the roughing cut is finished, all clamps must be loosened so that pinching or distortion, which always occurs, may be relieved and the cylinder checked for truing to dimensions. If $\frac{3}{32}$ or $\frac{3}{64}$ in. is allowed for finish, no fear need be felt as to cleaning up.

Speaking of limits for the diameter and variation in roundness, and taper of bore: Perfection in cylinder boring is an impossibility. I have made a hobby of caliper-ing all new cylinders of different makers for years and have never run across a true cylinder, as there is always some variation. Variation in roundness is caused by two things—clamping pressure while boring, or expansion of the cylinder during the machining operation. Taper of bore is caused by the boring tool being cold when starting and its travel and expansion during cutting, the degree of taper depending on the hardness of the iron and the speed and feed of the tool. The higher the speed and feed the more the expansion, hard iron heating more than soft. A taper bore is an advantage in gas-engine cylinders. The finish cut should always be started in the combustion end on single-acting cylinders.

The limits plus or minus standard size for 3 to 7½ in. can easily be held at 1½ thousandths, for both roundness and taper, as a maximum on reamed cylinders. On 8 to 12 in., 2 thousandths for bore and taper; from 13

to 22 in., 3 thousandths for variation in bore and taper. This is actual experience with reputable concerns. The cylinders were for gas engines, steam engines and air compressors. For the latter the cylinders were used on 350 to 450 lb. pressure, so that a good job was required. The limits were kept the same on all classes.

As to variation on high-speed and low-speed engines. I should say that the high-speed engines require closer work or there will be trouble. There is no variation for horizontal or vertical engines. I had that forcibly impressed upon me a short time ago. Some vertical-engine cylinders were rebored at a local repair shop, and the pistons were made so that they just fitted without any sliding allowance. In one week the cylinders were all scored and had to be rebored.

For the piston limits I recommend minus 10 thousandths variation on steam cylinders from 9 in. to 14 in. On gas-engine pistons no variation is allowed below the standard schedule size. Gas-engine piston-fit allowances are determined experimentally, due to expansion. The usual trial allowance is ¼ thousandth for every inch of diameter to 14 in.

G. STROM.

Brooklyn, N. Y.

A recent inquiry by Robert Newcomb, page 206, concerning allowances between piston and cylinder, prompts me to state that as the result of considerable experience the old rule, "Make the body of the piston one more thousandth loose than there are inches in the bore of the cylinder, and taper the piston over the ring grooves to the closed end the same amount," has proved a safe one to go by.

Briefly speaking, the question is. How much will the piston expand when heated up to working temperature? The conditions governing this are: The quality of iron used in the casting; presence of the machining strain in the finished piston; design of the piston and compression, and fuel used.

No matter how true and round the piston is when cold. I have always found that under working conditions it will expand and go out of round, the internal ribs affecting the expansion to a marked degree, and it will show high spots when removed after being run on test a while.

Compression, fuel and mixture do not make an appreciable difference in the smaller-sized pistons, as the expansion due to a few more degrees of heat is usually negligible.

Annealing pistons before final machining will help in allowing a closer initial fit in the cylinder, or failing that, seasoning after roughing out all over the machined faces. Oil grooves are better milled than chipped by hand, and in all finishing operations extreme care should be taken not to spring the castings.

The foregoing rule has been used successfully for pistons from 4½ in. to 20 in. in diameter on horizontal single-acting gas and gasoline engines. The taper is usually compromised by making the collars between the rings decrease in diameter in proportion to their number and the allowance made.

In the final analysis the allowance when making parts up in quantities is best determined experimentally, as the rib design may hold the piston in a certain shape whereas by changing the arrangement of the ribs the expansion might be more nearly uniform.

Iron-ton, Ohio.

R. V. HUTCHINSON.

The Care of Leather Belting in Shop Service

SPECIAL CORRESPONDENCE

SYNOPSIS—The final low cost and dependability in service of leather belting cannot be obtained except through intelligent installation and careful upkeep. Factors that enter into this part of belting practice are: Regular inspections, cleaning and dressing, maintaining proper tensions, using suitable lacings and fastenings and reclaiming used belting.

When leather belting of good quality has been secured from a reliable source and careful inspection has shown its worth, two important steps have been taken toward low ultimate cost and dependability of service; but unless proper care is exercised in its installation and upkeep, much of this advantage will be lost and the final result be far from satisfactory.

Longer Life—In normal times first-quality leather belting is worth about \$1 a pound and at present about \$1.50. At the latter price a 3-in. single belt 25 ft. long represents an investment of over \$15; and a 6-in. double, over \$60. In any shop the total investment is appreciable, and in some of the large ones it exceeds \$250,000. A similar amount of property in any other form is usually well cared for, but in most plants the belting is apt to receive less attention than any other part of the equipment. Usual practice is to do nothing until trouble develops. Few factory executives appreciate that good belting running under favorable conditions will last many years. Under ordinary conditions belts do not wear out; they are destroyed by abuse and neglect. It is entirely feasible to double and triple the life of most belts by reasonable care in service.

Low Cost of Upkeep—The historic investigation of the late Frederick W. Taylor, covering a period of nine years in a steel-works machine shop, clearly demonstrated that the most important item in the cost of power transmission by leather belting was loss of production due to belt failures. By the adoption of systematic inspection, periodical dressing and lower tensions, carefully maintained, he was able to reduce interruptions to manufacture from five per year to one in sixteen months. At the same time the cost per belt per year, including first cost and maintenance, was reduced 15 per cent.

Better Service—Another factor in satisfactory belt service which does not receive the attention its importance warrants is loss of power and production through excessive slip. Pulley friction may be reduced below the economical point, due to belt stretch or to loss of gripping power when the belt becomes dry, long before the belt slips perceptibly. During this period the machine slows down gradually and yet consumes more power than it should. Regular inspection will discover this tendency before it becomes serious, and the remedy is easily applied.

Competent Supervision—The first step in the proper care of belting is to centralize responsibility for its upkeep. It is poor policy to allow machine operators to install and maintain their own drives or, on the other hand, to trust these duties to unskilled men without com-

petent supervision. One man, trained for the work, should be given entire responsibility and held accountable for results. He should understand thoroughly the virtues and the limitations of the material with which he deals and be resourceful in adapting it to the varying requirements of the equipment he serves. Other essentials are open-mindedness, keenness of observation and firmness in the enforcement of good practice. A man of the foreman type who has graduated from a belt factory into the service department usually has the right foundation. Such assistance as he may need may come from the common labor class. An organization of this kind, with the necessary equipment and full authority, will amply justify its cost.

PROPER INSTALLATION OF LEATHER BELTING

The chief enemies of leather belting under ordinary conditions are abrasion, mineral oil, heat and overloads. They should be eliminated as far as possible when the drive is installed and the conditions kept up to this standard afterward by frequent inspection. The reason for the very common neglect to take these precautions is that any one factor detrimental to long life and good service is in itself apparently a trifling matter. Only those accustomed to handling leather appreciate how easily it may be injured and how well it repays good care.

Very many belts are brought to an untimely end by being allowed to rub against belt shifters, hangers, posts and machine frames. The result is frayed edges from which cracks may start and ultimately destroy the belt. Even before this can happen, the heat generated by the friction may burn the leather or open up cemented joints. Even more frequently, perhaps, are belts permitted to overrun the pulleys on one side, setting up severe strains in the fibers where they pass over the edge. When this occurs, the pulleys are usually found out of line or not parallel. If the pulleys are correct, the belt is at fault and should be rejected. The use of pulleys 25 per cent. wider than the belt will lessen this evil considerably.

Mineral oil destroys leather much as it does rubber, but less rapidly. Every effort within reason should be made to prevent lubricating oil from reaching the belt; and where this is not feasible, frequent cleaning is necessary, as outlined later.

Oak-tanned leather becomes brittle and lifeless when subjected to a temperature of 200 deg. F. or even less. Where slip is not excessive and metal pulleys are used, the heat is conducted away fast enough to protect the belt, unless the surrounding atmosphere is very hot. Pulleys of wood or other nonconductors are more severe on the belt. Chrome and several other specially tanned leathers will stand 400 deg. F. and will give better results where slip cannot be eliminated, as on reversing planer drives.

A belt that shows signs of being overloaded, by stretching rapidly or slipping when under proper tension, should receive immediate attention. The best remedy is a higher belt speed, obtained by using larger pulleys at both ends. A velocity of 4,000 ft. per min. is not excessive, but above

this point the belt has a shorter life. If the speed cannot be increased, a wider belt will be beneficial. Double belts should be used only where necessary, especially on vertical drives.

Regular Inspection—The best way to cure belt troubles is to prevent them. Each drive should be inspected as often as experience indicates is necessary to prevent injury to or failure of the belt. Inspection while running will determine whether the belt is rubbing against anything, whether it is running true on the pulleys or is slipping. Inspection while idle should cover dryness, oiliness, weakness at the lacing or cemented joints and too much or too little tension. All repairs should be made promptly outside working hours, so as not to interfere with production. Small defects rapidly become worse, and "a stitch in time" is nowhere more valuable than in the care of belting.

CLEANING AND DRESSING LEATHER BELTING

During manufacture about 8 per cent. of animal grease is worked into the leather to lubricate the fibers and promote pliability. On belting for general use, a second application is desirable before shipment, bringing the total grease content up to 12 or 15 per cent. This is not done by the manufacturer unless requested, but is advised by the makers and, as a rule, no extra charge is made. Such belting will hug the pulley well from the start, will remain pliable longer and is fairly well protected against moisture, oil, fumes and other destructive agents. This also means that it will be much less affected by humidity changes than undressed belting.

This grease, however, gradually works out and must be replaced. All belts need regreasing once in six months, and those exposed to heat, dust, oil or moisture should receive this treatment at more frequent intervals. All dirt should be wiped off with a cloth or cotton waste dampened with water. In some cases a thorough scraping may be necessary to remove a heavy coating. Only belts may be degreased by washing with naphtha, gasoline or carbon tetrachloride. Those completely saturated should be removed from the pulleys and immersed in solvent for several hours or packed in sawdust over night.

Dressing should be applied lightly to the grain side of single belts and to both sides of double belts. The application should be repeated if necessary to produce a soft, mellow condition of the leather. Any more than this will cause slippage on the pulleys.

The best dressing is that used in the original currying, a mixture of acidless tallow and cod-liver oil in equal proportions. The oil is heated to 110 deg. F. and the tallow added slowly. Unless carefully mixed, curdling will take place. Application to the belt should be made while hot, and several hours allowed for good penetration. Small firms may purchase a reliable dressing from any reputable belt manufacturer. Many injurious dressings are being exploited by irresponsible concerns, and caution is necessary in choosing a dressing of unknown composition. Most of them show good results for a time; but if they contain injurious ingredients, the belt will be destroyed prematurely. In a large plant this would mean a heavy loss, and no dressing should be used on a large scale until it has been thoroughly tested.

All sticky dressings should be avoided. A belt that will not pull its load when properly greased is too small for the job or is running too slowly.

The theory of power transmission by leather belting has received much attention and is well understood. Carl G. Barth's paper before the American Society of Mechanical Engineers (No. 1230, 1909) is a splendid exposition of the whole subject. He presents charts and a slide-rule for the application of his formulas and describes the equipment necessary to establish and maintain the tensions he recommends. The distinctive features of the Barth system of belt maintenance are that he follows Taylor in advocating larger belts and lighter tensions than those commonly employed and uses a card index for each belt, on which are recorded the data necessary to install and maintain it, as well as the date, nature and cost of all repairs. From these cards periodical inspection is directed and standard conditions maintained. The extra investment required and the considerable labor involved in the establishment and maintenance of this system have prevented its general adoption, but it is giving satisfactory results in a number of well-conducted establishments.

In factories where the individual workman is given some degree of initiative, which is the case in most small shops, the following method has been successful. When a new belt is installed, a piece, say 6 in. long, is inserted between the ends of the belt proper with some form of lacing which can readily be taken apart. The operator is furnished with additional pieces 5, 4 and 3 in. long, laced at both ends and ready for insertion in place of the next longer piece when the belt needs taking up. After the 3-in. piece becomes too small, the belt is shortened and the 6-in. piece reinstalled. In locations where atmospheric humidity changes are frequent and severe, this method makes it possible to compensate easily and quickly for the corresponding belt stretch and shrinkage.

BELT LACING AND FASTENINGS

The best way to install a belt is to make it endless with a cemented joint, provided the inevitable stretch can readily be taken up with an idler, an adjustable countershaft or other means. Endless belts should always be used on important motor drives, precision lathes, grinders and in general on all light, high-speed machinery where vibration is undesirable. In many cases, however, endless belts give endless trouble, chiefly due to the difficulty of arranging adequate take-up for slack. Some form of belt lacing must be used for the majority of drives.

The market offers a wide choice of fastenings, both leather and metal. Many of them are excellent for certain purposes, but none are suitable for universal application. The well-known rawhide lace is rapidly yielding to stronger and more lasting leather competitors, such as the chrome and oil tannages, as well as to the numerous forms of metallic fastenings. Whatever lacing is determined by experiment to be best adapted for a particular kind of drive, it is important that more care be taken in its application than is usually the case. Nor should its replacement be deferred until failure occurs.

Reclamation of Old Belting—Many belts supposedly worn out are still useful if intelligently treated. All dirt should be scraped off, the grease dissolved out, frayed edges trimmed, joints repaired and new grease applied. Even if this treatment does not renew its usefulness for the drive on which it was originally installed, frequently such a belt will give satisfactory service under less severe conditions.

Editorials

Congress as an Industrial Brakeman

Congress has given a tightening twist to the brakes of industry by declaring for inefficiency in Government plants. Federal money cannot be spent in Government shops for time studies or for the paying of bonuses or premiums. The premium is taken off effective work and tacked onto inefficiency.

Both the trade and the technical press have hammered away at this question; letter after letter has been written to congressmen, and a delegation of manufacturers visited President Wilson and laid the matter before him. All to no purpose!

The organization whose members know most about modern industrial management is the American Society of Mechanical Engineers. What a pity that this society could not in some way influence the course of legislation! What a pity that congressional committees could not refer a question of this kind to such a society and then vote in accordance with the information given.

With great wisdom the men who founded the American Society of Mechanical Engineers so framed the constitution that the organization as a whole cannot express its opinion on political or commercial matters. But the society has profoundly influenced some legislation, as shown by the boiler license and inspection laws that have been enacted in various states since its code was completed. It is probable that the real influence is greater through this indirect means than it would be if an attempt were made to indorse or condemn a bit of projected legislation.

But it is still regrettable that the opinion of the society concerning this great subject of industrial management could not have been brought to the knowledge of the senators and representatives at Washington in such a way that they would have known where truth and progress lie.

✽

Cost System for Manufacturers

Under date of July 1, the Federal Trade Commission has issued a pamphlet entitled "Fundamentals of a Cost System for Manufacturers." The purpose is set forth as follows: "It is a fact too little realized that an accurate determination of costs is fundamentally related to manufacturing efficiency. More and more concerns are joining the ranks of those who realize the necessity of knowing accurately their costs of manufacturing and selling. Every business man who joins in this work can feel that he is doing his part toward the improvement of business conditions generally, and his own business conditions in particular. This bulletin has been prepared with a view to aiding the campaign of education by explaining what a cost system is, how it operates, the results obtained, and the benefits to be derived from its operation."

There is much that is good in its 31 pages. In one particular it advocates a practice that is ahead of that

found in the average shop; but take it all in all, the viewpoint is some 10 years behind the times. The *American Machinist* says this reluctantly, for it has a keen appreciation of the advantages that might grow from a uniform method of determining shop costs. Were such a system universally adopted, wild bidding would be practically eliminated, losses would be forestalled, and business would be on a sounder basis. It is possible that the position taken in this pamphlet is the only one that can be advocated for the small manufacturer. But measured by the best that we know, there are a number of points to which objection can be legitimately raised.

What is a cost system for? The pamphlet says: "The prime object of a cost system is to determine costs, to analyze and compare them, and to use them as a basis for making prices. But the uses and advantages go farther. A manufacturer from reliable records is able to make clearer and more intelligent statements to his bank and thereby obtain a larger line of credit than he could without them." If the prime object of a cost system is to furnish a basis for making prices, then prices must be fixed by costs. This matter was discussed on page 81 of Volume 44, and the conclusion was reached that in the machine-building field, at least, prices are not set by costs, but are fixed by competitors' prices, the condition of the market, what the traffic can bear, etc. The reasons for finding costs were given as "to control costs; to govern policy; to set prices."

The Federal Trade Commission has lost sight of the first two and, by the way, the two most important reasons. Not a word is said about employing the cost system as a means to control costs when they are in the making. Apparently the only use that is foreseen for the system and its records is to supply facts in statistical form. That is, costs have been viewed as history, not as living information that can serve to control the work of the factory as it is being done.

But there is even a more advanced view in regard to cost keeping than the one which says that the cost system should control costs. This newer thought is that costs are merely a byproduct. The all-important thing in a manufacturing plant is production. That is what a shop exists for. But properly organized and managed, there is some method of controlling production, one that turns out specified articles in an economical manner to meet promised dates of shipment.

The records that flow in from the shop concerning jobs, men's time and the like are planned primarily to give production control. This is their first and prime function. A secondary function is to supply information in regard to labor costs and machine utilization. In a similar fashion a secondary function of storekeeping is to supply information in regard to the cost of material. But both of these functions are subservient to the principal or prime function.

Thus it can be truly said that costs are merely a byproduct of a properly worked-out and organized produc-

tion system. But no suggestion of this important truth can be found in the pamphlet under consideration.

The viewpoint taken by the commission leads to minor features of the advocated plan that can be questioned. On page 8 in discussing "The Job Cost System" a tabulation is given of the information needed on the factory form. Nothing is said as to the "how" of the job. Yet this "how" is a most important matter in production.

Again on page 9 in discussing the storeroom nothing is said about establishing means for checking the stock-ledger cards, nor for separating material of an old lot from that which has just been received, nor for providing mechanical means for indicating when a new order should be placed. These three factors are of the greatest importance in a successful stock-keeping system.

In contrast, the discussion of overhead expense, depreciation, interest and distribution of overhead charges is excellent. The recommendation in regard to charging interest on investments is as follows: "It is recommended that where interest on the investment is treated as an item of cost, the interest charged to the goods on hand be eliminated from inventory values, and that in preparing profit and loss statements the amount of the interest charged to cost during the period be returned to 'Income' under the specific caption 'Interest on Investment.'"

Another positive recommendation is in favor of the machine-hour rate for apportioning overhead expense. The item reads: "Another method, and the one that is recognized by the majority of manufacturers and accountants as the standard, is what is known as the 'Productive-hour Method.' In a plant where practically all the labor is hand labor, the man-hour is the basis and the total hours divided into the total overhead expense give a rate per hour, which rate multiplied by the hours spent on a job gives the overhead expense chargeable to that job. In a plant where machines are the producing unit, the distribution must be on a basis of the machine-hour, and the same method is pursued as in the case of the man-hour."

The *American Machinist* does not by any means wish to be thought of as condemning this cost system. If it has any influence in establishing uniform costs among small machine shops, the efforts and expense that have gone into the preparation of the pamphlet have been well spent indeed. But when this bulletin is read and considered, it must be remembered that it is the product of a cost accountant, not of a factory engineer. It is more than likely that cost accountancy will be rewritten during the next decade by engineers who are interested in the prime function of a manufacturing plant—production—as opposed to accountants, whose job it is to supply statistics to the financier.

Shop Power Tests as an Aid to Economy

The power required to drive the average machine tool, ranging in value from approximately 2 to 3 per cent. of the total cost of its production, does not form a very attractive field for cost reductions, because of the relatively low proportion to the total expense in its operation. It is of course important to have the various machine tools in the shop driven by motors of sufficient size and with the proper characteristics to permit the work to be

done at advantageous speeds and without those losses which occur when the most economical speeds cannot be obtained either because of lack of adequate speed gradations or through an insufficiency of torque at certain parts of the operating cycle.

To have motors, on the one hand, too small to realize the possible advantages or, on the other hand, larger than necessary for their realization means the introduction of losses. First, the motor of insufficient capacity limits the operator in the amount of work he is capable of turning out; second, the motor of a size larger than necessary usually means that it cannot be operated at a point of maximum efficiency; further, its first cost and the interest and depreciation charges against it are larger than they ought to be for the machine tool in question. These reasons make it important to use intelligent ways and means for a determination of the correct size and type of motor when making the initial purchase. In those cases where a motor has been installed without due regard to its size and type as related to the machine tool with which it is to be used it is equally important to have a way of testing the motor under operating conditions.

In the latter instance, typified by shops where motors have been installed for some years, or in cases where operations are involved concerning which little is known in advance of the power requirements of the different parts of the operating cycle, the graphic electrical measuring instruments may be employed for a ready determination of these requirements. Instruments of the graphic type have been perfected to a marked degree during the past few years, and one of the chief advantages claimed for them by designers and manufacturers is in tests of just this kind on the motors used for machine-tool drives.

While tests on motors for insufficient or over-capacity, as just outlined, are naturally valuable, they can hardly be placed in the same class of importance with the corresponding tests, which are becoming more and more common, whereby the cycles of a given machine tool may be analyzed in detail. In a planer, for example, a single cycle includes a cutting stroke, braking to bring the table to rest, acceleration in the reverse direction, a return stroke, braking on the return to bring the table to rest, and finally acceleration again up to the speed of the new cutting stroke. These six elements of the cycle may introduce sources of loss if any or all involve more time than necessary.

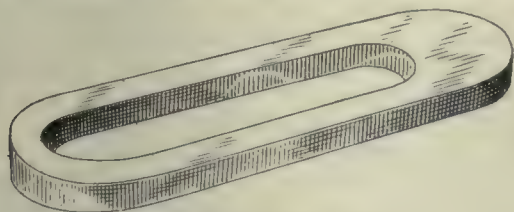
A planer cycle, if run off by means of a graphic ammeter connected into the driving-motor circuit, indicates in excellent shape each of the cycle elements and permits an analysis to be made of the way in which the machine is being handled. In other words, the graphic instrument gives a visible picture of the operation, which can hardly be obtained by any other means. Taking such a chart as a basis, it is readily possible to modify the speeds of given parts of the cycle so as to reduce the unnecessary time taken for such parts. Or in case the chart shows that the time consumed by the machine is as low as permitted by the capacity of the motor, the characteristics of the motor may be investigated, and a new motor better fitted to the job can be installed.

This is an important matter in any shop where an effort is being made to run the plant efficiently and intelligently.

Shop Equipment News

Balancing Washer

The balancing washer shown is intended for quickly balancing polishing wheels. For this purpose it is placed so that the heavy end counterbalances the off-center weight of the wheel. This does away with the practice of tacking pieces of lead on the sides of the wheel or driving in



BALANCING WASHER.

pieces of metal or nails. Special clamping washers are used to retain the balancing washer in position on the arbor.

For determining the balance of the wheel before placing it on the machine arbor, a special balancing mandrel and adjustable balancing ways are used. Any number of wheels may be balanced and then marked for the washer position, so as to be quickly set on the machine arbor.

These washers are made by the Munning-Loeb Co., Matawan, N. J.



Improved Planer Belt Shifter

The planer belt-shifting mechanism here shown is an improved form of that previously used by the Cincinnati Planer Co., Cincinnati, Ohio, and thorough shop tests have proved its worth. A general view of the device is given in Fig. 1. The shifting cam is entirely inclosed by a cover bolted to the overhanging arm, which eliminates belt scrapings, grit and the accumulation of dirt usually found on top of the shifting mechanism of the planer.

In Fig. 2 the cover has been removed. The upper belt guide is provided with a sliding bearing on the overarm bracket, as at A, which relieves the fulcrum stud

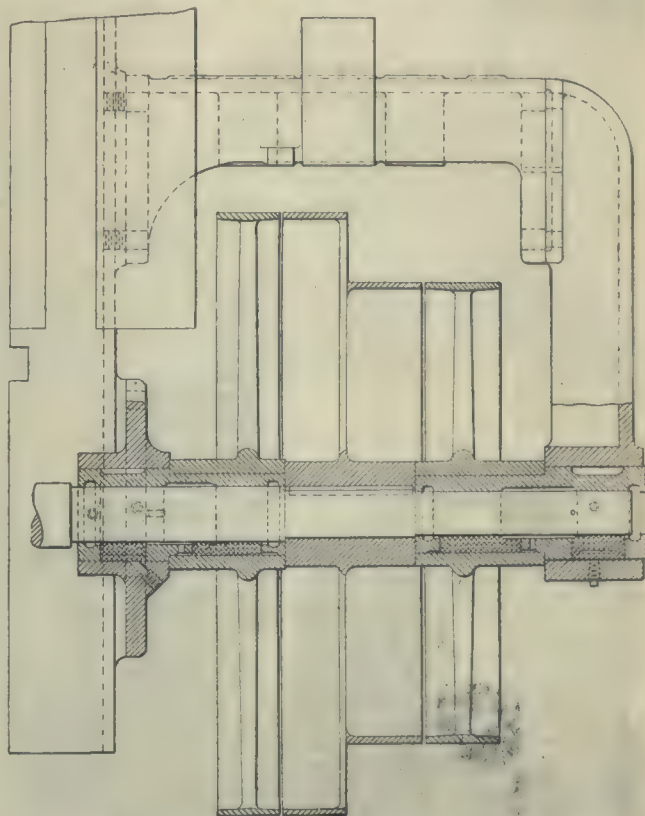


FIG. 3. DETAILS OF OVERARM AND BRACKET

from the downward pressure of the belt, thereby prolonging the life of this important part. A drip pan is fastened underneath the overarm bracket so as to catch the oil usually found dripping from the cam or parts

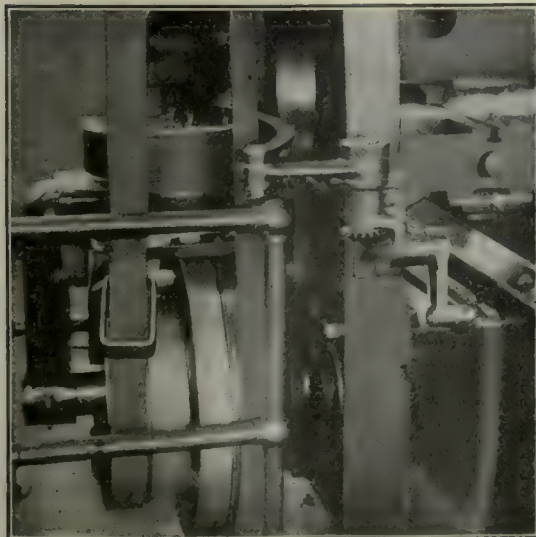


FIG. 1. IMPROVED PLANER BELT SHIFTER

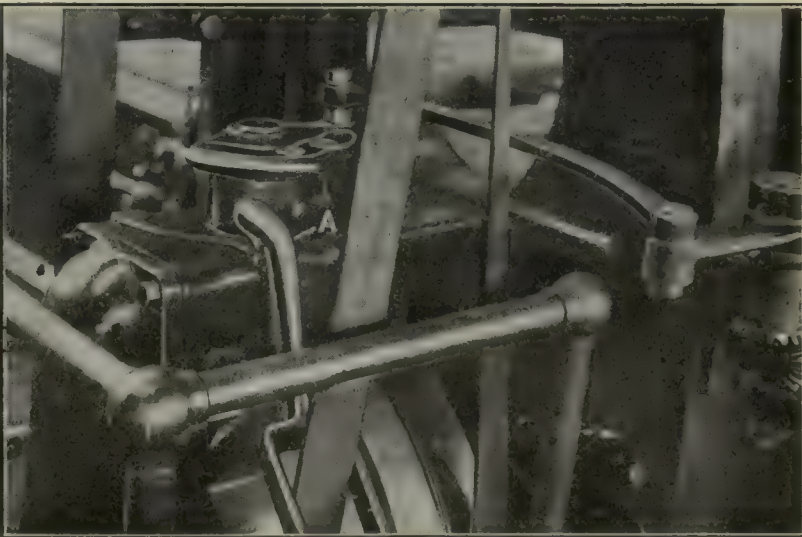


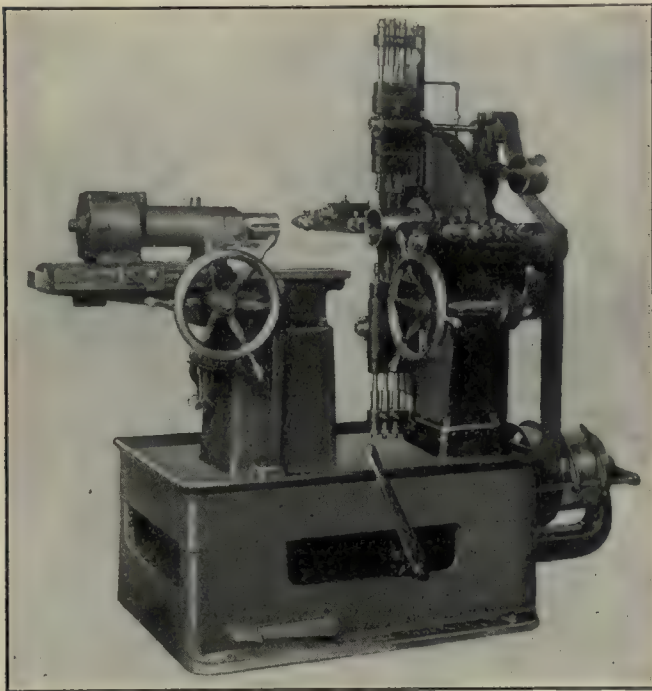
FIG. 2. SHIFTER WITH CAM COVER REMOVED

above the pulleys. This pan keeps the belts bone dry and at the highest efficiency.

A feature, shown in detail in Fig. 3, is the placing of the loose pulley on a stationary bushing set into the lower end of the overarm. The end of the shaft revolves in this bushing as in an ordinary bearing. This does away with the objectionable arrangement of having the shaft revolve one way at high speed at the same time that the loose pulley revolves on it at high speed in an opposite direction, resulting in an addition of the two speeds and consequently greater wear.

Multiple Drilling Machine

The machine shown was designed especially by the Langelier Manufacturing Co., Providence, R. I., for drilling at one operation twelve $\frac{1}{8}$ -in. oil holes in the outer sleeve of a Willys-Overland motor. Another machine was also built to drill four $\frac{1}{8}$ -in. holes in the



MULTIPLE-SPINDLE DRILLING MACHINE

Capacity, twelve $\frac{1}{8}$ -in. holes; drilling speed, 2,500 r.p.m.; tight and loose pulley speed, 446 r.p.m.; floor space, 4x6 ft.; weight, 3,500 lb.

inner sleeve. The machines are identical except that one has twelve and the other four drilling spindles.

The sleeves are held and located in their drilling position in the machines by an internal expanding arbor mounted in a tailstock and sliding upon ways in line with the axis of the machine.

The expanding arbor is opened and closed automatically by compressed air. The construction consists of a split sleeve attached directly to the piston of the compressed-air cylinder. Inside of the sleeve is a fixed arbor with a tapered end attached to the cylinder head. A slight travel of the sleeve upon the tapered portion of the fixed arbor will cause the sleeve to expand and hold the work firmly. Excess movement is avoided by a stop collar on the sleeve and tapered arbor.

The air to the cylinder is controlled by a small piston valve placed on the tailstock at the rear and is operated by contact with a fixed stop on the tailstock slide. The

tailstock is shown in its outer or loading position by the handwheel at the front. The drilling position is obtained by the sleeves to be drilled coming in contact with a stop located inside of the drill jig. This stop can be adjusted at the left end of the machine. The tailstock is also automatically located when in its drilling position and is unlocked by the foot pedal shown at the front of bed. The lock is adjustable and can be set to suit the drilling position.

The drilling heads are located radially 90 deg. apart upon a circular faceplate mounted upon a column attached to the bed. The drilling spindles are driven by spiral gears, the drivers extending to the rear and having pulleys on their ends. The spiral thrust of both the drilling spindle and the driving shell is taken up by ball thrust bearings. The drilling feed of the spindles is operated by the handwheel at the right. It has a spur-gear connection to a rim gear located inside and concentrically to the faceplate. The rim gear carries a segment feed cam for each head that has roll contact with the feed yokes of each drilling head. The yokes have a clamp connection to the sleeve on the outer end of the drilling spindles. This clamp connection provides a ready means of adjusting the feeding position of the drilling spindles.

Three-Inch Shell Work in a Small Shop

In the early days of the war shops not fitted to handle munitions work and unable to get new machines had to make over or put attachments on the machines already on hand. One of these firms was Wogaman Brothers Co., Greenville, Ohio, who had been making gasoline engines and doing general jobbing work. They had a number of lathes, turret lathes, drilling machines and other small tools, but nothing on hand really heavy enough for the new work. So they proceeded to put on the necessary attachments and to fit the various machines for the heavier work required. The result was so satisfactory that out of the first two carloads of shells delivered only a few hundred were rejected, and part of these had defects so slight as to be subsequently remedied. One reason for this was no doubt owing to the fact that the shopmen were used to doing all kinds of work, and shell work was merely another "job." Another factor was the ingenuity of Mr. Wogaman in meeting the various gaging and machining difficulties as they came up.

The ends of the forgings are cut off in the machine illustrated in Fig. 1. This machine was made from an old lathe, using the legs, headstock and part of the cross-slide. The bed is of flat stock, and the saddle is clamped on with setscrews, as seen at A. The work is held in a three-jawed universal chuck carried on a spindle set into a special bearing bracket. The shells are set by means of the sliding stop B, which closely resembles those used in other shops. The cross-slide is power driven from a belt-driven worm at the back, which meshes with the worm gear C. The clutch is thrown in or out by the lever D, which also carries a stop into which a stop E on the slide can bump and throw out the feed at the end of the cut. The whole machine represents the use of otherwise practically useless parts for a serviceable machine.

The "buttons" on the closed ends are centered and the outside rough-turned as usual. The shells are then in-

serted in chucks of the push-in type, the inside bored and the powder pocket, diaphragm chamber and seat machined out, in a large turret lathe. The taper boring is done by means of a master guide over the chuck.

For finish taper boring, or for corrective purposes, an old 18-in. lathe fitted as shown in Fig. 2, is utilized. This lathe is fitted with a special spindle and bearing bracket for the chuck—practically what would be called a quill

undercutting, while the other is used for waving. While cutting the groove for the driving band, the rod *A*, which is hooked on the end, is thrown back out of the way and the tool is fed in by hand. The slide is then moved along to bring the waving tool in line with the groove, and the rod *A* is put in place, as shown. As the shell turns, the tool is given a reciprocating motion by the connecting-rod, fastened to the lever *B*, which carries at

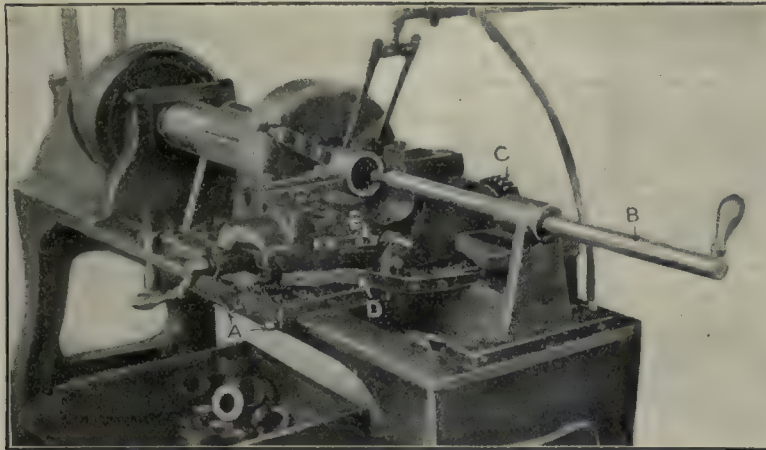


FIG. 1. OLD LATHE PARTS MADE INTO A CUT-OFF MACHINE

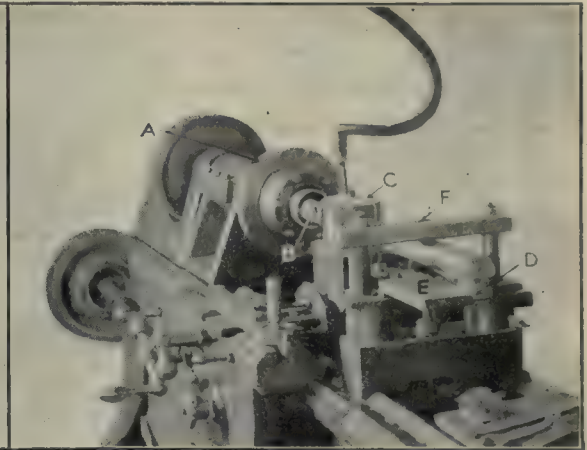


FIG. 2. TAPER BORING ATTACHMENT AND CHUCK CARRIER

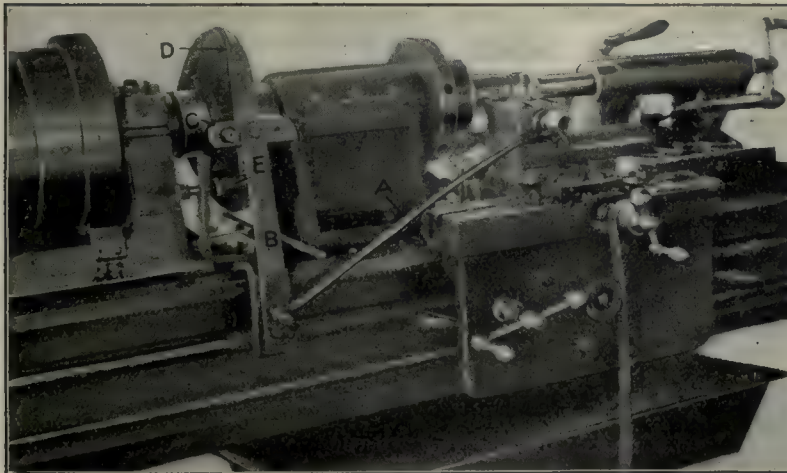


FIG. 3. GROOVING AND WAVING ATTACHMENT

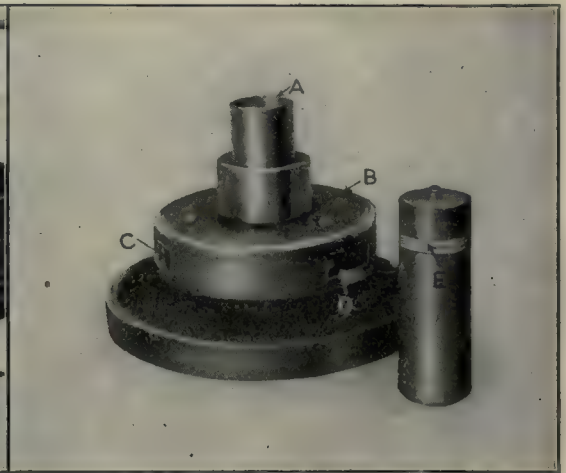


FIG. 4. SHELL-NOTCHING DEVICE

in a watch factory, for the chuck spindle and bearing are entirely separate from the headstock, except for a driving connection. By using this method and a split chuck, the shell may be solidly set and held as well as in a much heavier lathe. The split collet fits into the taper-bored end of the spindle and is locked by turning the flanged collar *A* by a rod set into holes drilled in the edge of the flange. The boring bar *B* is carried in a swiveled block *C* on the cross-slide. The outer end of the bar carries a roller *D*, which is guided by the master plate *E*, against which it runs as the bar is fed forward. The crossbar *F* acts as a steadyrest for the boring bar and prevents chatter on the cut. The output is about 20 per hr.

Grooving and waving are done on the same machine, which is illustrated in Fig. 3. This machine is also fitted with a special chuck bearing, as were the two previously shown. One end of the shell is held in the split chuck, and the other is supported by the tail center. The tool block carries two tools. One is used for grooving and

C a roller that rides on the cam *D*, being held in contact by the spring *E*.

The waving in the driving-band groove is notched in three equidistant places. In many shops this is done by hand with a hammer and chisel. Here a special device, Fig. 4, is used. Its advantages over the hand method are many. It accurately spaces the notches; all are cut the same depth simultaneously and much faster than can possibly be done with a hammer and chisel. At the same time the device costs but little to make.

The shell to be notched is placed at *A* in a sort of sleeve, which is stationary and carries three chisels properly set. An outer ring *B* is movable and carries three rollers like those seen at *C* and *D*. This ring is rotated through a short arc by giving it a pull or push by hand. The rollers ram the chisels into the wave and make the notches. The rebound of the chisels causes them to clear the groove, so that the shell is easily removed. One of the shells, with a notch *E*, may be seen at the right.

New Publications

Gas Engine Ignition. By E. B. Norris, R. K. Winning and W. C. Weaver. Published by McGraw-Hill Book Co., New York, 1916. Cloth; 6x8 in.; 174 pages; illustrated. Price, \$1.50.

The material for this book was prepared as part of the extension course of the University of Wisconsin and is largely descriptive in character. The first chapter is devoted to the different methods of ignition used with internal-combustion engines; this is followed by an explanation of the jump-spark battery systems, nonvibrating coils, batteries, magnetos and generators. The operations of several well-known systems are described and illustrated.

Written primarily as a textbook, the matter has been arranged with particular reference to home study. It should also find a field among automobile repairmen.

Personals

Fred Lankenheimer has been appointed general foreman of the Stoner-Thaw Co., Ltd., Pittsburgh, Penn.

O. P. Hand who was advertising manager of the Burd High Compression Ring Co., Rockford, Ill., has been advanced to the position of vice-president and sales manager.

E. Ver Linden for sometime past factory manager of the Olds Motor Works, Lansing, Mich., has become general manager of the concern, following the resignation of Jay Hall.

H. W. Johnson, until recently efficiency engineer with the Russell Burdall & Ward Bolt and Nut Co., has become superintendent of the Putnam Machine Co., Fitchburg, Mass.

C. K. Cairns has been appointed sales manager of the Cincinnati Pulley Machinery Co., Cincinnati, Ohio. Mr. Cairns was formerly associated with the American Tool Works Company.

C. R. Adams has resigned his position as assistant engineer of the Chandler Motor Car Co. in order to accept the factory management of the Sibley Machine Tool Co., South Bend, Ind.

Herbert S. Barrows, for the past two years supervisor of repairs for the Hendee Mfg. Co., Springfield, Mass., has been promoted to the position of superintendent of the State Street plant.

H. E. Miller, Jr., formerly with the Pittsburgh Plate Glass Co. and the Lilly Varnish Co., is now looking after the interests of the Moller & Schumann Co., Brooklyn, N. Y., in the New England territory.

John W. Morton has been appointed chief draftsman of the Baltimore Oil Engine Co., Baltimore, Md. Mr. Morton was formerly associated with the designing department of McIntosh & Seymour Corporation.

John Calder has been appointed assistant to Vice-President H. H. Pinney, of the Remington Arms Union Metallic Cartridge Co., Inc., Bridgeport, Conn., and will represent him as chief executive at the Bridgeport Remington Arms plant.

T. E. Keefe has become associated with the Franklin Oil and Gas Co., Bedford, Ohio, as Eastern representative. Mr. Keefe was formerly connected with the Pierce-Arrow Motor Car Co. and the National-Acme Manufacturing Co.

W. F. Rockwell, for the past few years at the head of the industrial engineering division of Clinton H. Scovell & Co., has resigned to become assistant general manager and works manager of the Forbensen Gear and Axle Co., Cleveland, Ohio.

Obituary

Charles D. Peck, superintendent of the shops of the H. K. Porter Co., Pittsburgh, Penn., died on Aug. 4 as the result of an automobile accident in which his wife was also killed.

C. F. A. Schlutter, president of the recently organized Schlutter-Zastrow Machine Co., Baltimore, Md., died in that city on Aug. 2, aged 39 years. Mr. Schlutter was formerly connected with the Calvert Machine Co.

David Wilson Mesick, proprietor of the Fulton Foundry and Machine Co., Brooklyn, N. Y., died at his home in that city on Aug. 9. Mr. Mesick was at one time superintendent of Professor Sweet's Straight Line Engine shop in Syracuse and is credited with instituting reforms in the factory organization that resulted in putting the business on a financially profitable basis.

R. J. Collins, for the past twelve years associated with the Cataract Refining and Manufacturing Co., died at his home in Buffalo, N. Y., July 20. As sales manager, for the past six years of the cutting compound department of his company, Mr. Collins became a familiar figure in the machine-tool industry and his untimely death will be mourned by a large circle of business friends.

Business Items

J. L. Miller and Eugene S. Reilly have formed the J. L. Miller Machinery Co., 3 Wood St., Pittsburgh, for the purpose of dealing in metal and woodworking machinery.

Hyatt Roller Bearing Co., Newark, N. J., announces a change in the name of its former commercial sales division to that of industrial department. The industrial department includes all applications other than automobile.

The Harmatta Spot Welding patent controlled by the Universal Electric Welding Co. was declared valid by the U. S. Circuit Court of Appeals on July 17, 1916. It is understood that reasonable terms will be made with users for machinery covered by this patent.

The Association of French Importers of Machine Tools has recently been formed in Paris, F. Fenwick, president. It is "open to all French importers and dealers, old or new, big or small. We intend to support and to stimulate morally all our members for their own benefit and indirectly for the benefit of the manufacturers that they will represent." The office of the new association is at 15, Rue Fenelon, Paris.

Transmission Ball Bearing Co., Buffalo, N. Y., have found it necessary, owing to the demand for its line of Chapman ball bearings, to build and equip a new factory to afford greatly increased manufacturing facilities. A complete installation of new equipment for the manufacture of shafting bearings and loose pulley bushings, as well as elevating trucks, is contemplated.

The Capital Stock of the Morse Chain Co. of Ithaca, N. Y., has been increased from \$400,000 to \$1,500,000 for expansive purposes in the shape of new buildings and additions to old ones already under way. Present plans contemplate again doubling the size of the plant, a large storage building being about completed, additions to the steel and wire mills and a new gas-producer building being well under way, and another addition to the main building, increasing its total length to more than 900 ft., soon to be started. When these buildings are completed, the Morse Chain Co. will have a total floor space of approximately seven acres, all of which will be devoted exclusively to the manufacture of Morse rocker-joint power transmission.

Trade Catalogs

Wet Tool Grinding Machines. Diamond Machine Co., Providence, R. I. Bulletin; pp. 12, 8½x11 in.; illustrated.

Roller Bearings. American Roller Bearing Co., Pittsburgh, Penn. Bulletin No. 1003. Pp. 22; 6½x10 in. Illustrated.

Ball Bearings. U. S. Ball Bearing Manufacturing Co., Palmer St. and Kolmar Ave., Chicago, Ill. Catalog F; pp. 34, 7x9 in.; illustrated.

Bolt Pointing, Threading and Special Tapping Machines. Webster & Perks Tool Co., Springfield, Ohio. Catalog; pp. 34, 6x9 in.; illustrated.

Ladies. Whiting Foundry Equipment Co., Harvey, Ill. Catalog No. 122. Pp. 24; 6x9 in.; illustrated. This catalog supersedes No. 103.

Friction Clutches and Friction Cut-Off Couplings. Hilliard Clutch & Machinery Co., Elmira, N. Y. Catalog C. Pp. 12; 6x9 in. Illustrated.

Rotary Surface Grinder. The Persons-Arter Machine Co., Worcester, Mass. Catalog No. 2; pp. 12, 6x9 in. This describes Model A 8- to 12-in. grinders.

Ball Bearings. S-K-F Ball Bearing Co., Hartford, Conn. Bulletin; pp. 40, 6x9 in.; illustrated. This bulletin is devoted specially to ball bearings for cottonseed oil machinery.

Air Compressors. Chicago Pneumatic Tool Co., Chicago, Ill. Bulletin 34-N. Pp. 20; 6x9 in. This bulletin illustrates and describes single steam and belt-driven compressors.

Steam Condensing Plants. Ingersoll-Rand Co., 11 Broadway, New York. Form No. 9024. Pp. 32; 6x9 in. This bulletin describes the Bayer barometric type of condenser.

Combination Gas & Oil Burning Equipment for Industrial Heating. Tate-Jones & Co., Inc., Empire Building, Pittsburgh, Penn. Circular No. 155. Pp. 8; 8x11 in. Illustrated.

Link-Belt Sprocket Wheels, Traction Wheels, Gears, Buckets, Etc. Link-Belt Co., Chicago, Ill. Book No. 275. Pp. 112; 6x9 in. This contains revised list prices effective July 15, 1916.

"Libby" Heavy Duty Turret Lathe. International Machine Tool Co., Indianapolis, Ind. Booklet; pp. 16; 6x9 in. This booklet shows the application of this lathe in railroad shops.

Electric Portable Tools. Chicago Pneumatic Tool Co., Chicago, Ill. Bulletin 3-41. Pp. 8; 6x9 in. This bulletin describes the Duntley electric tools for street and interurban railways.

Radmore Heads. Lawson & Co., 90 West St., New York. Catalog. Pp. 18; 5½x7 in. These

are the Radmore heads for drilling square holes formerly made by the Radical Boring Head Corp.

Portable Conveyors. The Jeffrey Manufacturing Co., Columbus, Ohio. Bulletin No. 184. Pp. 12; 6x9 in. Illustrated. These conveyors are used in handling barrels, boxes, packages, bags, etc.

Air Compressors. Ingersoll-Rand Co., 11 Broadway, New York. Form No. 3063. Pp. 28; 6x9 in. Imperial Type "XPV" duplex steam driven compressors are described and illustrated in this bulletin.

Overhead Carrying Devices. New Jersey Foundry and Machine Co., 90 West St., New York. Catalog 88; pp. 48, 6x9 in. This describes the tracking, trolleys, hoists, cranes, cars, etc., made by this company.

Tool Holders, Hollowed Bored Forgings, Planer Bolts. National Forge and Tool Co., Erie, Penn. Catalog; pp. 20, 6x9 in.; illustrated. The tool holders and planer bolts described in this catalog were formerly made by the G. R. Lang Co., of Meadville, Penn.

"Products de la Ingersoll-Rand." Ingersoll-Rand Co., 11 Broadway, New York. Catalog; pp. 124, 6x9 in. This is a Spanish catalog covering completely the company's line of air and gas compressors, pumps, pneumatic tools for machine, boiler shop and foundry work.

Oxy-Acetylene Welding and Cutting Apparatus. The Prest-O-Lite Co., Indianapolis, Ind. Fourth edition of instruction book (paper cover) on oxy-acetylene welding and cutting, in which are presented up-to-date and practical data on the welding of different metals. Price, 50c.

Iron Cements, Paints, Etc. Smooth-On Mfg. Co., 570-574 Communipaw Ave., Jersey City, N. J. Smooth-On Instruction Book No. 16. Pp. 144; 4½x6½ in. This contains many new examples and illustrations showing the working of the different Smooth-On iron cements and should be of value to any machine shop and foundry.

Belt Pulleys. This is the title of two booklets issued by the American Pulley Co., Philadelphia, Penn., in which pulley data are compiled and tabulated. One contains report of tests for belt slip by H. M. Haven and William W. Crosby, engineers and architects, and the other is a reprint of a paper by Charles A. Brinley read before the Engineers Club of Philadelphia, Penn.

Catalogs Wanted

The Cox Traveling Grate Co., Port Carbon, Penn., would like to receive catalogs of machine tools and general equipment for a machine shop and foundry.

Forthcoming Meetings

American Foundrymen's Association and American Institute of Metals. Annual meeting, Sept. 11-16, Cleveland, Ohio. A. O. Backert, secretary, American Foundrymen's Association, Cleveland, Ohio.

National Machine Tool Builders' Association. Annual convention, Oct. 24-25, Hotel Astor, New York City. Charles E. Hildreth, general manager, Worcester, Mass.

American Society of Mechanical Engineers. Monthly meeting, first Tuesday. Calvin W. Rice, secretary, 29 West 39th St., New York City.

Boston Branch National Metal Trades Association. Monthly meeting on first Wednesday of each month. Young's Hotel. W. W. Poole, secretary, 40 Central St., Boston, Mass.

Providence Association of Mechanical Engineers. Monthly meeting, fourth Wednesday of each month. J. A. Brooks, secretary, Brown University, Providence, R. I.

New England Foundrymen's Association. Regular meeting, second Wednesday of each month. Exchange Club, Boston, Mass. Fred F. Stockwell, 205 Broadway, Cambridgeport, Mass.

Engineers' Society of Western Pennsylvania. Monthly meeting, third Tuesday; section meeting, first Tuesday. Elmer K. Hiles, secretary, Oliver Building, Pittsburgh, Penn.

Rochester Society of Technical Draftsmen. Monthly meeting, last Thursday. O. L. Angerine, Jr., secretary, 857 Genesee St., Rochester, N. Y.

Superintendents' and Foremen's Club of Cleveland. Monthly meeting, third Saturday. Philip Frankel, secretary, 310 New England Building, Cleveland, Ohio.

Western Society of Engineers, Chicago, Ill. Regular meeting, first Wednesday evening of each month, excepting July and August. J. H. Warder, secretary, 1785 Monadnock Block, Chicago, Ill.

Philadelphia Foundrymen's Association. Meetings first Wednesday of each month. Manufacturers' Club, Philadelphia, Penn. Howard Evans, secretary, Pier 45 North, Philadelphia, Penn.

Technical League of America. Regular meeting, second Friday of each month. Oscar S. Teale, secretary, 35 Broadway, New York, N. Y.

Williams' "Master Form" Gearing

BY REGINALD TRAUTSCHOLD

SYNOPSIS—The Williams' system of longitudinally parallel and transversely converging bevel-gear tooth construction is described, tooth contact and tooth proportions discussed, machining operations for gears and pinions explained. Advantages and limitations of the system are taken up.

By fully recognizing the fundamental law governing all gearing and by admitting the futility of attempting to make bevel gears interchangeable, Harvey D. Williams proposes to revolutionize the cutting of bevel gears of commercial size by substituting a method of multiple production for the tedious and individual production method so long in vogue.

The fundamental law whose importance Mr. Williams seems to have appreciated more than other designers is that

decided further advantage offered by plane-surface production by making two tooth profiles longitudinally parallel, though transversely converging, so that they can be finished simultaneously and with the same cutter.

As but one of a pair of bevels can have its teeth so proportioned, Mr. Williams proposes the construction naturally for the larger, the gear, and makes the smaller wheel, the pinion, the conjugate of the gear with pairs of longitudinally parallel and transversely converging plane-surface tooth profiles. The usual pair of bevel-gears, those for which there is the greatest commercial demand, have a speed ratio of up to four to one, or even up to six to one, so that 80 per cent. sometimes as high as 86 per cent. of the teeth of such sets of gears could be of the simple Williams' form. Even in the case of miter bevel-gears, or in instances in which the pinion might be furnished with the simple teeth, very considerable economies in

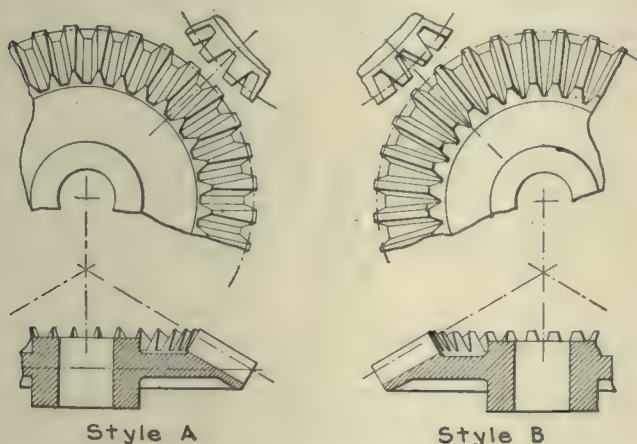


FIG. 1. EXAMPLES OF WILLIAMS' "MASTER FORM" GEARS

any gear will mesh perfectly with its conjugate, irrespective of the shape of the teeth. Cycloidal, involute, ovoid, etc., are but tooth forms, standardized by years of usage, which present more or less difficulty in reproduction. Their chief virtue lies in the fact that they are developments following definite geometrical laws—thus permitting duplication within reasonable degree of accuracy. In spur gearing the form of the tooth is not of particular importance—from a manufacturing standpoint—as the tooth proportions are similar over the entire face of the gear, so that cutting tools with correct profile can be evolved which will finish the teeth in simple operations. In bevel gearing, however, accurate cutting of teeth is made much more difficult by the fact that the proportions of the teeth vary from end to end, necessitating various adjustments of both work and cutting tools and making accurate reproduction an exceedingly difficult task.

Economy in multiple production of any mechanism is dependent upon the simplicity of the operations involved and the speed with which they can be performed. In the machine shop, comparatively small plane-surfaces can be reproduced in quantities with the greatest degree of precision, minimum difficulty and maximum economy—excepting only the production of small cylinders in quantities. Mr. Williams has adopted the plane-surface, therefore, for the profile plane of his gear tooth, one of a mating pair of bevel gears, and has secured the very

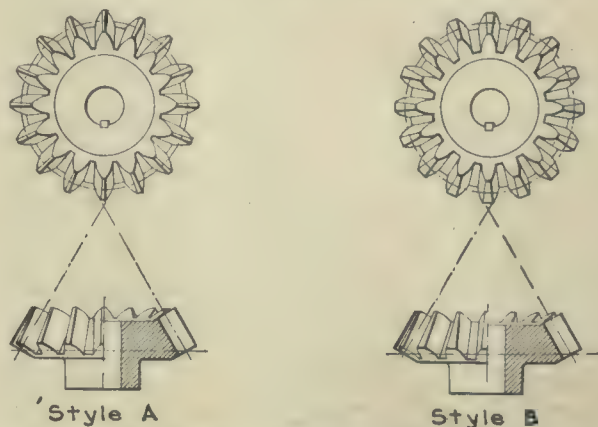


FIG. 2. PINIONS FOR WILLIAMS' "MASTER FORM" GEARS

manufacture, as will be seen, would result from the adoption of the new shaped teeth.

Mr. Williams' principle of longitudinally parallel and transversely converging plane-surface tooth profiles permits of two constructions (see Fig. 1), in one of which the opposite sides of alternate teeth are longitudinally parallel—*Style A*—and in the other of which the two sides of the same tooth are longitudinally parallel—*Style B*. In the former, the space between the teeth is constant; and in the latter, the thickness of the tooth is the same from end to end; teeth of parallel depth being employed in the Williams' gear. Either of these forms may be adopted, but for manufacturing considerations in general, the advisable form is that represented as *Style A*.

In the design in which the teeth are radial and the spaces parallel (*Style A*), the contact plane between the gear and the pinion is slightly increased, just as if the face of the gear were slightly elongated, the pressure of the pinion on the gear being exerted at a slight inclination to the normal. In the design in which the spaces are radial and the teeth parallel (*Style B*), the contact plane between the gear and the pinion is no longer than in the ordinary types of bevel gears with longitudinally converging tooth profiles, but the pressure of the gear on the pinion is exerted at a slight inclination to the normal, the face of the pinion being slightly elongated in this case.

This slight oblique transmission of pressure, in sets of gears in which the axes of both the gear and pinion lie in the same plane, produces a slight "skew action," similar to that produced in an ordinary pair of skew-bevel gears. The plane tooth profiles are tangent to the frustum of a "skew cone" having an apex angle equal to twice the pressure angle of the gear and the diameter of its smaller base equal to the width of the bottom of the tooth space in *Style A* gears and to the width of the top of the tooth in *Style B* gears—see Fig. 1.

This "skew action" not only is responsible for the quite appreciable gain in smoothness and silence in operation common to skew-bevel gears in general but also discounts to some extent the necessity of the exactness in shaft alignment required for the smooth operation of ordinary bevel-gears. But a very slight difference in the planes of ordinary bevel-gears causes them to chatter and pound for it is equivalent to operating gears as skew-bevels, which are not proportioned for such service. In the Williams' system, the troubles resulting from slight misalignment of shafts are discounted by the fact that a certain "skew action" is inherent to the gears so that a slight increase in the amount of "skew" is proportionally very much less serious than where complete avoidance of "skew" is necessary for satisfactory operation.

PINIONS FOR WILLIAMS' "MASTER FORM" GEARS

Fig. 2 illustrates the forms of pinions developed to run with the "master form" gears; *Style A* mating with a gear in which the teeth are radial and the spaces parallel, *Style B* mating with a gear in which the spaces are radial and the teeth parallel. *Style A* shows a somewhat better distribution of metal than does the pinion of *Style B*, the flanks of the former being generally heavier, more metal being removed from *Style B* pinions on account of the proportionally greater amount of metal in the gear teeth of constant cross-section—*Style B* gear. The profiles of both styles of pinions are curved surfaces transversely, and to some extent longitudinally, so the action of tooth engagement is more one of rolling, the pinion rolling into mesh with the gear, instead of the sliding action taking place in ordinary bevels of the skew-bevel type—this peculiarity will be referred to again.

Either style of pinion can be cut on a generating machine with about equal ease and considerably more expeditiously than can be the ordinary type of bevel-gear. The cutting tool for *Style A* pinions is slightly the more difficult to produce and to keep in good condition, but the advantage of *Style A* gear, from manufacturing considerations, makes *Style A* pinion preferable to *Style B* pinion. In addition to which there is, of course, the advantage of greater strength favoring *Style A* pinion.

Parallel depth teeth being employed in the Williams' "master-form" method of gearing, tooth contact between advancing pinion and gear teeth commences while the preceding teeth are in full mesh and before the receding teeth are completely out of mesh, as is the case in parallel depth bevel-gears of the ordinary type. In addition to which desirable feature, a peculiarity possessed by this class of gearing, due to the slight longitudinal curvature of the pinion teeth above the contact lines in full mesh, is the rolling action of the teeth on entering and leaving mesh.

Fig. 3 (b) depicts the action of the teeth as they enter mesh. Contact between the pinion and the gear com-

mences at some point removed from the inner end of the gear tooth, such as point *c* shown on the first view of detail (b). As the gears advance the teeth enter mesh—as shown in the subsequent views of detail (b)—with a rolling action rather than one of pure sliding, on account of the slightly greater length of advancing contact line on the pinion tooth due to its slight longitudinal curvature, the end of the pinion tooth rolling from the initial contact point *c* to its position in line with the inner end of the gear tooth in full mesh and then similarly rolling out as the teeth disengage.

Detail (a), Fig. 3, shows the points of contact (projections of the contact lines) when the gear and pinion are in full mesh. These points are normal projections of the "instant center," the point of tangency between the pitch circles of the gear and pinion, upon the plane-surface tooth profiles of the gear teeth. In this position, a longitudinal section of the pinion tooth on the plane of the two contact lines is a parallelogram conforming to the corresponding rectangular section of the gear tooth space in *Style A* gearing, or a regular trapezoid corresponding to the section of the gear tooth space in *Style B* gearing. As the teeth enter or leave mesh, the contact points always lie on a plane passing through the "instant axis," of which

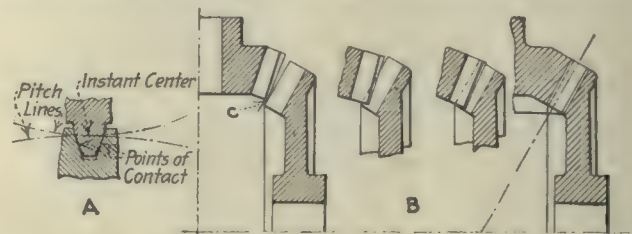


FIG. 3. DETAILS OF TOOTH CONTACT

the "instant center" is the projection, and normal to the gear tooth profile, the profile of the pinion tooth being the envelop of contact points lying in planes passing through the "instant axis" of the pinion tooth. That is, any line passing through the "instant axis" of the pinion is normal to the plane-surface profile of the gear tooth at instant of tooth contact.

The location of the pitch line in this type of gearing is of interest in locating the "instant center" and also in showing the excellent distribution of load on the teeth. The addendum is made about one-third of the working depth of the gear tooth, two-thirds of the working depth of the pinion tooth, so the contact lines in full mesh, which have been seen to lie below the pitch line of the pinion, are actually located close to mid-tooth in both the gear and pinion where the thickness of the respective teeth is about equal. A central location of the pitch line would result in teeth of unwieldy working depth for the gear, the serious undercutting of the pinion teeth and usually the removal of much of the top of pinion teeth in *Style A* pinions during generation.

The longitudinally parallel and transversely converging tooth profiles of the gears call for particularly simple machining operations. All that is required is a series of straight cuts with a suitably-shaped tool in the general direction of the gear's apex—see diagrams of Fig. 4. In the case of *Style A* gears, in which the bottom of the tooth space is of constant width, a plain "V" shaped tool is employed for cutting out the tooth spaces, the only requirements of which are that the cutting edge angles conform to the pressure angle of the gear and that the tip

of the tool be removed so that its truncated end conforms to the width of the bottom of the tooth space. These simple requirements permit the use of milling cutters so that the work can be most expeditiously performed—particularly as the sides of adjacent teeth can be finished in one setting of the blank. Such a milling cutter can be accurately gaged and kept precisely ground with the minimum liability of deviation from correct proportions.

The cutting tool employed for *Style B* gears, in which the top of the tooth is of constant width and the sides of each individual tooth are longitudinally parallel is the conjugate of the tool used for *Style A* gears—see Fig. 4—and such a form of tool cannot readily be reproduced in the shape of a milling cutter. Not only would a milling cutter of the requisite shape be difficult to make but it would be extremely difficult to grind.

The various dimensions given on the "Detail of Cutting Tool," Fig. 4, should advisably be kept as indicated, as well as the included angle ground to precision. Dimension a must not be greater than the bottom width of the space between the inner ends of adjacent teeth nor should

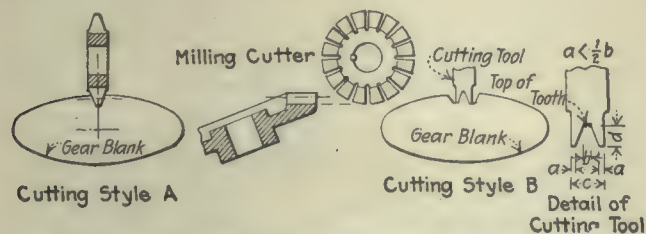


FIG. 4. MACHINING OPERATIONS FOR WILLIAMS' "MASTER FORM" GEARS

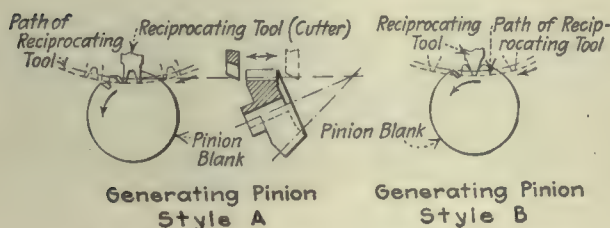


FIG. 5. MACHINING OPERATIONS FOR PINIONS

it be less than one-half the bottom width of the space at the outer ends of the teeth, in order that a second tool may not be required to finish off the bottom of the tooth space. These quite rigid requirements practically limit the cutting of this style of gear to shapers or planers, the conditions imposed being severe for millers in productive work.

The mating pinions for "master form" gears are advisably cut on generating machines employing a simple cutting tool which is the counterpart, or mate, of the tool employed for cutting the "master form" gear, the compound operation of the machine reproducing in a conjugational manner the mating tooth of the gear—see Fig. 5. The cutting tool reciprocates in the line of the tooth form axis and at the same time is given a slow movement in a circle conforming to the circumference of the mating gear, while the pinion blank revolves at a proportional speed as if actually in operation with its mating gear. Either style of pinion is generated in the same manner, the only difference being in the shape of the reciprocating tool. For *Style A* pinions the cutting tool is similar in shape to the tool employed for cutting *Style B* "master form" gears, while the cutting tool for *Style B* pinions is

similar in section to the tool used in cutting *Style A* "master form" gears.

Reciprocating tools being employed to generate either type of pinion, the simpler tool for cutting *Style B* pinion does not possess the same degree of advantage over the more complicated generating tool for *Style A* pinions that exists in the respective tools for cutting the "master form" gears, so that *Style A* pinion is little more difficult to generate, notwithstanding the objections raised in the case of a similar tool for cutting the gears and which, of course, apply with equal force to the tool required for generating the pinion.

The form of the reciprocating tools conforming exactly in outline to the profiles of the gear teeth—the cutting edges of the generating tool for *Style A* pinions conforming to the bounding profiles of individual gear teeth and the cutting edges of the generating tool for *Style B* pinion conforming to the opposite profiles of adjacent gear teeth—both sides of the pinion teeth are finished at the same time. Fig. 6 shows a pinion tool and pinion setup in a shaper fixture used to cut experimental gems.

This simplification of the generating operations also makes possible the substitution of a rotary cutter for the reciprocating tool of the generating machine, an improvement which would complicate the design of the generating machine, it is true, but one which would at the same time greatly increase its output. The employment of such an improved type of generating machine would again raise the question of advisable type of pinion to adopt for the "master-form" type of gearing. As in the case of the "master form" gears, simplicity would favor *Style B* pinion, but this would necessitate at the same time the adoption of *Style B* "master form" gear, so that the simplicity in the production of the gear would have to be sacrificed. As will be seen when considering multiple production of "master form" gears, the cutting of the gear teeth can be accomplished much more rapidly than the generation of pinion teeth, even with a generating machine equipped with a rotary cutter, so it would be advisable to stick to the generation of *Style A* pinions, notwithstanding the difficulties of producing and maintaining a satisfactory rotary cutter of the required form. Thus leaving the simpler form of tool for the milling cutter for finishing the gears expeditiously. Adding considerable weight to the wisdom of such selection of type of "master form" gearing is the fact that in commercial gearing for which there is the greatest demand there are considerably more teeth on the gear than on the pinion so that the more extended task of cutting the gear teeth should advisably be performed with the simpler and more easily maintained cutting tool.

Entirely aside from the very decided advantages in simplicity and cheapness of manufacture of "master form" gearing, it possesses other features which likewise reduce costs of production or possess merits of economic value.

Only a single pair of counterpart tools is required for making all pairs of "master form" bevel-gears of a given pitch, quite irrespective of the number of teeth or the cone angles, the form of tooth being truly a "master form."

Any number of pinions, of the same or differing number of teeth and cone angles, for which there is space and within reasonable limits, can be run with a single "master form" gear so that a number of different speed reductions can be obtained from the same driving gear through separate pinions mounted on individual shafts.

Pinions which are not conjugately related to the cone angle of the gear necessitate the offset of the pinion shaft from the plane of the "master form" gear in order that the respective cones of revolution may be tangent to one another on the line of tooth contact, the skew-bevel arrangement. In this usually avoided arrangement—for ordinary types of bevel-gears—is to be found one of the most valuable features of the longitudinally parallel and transversely converging arrangement of teeth, especially in *Style A* "master form" gears. The "skew" due to the offset of the pinion shaft may be confined to the pinion—that is, the pinion generated with the spindle of the generating machine offset from the plane of the pinion blank a distance equal to the total offset of the pinion shaft—so that a "master form" gear can operate with either a pinion lying in the same plane or one in some other plane, or with both such pinions at the same time. A "skew-located pinion" for a "master form" gear is no more difficult to generate than one lying in the same plane as the "master form" gear, so that the skew-bevel arrangement of "master form" gearing need be no more difficult or expensive to manufacture than similar gearing all in one plane.

In skew-bevel arrangement of "master form" gearing, *Style A* gears and pinions are advisably employed, for the inherent "skew action" of this design tends to nullify the crowding of the pinion out of mesh, which is a common failing of the usual type of skew-bevels.

Another peculiarity of the "master form" type of skew-bevels is their increased smoothness in operation. The longitudinally parallel arrangement of teeth possessing an inherent "skew action" even when the planes of the gear and pinion are the same, offsetting these planes does not in any way alter this inherent "skew action" of the arrangement so that the skew action due to the offsetting of the pinion shaft is simply added to that already possessed by the gears. This combination of actions results in an even more smoothly running pair of gears than it is possible to obtain with the same pinion offset in ordinary skew-bevels.

The skew-bevel arrangement of "master form" gearing is not limited to arrangements in which the "skew" is confined to the pinion, for it may be confined to the gear or the "skew" divided between the gear and the pinion, as in the ordinary system of bevel-gearing. The "master form" system of gearing can be adapted to any arrangement that is possible for ordinary systems of bevel-gears and furthermore lends itself to individual systems, making it an exceedingly flexible system of gearing as well as one presenting unusual advantages in the way of simplicity and cheapness in production.

Still another feature which "master form" gearing promises to possess is unusual wearing qualities and ability to take up wear. Wear in bevel-gearing, as in other mechanism, is due to the slippage between contact surfaces and is aggravated by increased difference in curvature between the surfaces. In "master form" gearing, slippage is reduced to a minimum and when it does occur takes place between the comparatively flat curved profiles of the pinion and the plane-surface of the gear teeth so that the wear is extremely slight, almost as little as would occur between two plane-surfaces moving but very slightly upon one another. Should wear become appreciable, the fact that the profile of the pinion tooth is the envelop of its points of contact with a plane-surface

allows the pinion to be shifted an appreciable distance toward or away from its normal position without interfering with the character of tooth contact. That is, the adjustability of "master form" gears is greater than that of any other system of gearing with the exception of involute gearing.

The one limitation inherent to this new system of gearing that tends to complicate to some extent the proper selection of suitable gearing for a specific task is the relationship necessarily existing between the face of the gear, its pitch and the proportions of the teeth. In order that the gears and pinions may be most expeditiously cut without the necessity of employing more than one set of counterpart cutting tools for a pair of bevel-gears, the tools employed for cutting *Style B* gears and *Style A* pinions must be proportioned so that they will pass through the tooth spaces at the inner ends of the teeth and at the same time completely span the tooth space at the outer end of the teeth on the completion of successive teeth. The counterpart tools, naturally, must be proportioned correspondingly. This establishes a definite relationship between the pitch and face of "master form" gearing which can only be avoided by the sacrifice of economy in manufacture—an additional machining operation being required to remove the surplus material

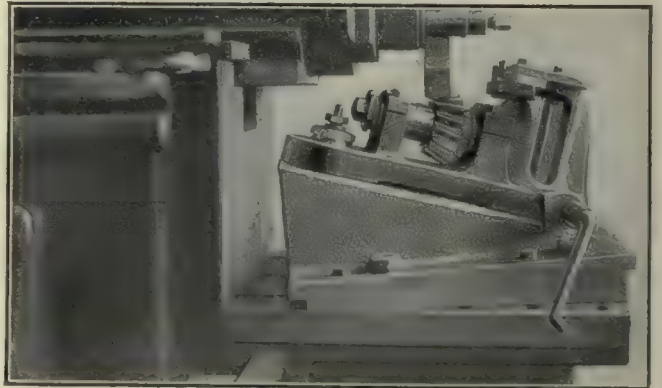


FIG. 6. SHAPER FIXTURE USED TO CUT PINIONS

between the teeth if the relationship is not maintained. This limitation is not serious, however, for when cutting a number of bevels a suitable pitch can always be selected which permits the maintenance of the definite relationship between pitch and face, or the pressure angle can be altered in certain cases to suit the requirements.

Although a pinion of any number of teeth may be run with a specified "master form" gear, each pinion has to be generated with the particular gear so that the same pinion cannot be used with gears of varying diameter. This limitation carries little weight, however, for the satisfactory interchangeability of the ordinary type of bevel-gears depends so much on accurate workmanship and perfect alignment of shafts that the importance of such feature is apt to be much overrated. From a purely practical standpoint it is always advisable to employ pairs of bevels which have been definitely proportioned to run together—this is necessary in the case of the Williams' system and advisable in all systems of bevel gearing.

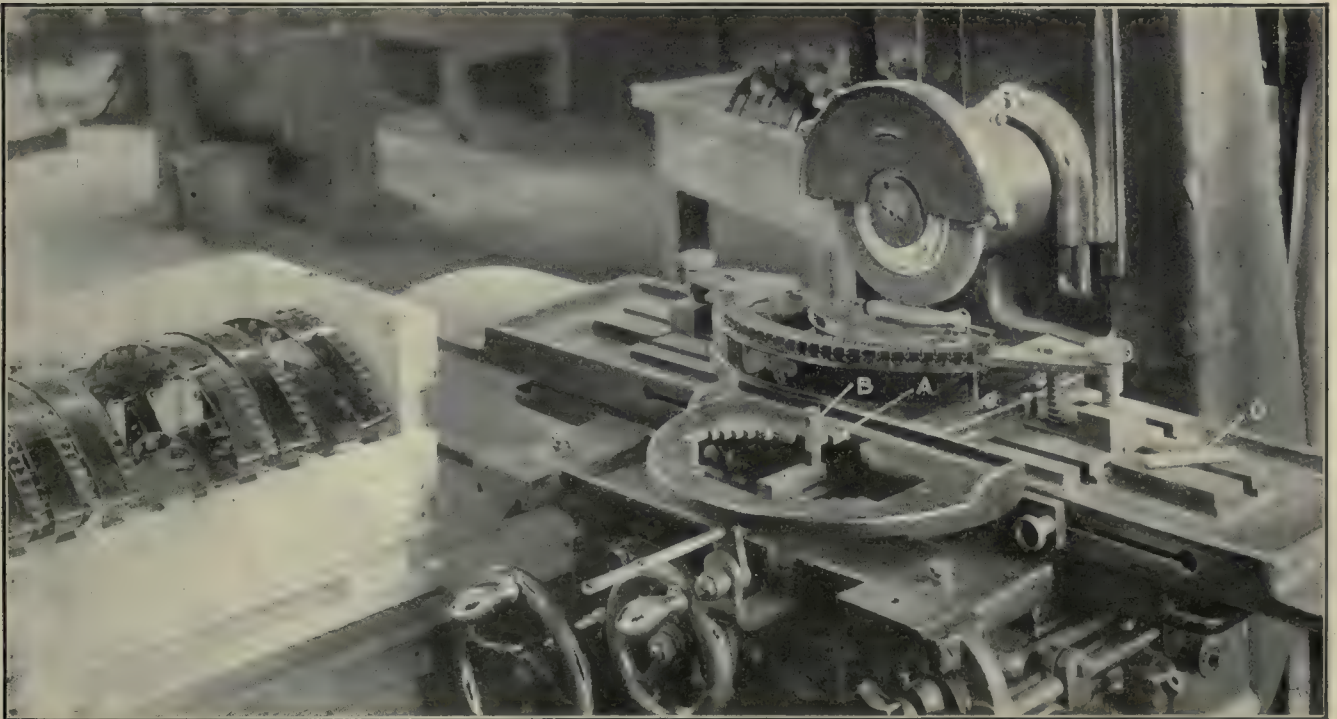
When the plus and minus limits usually given for precision work are considered, the rigidity of machines is a large factor. It is pointed out that the Williams' method of cutting gears permits the most rigid design of cutting machinery, as the gear teeth and the pinions are cut without any generating motions.

New Stop for Surface Grinder

The illustration shows an interesting operation in connection with the manufacture of the top plate for the Noiseless typewriter, giving the method of grinding off the surface of the hardened plate that forms a seat for the type bars in operation. Moreover, the view shows how this hardened plate is finished accurately after it is attached in position to the top plate. This photograph also brings out a novel form of reverse control of the table, which might be called a variable reversing device, whereby great economy in time is effected in the surface grinding of a job where the area to be covered by the wheel varies from point to point. This new form of reversing plate, as designed by the Noiseless Typewriter plant at Middletown, Conn., is so clearly pictured that it requires little in the way of description, although it is difficult to refrain from considerable commendation of so ingeniously de-

The narrow, inner portion of the notch *A* is across that section which controls the table reverse during the passage of the wheel over the sharp V-point of the finished surface. This gives a very short table stroke, and as the wheel gets farther on the V- or fan-shaped surface, the deeper notches in the reverse plate come opposite the reversing dog, which is here seen at *B*, sticking upright from the horizontal block, and the stroke of the table is lengthened to correspond. This increase takes place every few strokes of the table, until the maximum travel of the work necessary to accomplish the grinding operation clear across has been reached.

The control of the reverse is by the rocker shaft *C*, shown projecting crosswise from the front of the table, on which is mounted the horizontal block carrying the vertical contact post *B*, which is engaged by the notches in the body of the controlling casting. This upright post or dog is normally held in a perpendicular position by a spring.



ATTACHMENT FOR AUTOMATICALLY GIVING A VARIABLE LENGTH OF STROKE TO THE GRINDER TABLE

signed an attachment, which in spite of the unusual work that it accomplishes, is so simple in its nature.

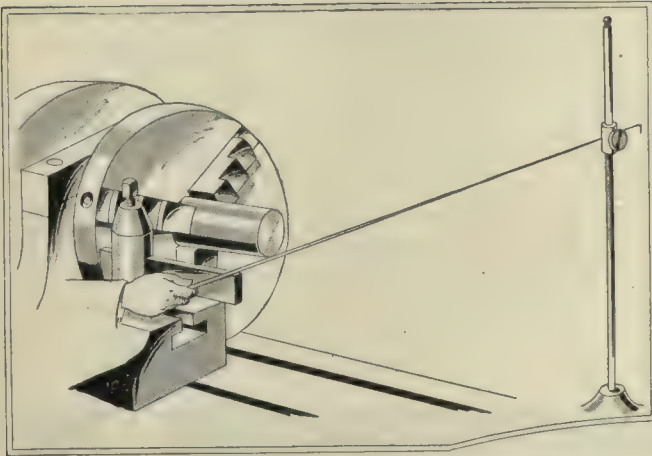
It consists, as will be seen, of a casting cored out with a series of steps corresponding in position to the general outline of the surface of the top plate, which has to be finished by grinding. As already pointed out, this surface is approximately in the form of an open fan. Therefore it is desirable that, as the work advances under the wheel with the crossfeed of the table, the stroke of the table should correspond in length. At the same time, since the surface is not one flat plane, but made up of a series of three ribs in the form of arcs, there are certain positions in the advance of the work under the wheel when it is desirable that the stroke of the table should be lengthened materially. But so far as concerns other points in the increase of the length of the stroke, this is not in a uniform ratio with the crossfeed of the work back under the wheel. The difference in the increased length of the notches in the controlling plate at the front of the table will indicate this clearly.

As the work table passes inward to a point where the corners of the controlling notches begin to come in contact with the dog and shows a tendency toward catching on the sharp corners, the spring simply allows the dog to swing backward and clear the notch corners a stroke or two earlier than would otherwise be the case. There is thus no danger of cramping or binding between the two. The stop portions on the controlling plate either secure a perfectly flat, square, secure grip upon the upright reversing dog *B* or as soon as they begin to strike upon its corners, it springs back against the pressure of the spring and allows the reverse plate to pass until the next contact surface strikes the jaws and reverses the table.

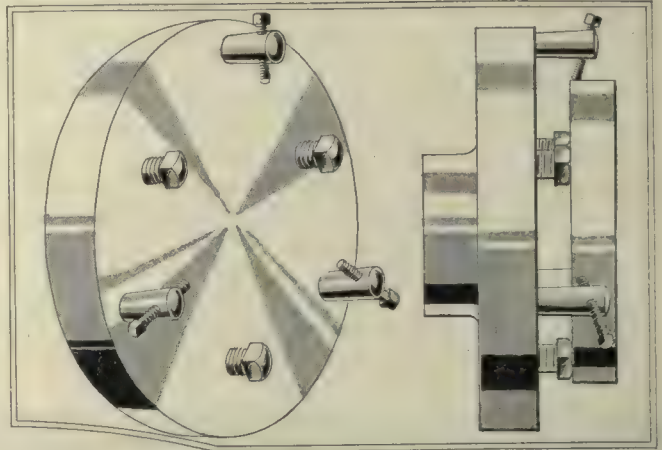
The cut taken under this wheel is slight, and the surface of the wheel is maintained in perfect condition at a definite height from the table by means of the diamond holder *D*, shown at the right-hand end of the table. This is slipped into a hole at the rear end of the grinder fixture itself and brings the diamond a certain distance above the work-holding surface.

From a Small-Shop Notebook

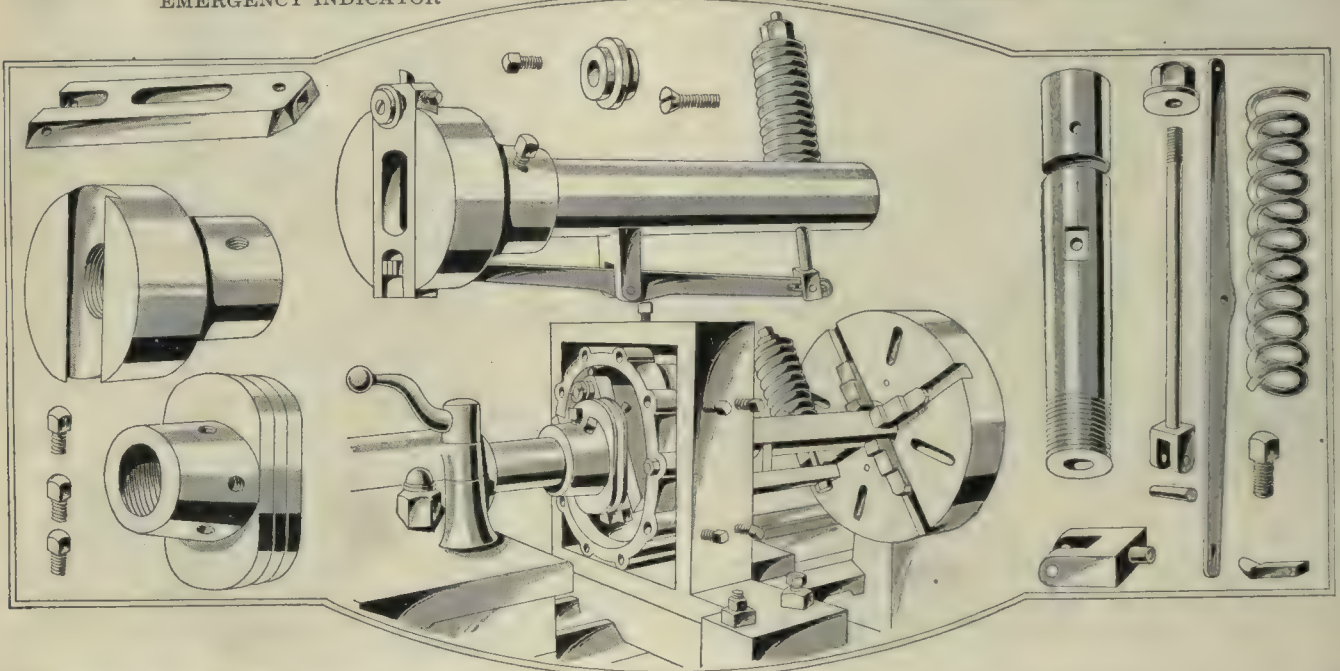
By JOHN H. VAN DEVENTER



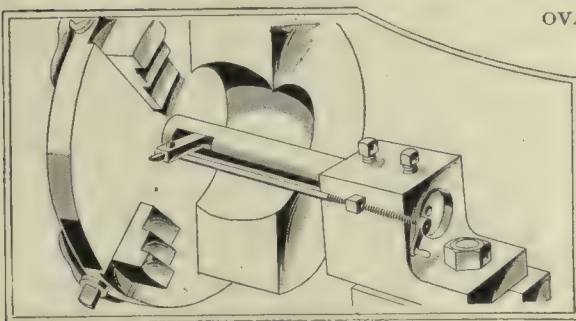
EMERGENCY INDICATOR



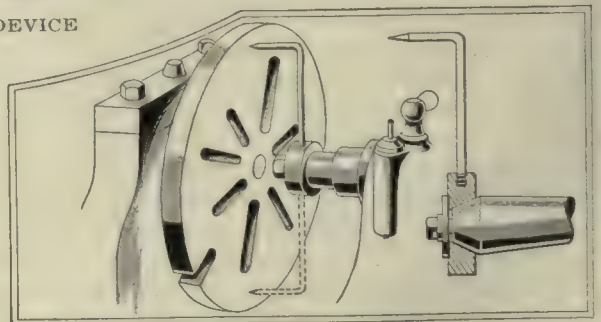
HOME-MADE CHUCK



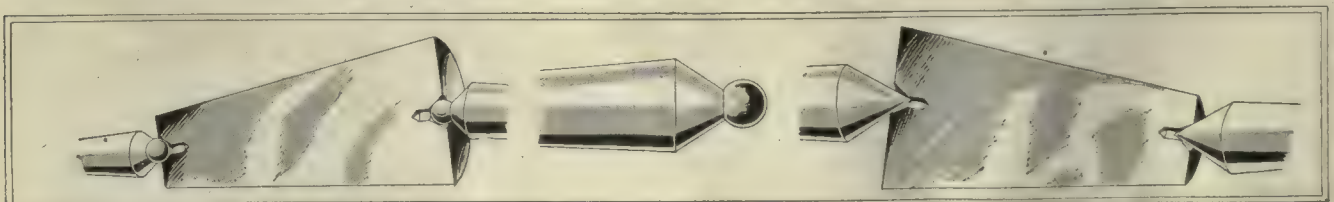
OVAL-TURNING DEVICE



INTERNAL SPHERICAL TURNING



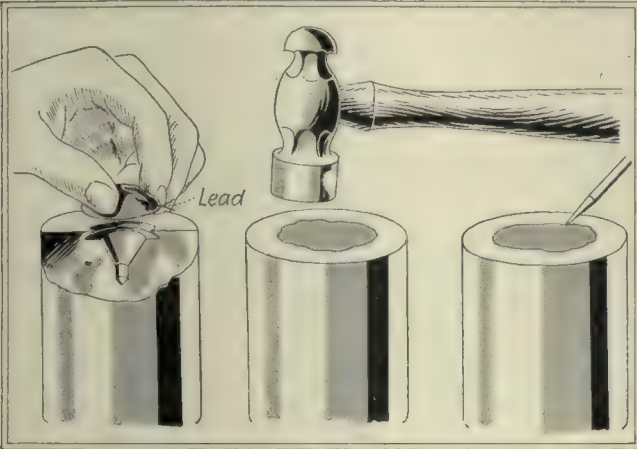
A FACEPLATE TESTER



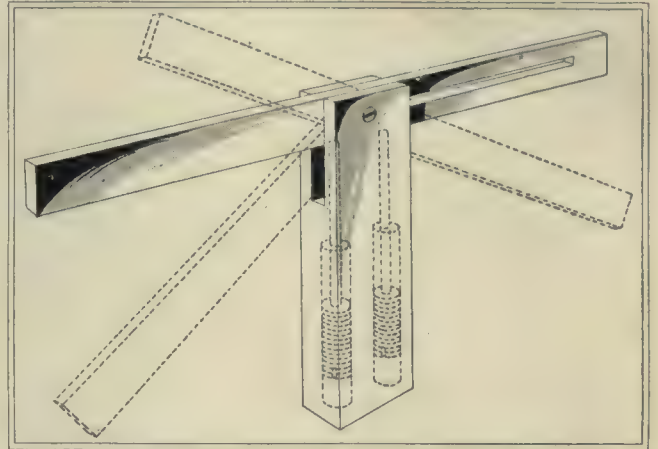
THE UTILITY OF BALL CENTERS IN TAPER TURNING



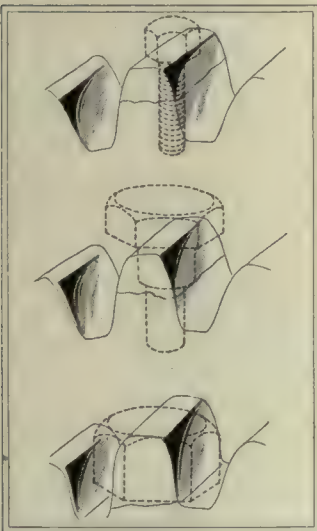
KEEP YOUR SOLDERING IRONS CLEAN AND DON'T BURN THE TABLES



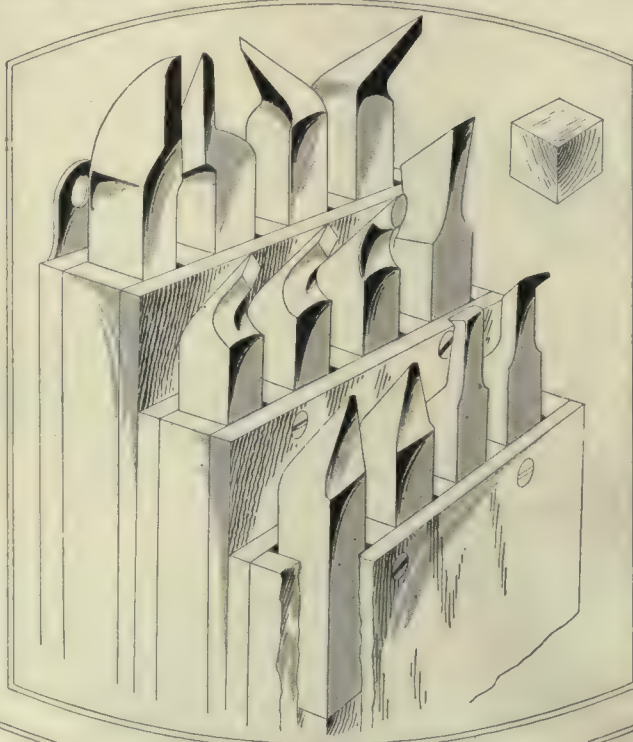
"SAFETY FIRST" ON MANDREL CENTERS



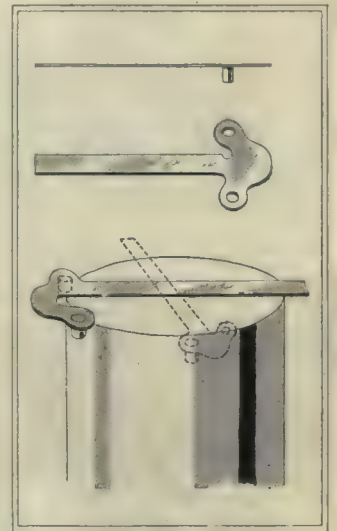
AN "ALL-IN-ONE" ANGLE SQUARE



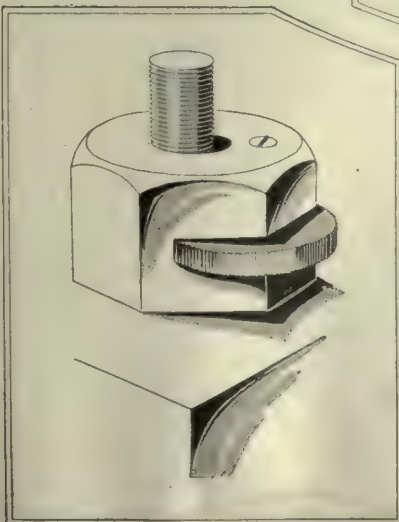
GEAR DENTISTRY



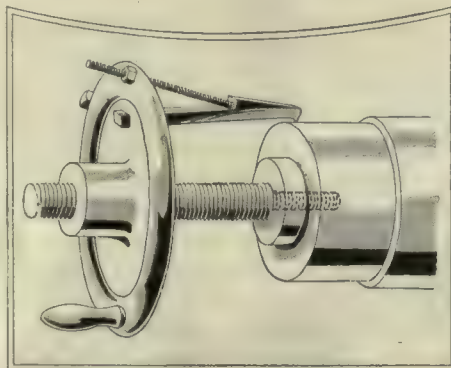
AVOID HUNTING FOR TOOLS



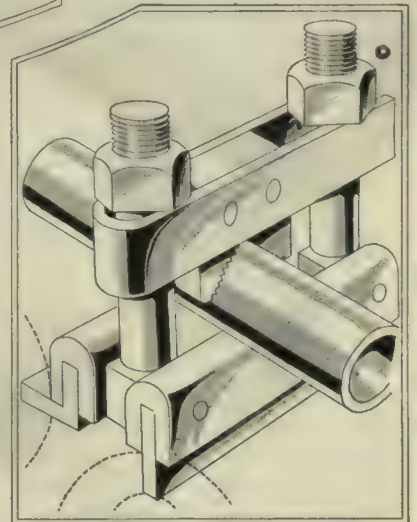
A CENTER SQUARE



ECCENTRIC STUD DRIVER



HAND-TURNING DEVICE



CONVERTIBLE PIPE VISE

Construction of Tip-Welded Cutting Tools

BY T. PILKINGTON

Owing to the present prices of high-speed steels, various methods for their economic use have been developed. One of the greatest reductions in the consumption of high-speed steel is effected by the substitution of tip-welded tools for the usual entire high-speed steel tools—commonly spoken of as solid tools—the heavy roughing tools naturally receiving first attention.

Little, however, has been published that throws much light upon the relative cost, output and durability of tip-welded and solid tools, and the following particulars are given in the hope that they may be found interesting.

It may be well to state that the ensuing remarks apply more particularly to rough turning tools, the tip-welded tools being made up of high-speed steel tips welded to carbon-steel bodies, the solid tools being forged or milled to shape from the solid high-speed steel bar.

Tool bodies have been made from the usual commercial hot-rolled bars of mild steel, and where care is taken to support the tool close to its cutting edge, this material gives satisfactory results. However, after many trials

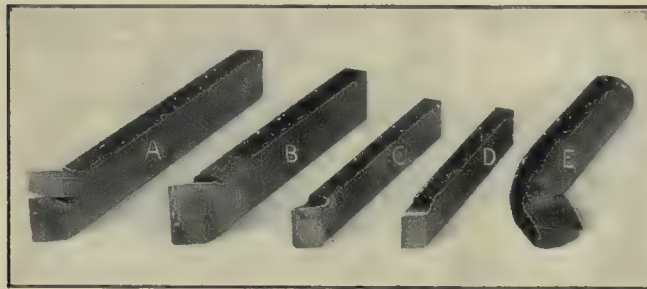


FIG. 1. SEVERAL TIP-WELDED TOOLS

with heavy cuts and feeds, under usual machine-shop conditions, it has been found that a cheap carbon-tool steel is preferable, as with this steel the tools do not become bent or distorted.

Several tip-welded tools are shown in Fig. 1. At A, the parts of a 1x2-in. rough turning tool are shown in their relative positions as prepared for arc-welding. The finished tool appears as shown at B. Tools C and D are of the $\frac{3}{4} \times \frac{1}{2}$ -in. size, and are shown in the worn-down condition—the high-speed steel on tool D being worn down to $\frac{1}{8}$ in. thick. At E, we have a very special form of finishing tool. In this case, a piece of high-speed steel $\frac{5}{16}$ in. thick by $2\frac{1}{2} \times 1\frac{3}{4}$ in. was arc-welded to an ordinary carbon tool-steel body.

An improved form of construction for a rough turning tool is shown in Fig. 2. In this tool, the cutting edge extends from A to B, and it will be noticed that the body of the tool is increased or reinforced at and near the cutting edge. This reinforcement calls for a few remarks.

Where heavy roughing tools are worked at, or near, their maximum capacity, workmen invariably prefer solid steel tools, it being common experience that tool holders with inserted steel tools are more cumbersome than solid tools. Also, generally speaking, tool holders do not conduct the heat from the cutting edge so rapidly as solid tools do, the reason for this latter defect being found in the imperfect junction between the tool holder and the tool. An examination of most of the tool holders in commercial

use at the present time will reveal the fact that very poor contact exists between tool and holder. Several tool holders have appeared recently in which tool and holder are ground to fit, and the output obtained under these conditions is usually much greater than the output obtained from tools that do not make good metallic contact with their holders.

A somewhat similar condition is found in tip-welded tools. The tip-welded tools shown in Fig. 1 rarely have

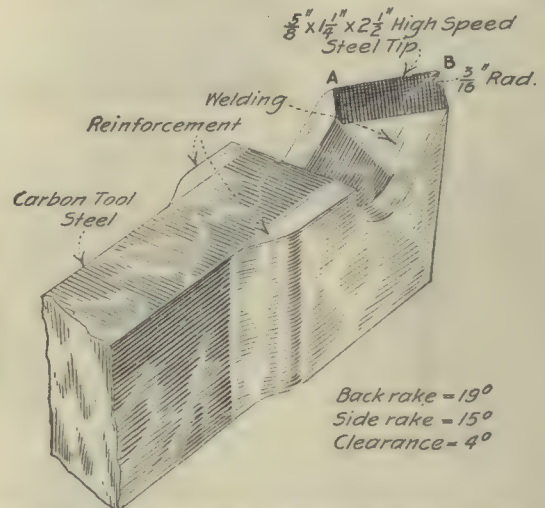


FIG. 2. TIP-WELDED ROUGH TURNING TOOL

welds which make perfect metallic contact over the whole of the surface which is supposed to be welded, and consequently, the heat conductivity between steel tip and body of tool is somewhat reduced.

By reinforcing the end of the tool, as shown, increased metallic contact between cutting edge and holder is obtained, resulting in a cooler cutting edge and a more rigid tool.

Fig. 3 shows the various stages through which such a tool passes during manufacture, and it will be noted that the preparatory machining operations are simple



FIG. 3. STAGES FOLLOWED WHEN MAKING A TOOL

and inexpensive, the parts being cut to the required length and shape in an ordinary power hack saw. On the extreme left of the figure at A, a fixture for giving the correct relative position of tool tip and body is shown. The tool body and tip are placed in this fixture, which gives the correct side and clearance angles, and while in this position they are lightly welded together by spotting the junction with the welding wire. The tool now appears as shown at B and is ready for preheating to a full red heat which is given slowly and uniformly to the steel tip and the bar end by means of a gas furnace. This treatment is given in order to prevent cracking, which is apt to occur if the intense heat of the electric arc sud-

denly be brought to bear on the cool high-speed steel. Several tools are kept in the gas furnace ready for the welder. When the tool is at a full red heat, it is withdrawn from the furnace and arc-welded. The tool now appears as shown at *C* in the figure. After welding, the



FIG. 4. OPERATOR WELDING TIPS

tool is rough-ground on a dry wheel, hardened by the process usually adopted for the hardening of similar high-speed solid tools and finish-ground on a wet wheel. The tool is now ready for work and appears as at *D* in the figure.

It may be stated here that the electric arc-welding process was adopted for this purpose after numerous experiments had been made with smith welds, oxyacetylene welds, electric incandescent welds and electric arc welds. Fig. 4 shows an arc welder at work upon a finishing tool

As this wire is expensive, costing 12c. per lb. at the present time, it is used in the gap between the tip and tool body only, a cold-rolled steel wire $\frac{3}{16}$ in. in diameter, containing approximately carbon 0.076, manganese 0.449, phosphorus 0.035, sulphur 0.051, silicon 0.035, being used for the reinforcement on the sides, as it costs only 2½c. per lb., and may be worked more rapidly than the smaller wire.

In order that uniformly satisfactory welds may be obtained, it is necessary that the voltage and current strength be maintained at approximately 80 volts 90 amperes for tools $\frac{3}{4} \times 1\frac{1}{2}$ -in. cross-section and 90 volts 105 amperes for tools 1x2-in. section. A flux of borax or borax slightly colored with lampblack will be found helpful.

The following particulars give some idea of the performance of these tip-welded tools under usual workshop conditions:

Number of Tools Tested	Description of Tool	Size of Piece When Rough-Turned, In.	Depth of Cut, In.	Feed, In. per Min.	Speed, R.P.M.	Total Number of Grinds	Average Number of Pieces Turned Per Grinding
5	$\frac{3}{4} \times 1\frac{1}{2}$ -in. ordinary tip-welded	$4\frac{1}{2} \times 13\frac{5}{8}$	$\frac{1}{4}$	$2\frac{1}{4}$	45	43	24
9	$\frac{3}{4} \times 1\frac{1}{2}$ -in. reinforced tip-welded	$4\frac{1}{2} \times 13\frac{5}{8}$	$\frac{1}{4}$	$2\frac{1}{4}$	45	76	31
4	$1 \times 1\frac{1}{2}$ -in. solid high-speed steel	$6\frac{3}{8} \times 17$	$\frac{1}{4}$	$2\frac{1}{4}$	28	17	12.125
2	1x2-in. reinforced tip-welded	$6\frac{3}{8} \times 17$	$\frac{1}{4}$	$2\frac{1}{4}$	29	70	13.2
3	$1\frac{1}{4} \times 2\frac{1}{4}$ -in. reinforced tip-welded	$15\frac{1}{8} \times 53\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{8}$ split feed	$9\frac{1}{2}$	3	5.17

The material machined was steel of the following approximate analysis: Carbon 0.50; manganese 0.60; phosphorus 0.02; sulphur 0.018; silicon 0.19 and was machined without the use of cutting compound. Fig. 5 shows two $1\frac{1}{4} \times 2\frac{1}{4}$ -in. reinforced tip-welded tools ar-

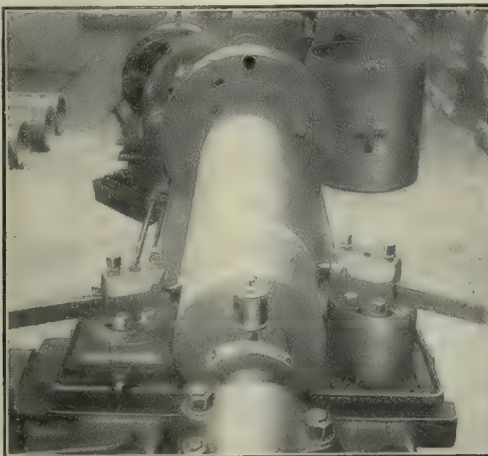


FIG. 5. LATHE WITH TWO TOOLS TURNING

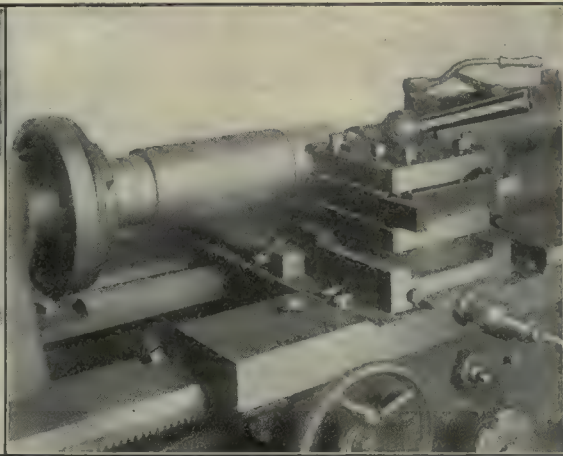


FIG. 6. LATHE WITH ONE TOOL OPERATING

such as shown at *E* in Fig. 1. One terminal of the electric circuit rests upon the cast-iron table seen in the figure, the other terminal is formed by the welding wire held in the welder's electrode holder, the circuit being completed through the tool and electric arc. To the left of the operator, a preheating furnace and two boxes of scrap mica are seen, the latter being used for slowly cooling the welded tools.

The best welding wire for use on this work is approximately $\frac{5}{32}$ in. in diameter and of the following composition: Carbon 0.04; manganese 0.002; phosphorus 0.034; sulphur 0.002; silicon, trace.

ranged to split the feed and Fig. 6 shows one of the $\frac{3}{4} \times 1\frac{1}{2}$ in. reinforced tip-welded tools at work.

The accompanying table compares tip-welded turning tools and solid high-speed tools.

Thus a direct saving of \$6.81 is effected by the substitution of one 1x2-in. tip-welded tool for one solid tool of equal size.

Many machine shops sell their high-speed steel scrap at about 65c. per lb. at the present time. Others are using much of this scrap in the makeup of tip-welded tools, and with excellent results. Where suitable scrap steel is not available, it will pay handsomely at present to use new

steel for tips, especially on the heavy tools. Under these circumstances, curves similar to that shown in Fig. 7 may be plotted for tools of various designs and weights and will be found instructive and useful. There are many tools used in all machine shops that may be tip-welded with economy even after the prices of high-speed steel have been reduced to the prices which ruled before the

The cost of new high-speed steel based upon... \$3.00 per lb.
The cost of scrap high-speed steel based upon... .75 per lb.
The cost of carbon tool steel based upon... .08 per lb.

Tip-Welded Tool	Solid High-Speed Steel Tool
First cost of tool..... \$1.82	First cost of tool..... \$30.00
10 grindings by operator .70	10 grindings by operator .70
8 high-speed steel tips completed 2.64	8 additional dressings... 2.56
8 dressings of old body.. .14	8 additional rough grindings .48
8 additional welds 3.38	8 additional hardenings. .48
8 additional rough grindings .48	8 additional finish grindings .32
8 additional hardenings. .48	8 additional nose grindings .48
8 additional finish grindings .32	8 additional neck drawings .13
8 additional nose grindings .48	80 additional grindings by operator 5.60
80 additional grindings by operator 5.60	
	Total of high-speed steel \$40.75
Salvage \$16.04	Salvage 18.70
Cost of tipped tool when worn out..... \$15.24	Cost of solid high-speed tool when worn out \$22.05

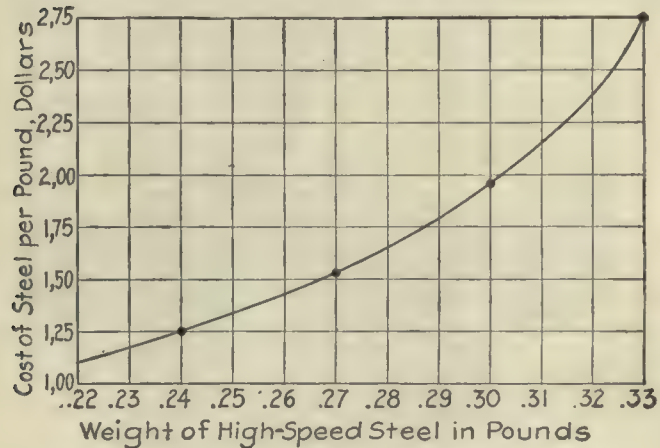


FIG. 7. COST OF SOLID AND TIP-WELDED TOOLS

present inflation. The goose-neck tool shown at *E* in Fig. 3 is a case in point.

However, one of the chief advantages to be derived from the use of tip-welded high-speed steel tools at the

present time lies in the great reduction of the stock of high-priced steel which will be on hand when prices return to their normal level. An indication of the importance of this matter may be obtained from the case of a manufacturing company where, owing to the introduction of tip welding, the high-speed steel orders covering a period of one year were reduced 114,000 lb., an equivalent weight of 8c. carbon tool steel for tool bodies being substituted for the \$3 steel.

Graduating Machine

BY ETHAN VIALI

Graduating machines as a rule are interesting, especially if the movements are at all complicated. The one here shown is used in the shop of the Kempsmith Manufacturing Co., Milwaukee, Wis.

Fig. 1 shows one side of the machine as set for graduating a bevel. The work head is adjusted to or from the tool head by means of the crank and screw *A*. The work spindle *B* is given its intermittent movement between tool strokes, through a worm gear on its lower end, with which a worm at *C* meshes. This worm is made to slide on the splined shaft *D* in order to accommodate the various settings of the work carriage. On the end of the shaft is a ratchet wheel *E* operated by a pawl, the bracket of which is connected to a geared crank by the rod *F*. The gearing of the crank and the number of teeth on the ratchet wheel govern the spacing of the graduations.

A view of the machine from the opposite side is given in Fig. 2. This shows part of the mechanism governing the tool stroke. The tool slide *A* is worked by means of a crank movement. On the opposite end of the shaft is a slotted crank *B*, which is joined to the rocking lever *C* by the rod *D*. The lever *C* is pivoted at *E* and carries a roll at *F* which rides in the cam slot *G*. As this cam turns, the tool is given a reciprocating movement through the mechanism outlined. Now, with a given setting, the strokes of the graduating tool would be all the same length if the pivot at *E* remained stationary. However, most work is graduated with some of the lines longer than others, as every fifth line, for example. This difference

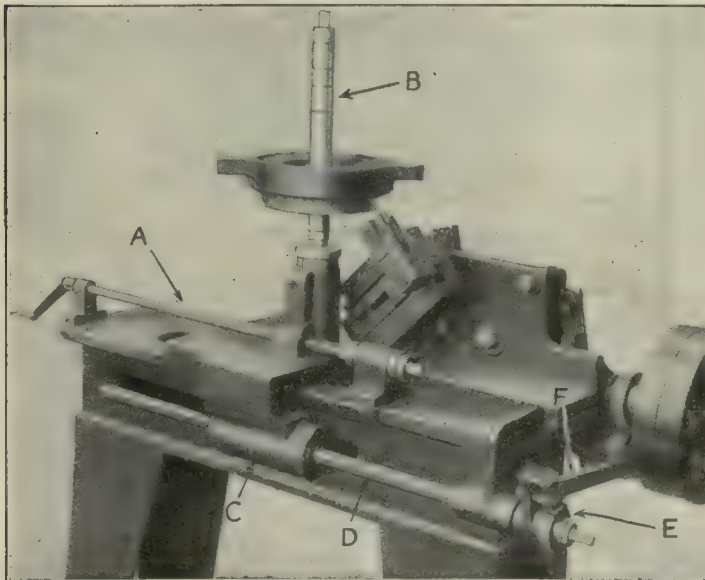


FIG. 1. A GRADUATING MACHINE

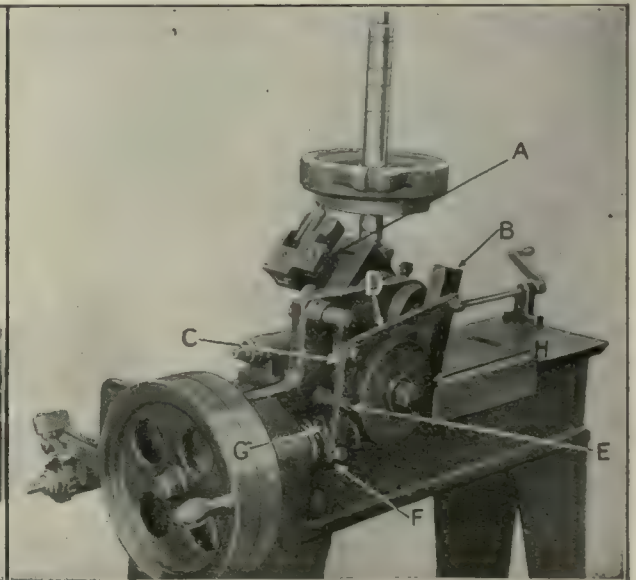


FIG. 2. REVERSE VIEW OF MACHINE

in line length is obtained by means of a cam wheel at *H*, which operates to vary the position of the pivot at *E*.

The method of changing the pivot position will be better understood by reference to Fig. 3. Here the cam *H* and its operating worm *I* have been removed. It will

count of the position of the lockers, only a partial view can be given.

Windows like the ones shown inclose two sides, making it one of the lightest places imaginable. The trough type of wash basin is used, the workman simply opening

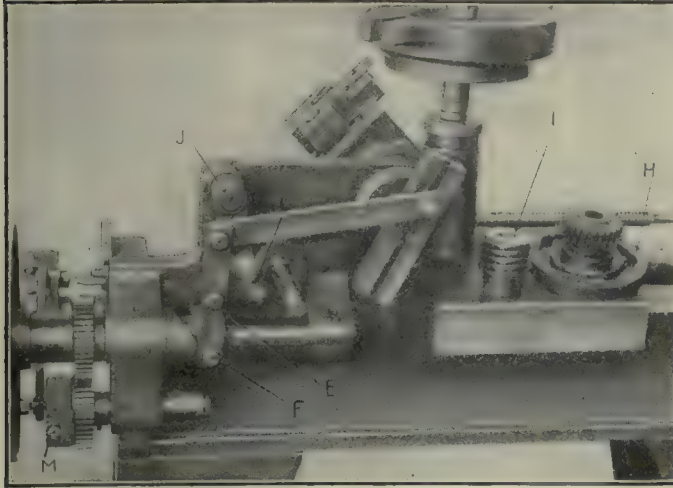


FIG. 3. DETAILS OF STROKE MECHANISM

at once be seen that the pivot *F* is carried on a bracket pivoted at *J*. On this bracket at *L* is a roll that works in the cam slot of *H*. This cam slot is cut with rises according to the line divisions wanted in the graduating, so that the center distance from the pivot *E* to the cam *H* is varied at regular intervals and the length of the tool stroke is automatically changed to correspond.

Any desired line grouping can be obtained by using a cam cut correctly, and any spacing of lines is secured by changing the gears or crank stroke at *M*.

Some of the work done on this machine is shown in Fig. 4. These pieces give a good idea of the range of the machine.



FIG. 4. EXAMPLES OF THE WORK DONE

the faucets and washing his hands in the running water, the basin acting only as a catch to carry off the water. The room is 27x60 ft., has at present four basins of 23 double faucets each, and 160 lockers of the screen-front, ventilated type, which allow damp clothes to dry or odors to escape to the ventilating chutes.

Simple Waving Attachment

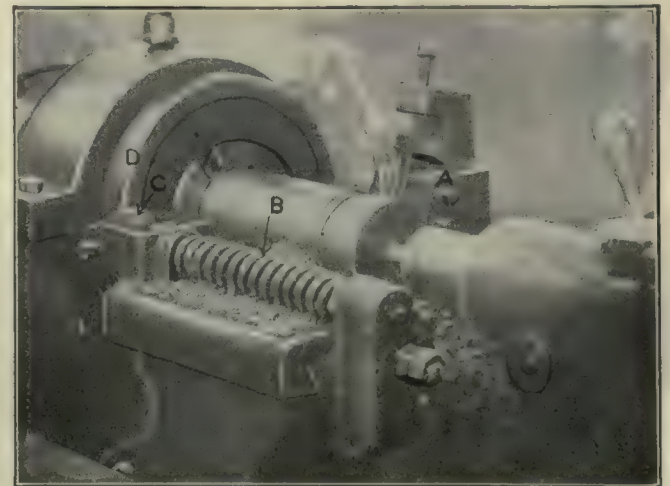
The driving-band groove-waving attachment here shown is one of the simplest of those in use in the Western shops on 3-in. shells. Both the grooving and the waving are done at one setting. The grooving tool is carried in the tool block *A*, at the back. The waving tool

Model Shop Washroom

A washroom has just been completed at the factory of the Cincinnati Planer Co., Cincinnati, which is a model



A MODEL WASHROOM



SHELL-WAVING ATTACHMENT

is carried in the holder in front. As can be seen, the upper part of the holder is made to slide on the lower, so that the spring *B* has a tendency to force it to the left and keep the roller *C* in contact with the cam *D* on the faceplate.

This attachment is in use in the shop of the Dayton Pipe Coupling Co., Dayton, Ohio, and an operator will turn out between 25 and 30 shells per hour with it.

in several ways. The room is an addition to those previously used and is placed above the toolroom, the main building being normally of the single-story type. On ac-

Tools Used in Machining Automobile Parts

BY ROBERT MAWSON

SYNOPSIS—On this and its companion page are shown jigs for machining parts of a motor truck. These tools are of modern design and incorporate some of the latest ideas in jig design. They are of a strong and rugged construction to produce interchangeable parts.

The International Motor Co., Mack Plant, Allentown, Penn., is building several sizes of automobile trucks. In this article are shown and described some of the jigs found helpful in machining elements for the trucks.

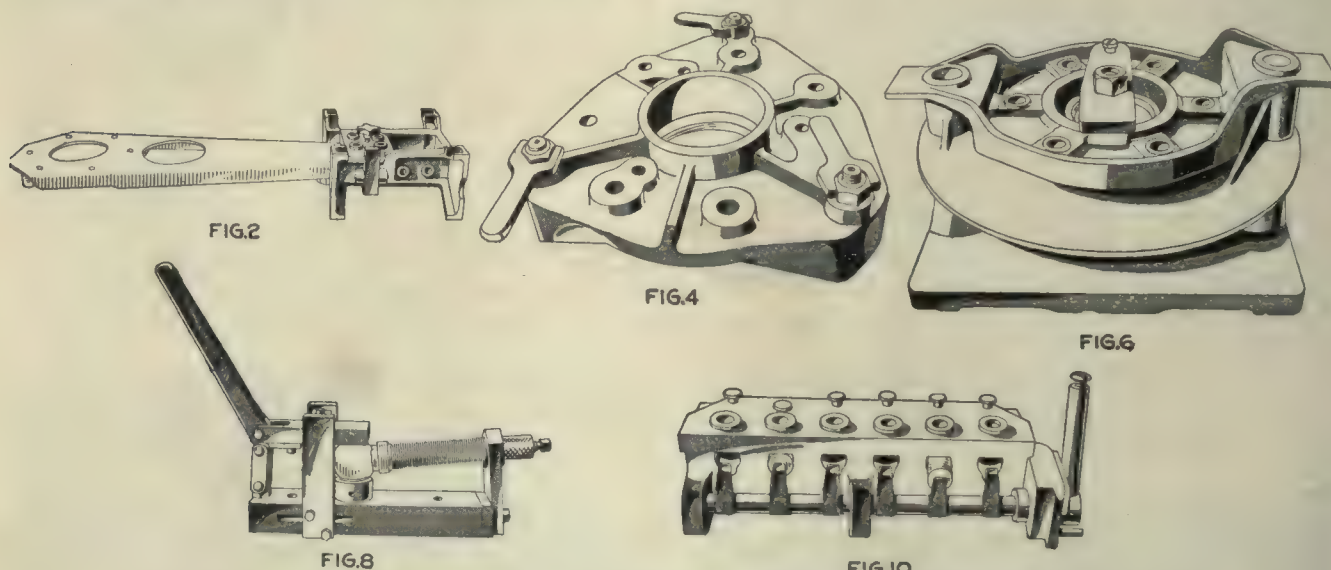
The jig used for drilling the radius rod is designed to machine the holes at the small end of the rod. The tool is made with a cover fitted with a quick-acting latch. A knob-headed screw is tightened through the cover onto the piece to hold it in the jig.

The tool for drilling the rear-hub flange is fitted with three hook bolts that, when tightened by means of the quick-acting spanner nuts, hold the part securely in

position. The jig used in drilling the brake spider is made in two parts. The base of the tool is fitted with a locating boss in the center and two locating pins on the ends. These two pins not only locate the piece in the jig, but also the jig plate over the part to be machined. An open strap and nut tightened on a bolt in the jig base hold together the jig and the piece being machined.

The last tool is a milling fixture for machining the hexagonal surface on the ball joint. This tool is also of the quick-acting type—a feature obtained with a toggle lever. A hexagonal nut screwed on the threaded end and fitting between machined surfaces of the tool serves as the locating means.

A careful inspection of these jigs and parts will give the toolmaker or designer a good idea of the general practice of this particular shop which turns out a large number of parts annually. Study of a few well chosen examples like these is far more profitable, as a rule, than even a more or less hasty trip through the shop itself, since such a trip can only reveal the superficial details.



DRILLING JIGS AND MILLING FIXTURE USED IN MACHINING AUTOMOBILE PARTS, WITH THE WORK SHOWN IN POSITION

FIGS. 2 AND 2-A

Operation—Drilling radius rod, Fig. 1. The piece is located in the jig against a steel pad. The cover is dropped down, being held by a spring latch. The knob screw is tightened on the part to hold it in position.

Holes Machined—Four $\frac{3}{8}$ -in. drilled.

FIGS. 4 AND 4-A

Operation—Drilling rear-hub flange, Fig. 3. The casting is placed with its unfinished boss in the cored hole of the jig. Three hook bolts tightened with spanner-operated nuts hold the part in position.

Holes Machined—Seven $\frac{1}{8}$ -in. drilled and three $\frac{3}{8}$ -in. drilled. The latter holes are tapped with $\frac{1}{2}$ -in. U. S. S. threads with the piece removed from the jig.

FIGS. 6 AND 6-A

Operation—Drilling brake spider, Fig. 5. The casting is located on the jig base by three machined plugs that fit into bored holes, one in the center and one on each end of the spider. The jig plate is then placed over the piece, being located by the same two outer plugs used to locate the casting arm. An open strap and nut hold the jig plate in position.

Holes Machined—Six $\frac{1}{8}$ -in. drilled.

FIGS. 8 AND 8-A

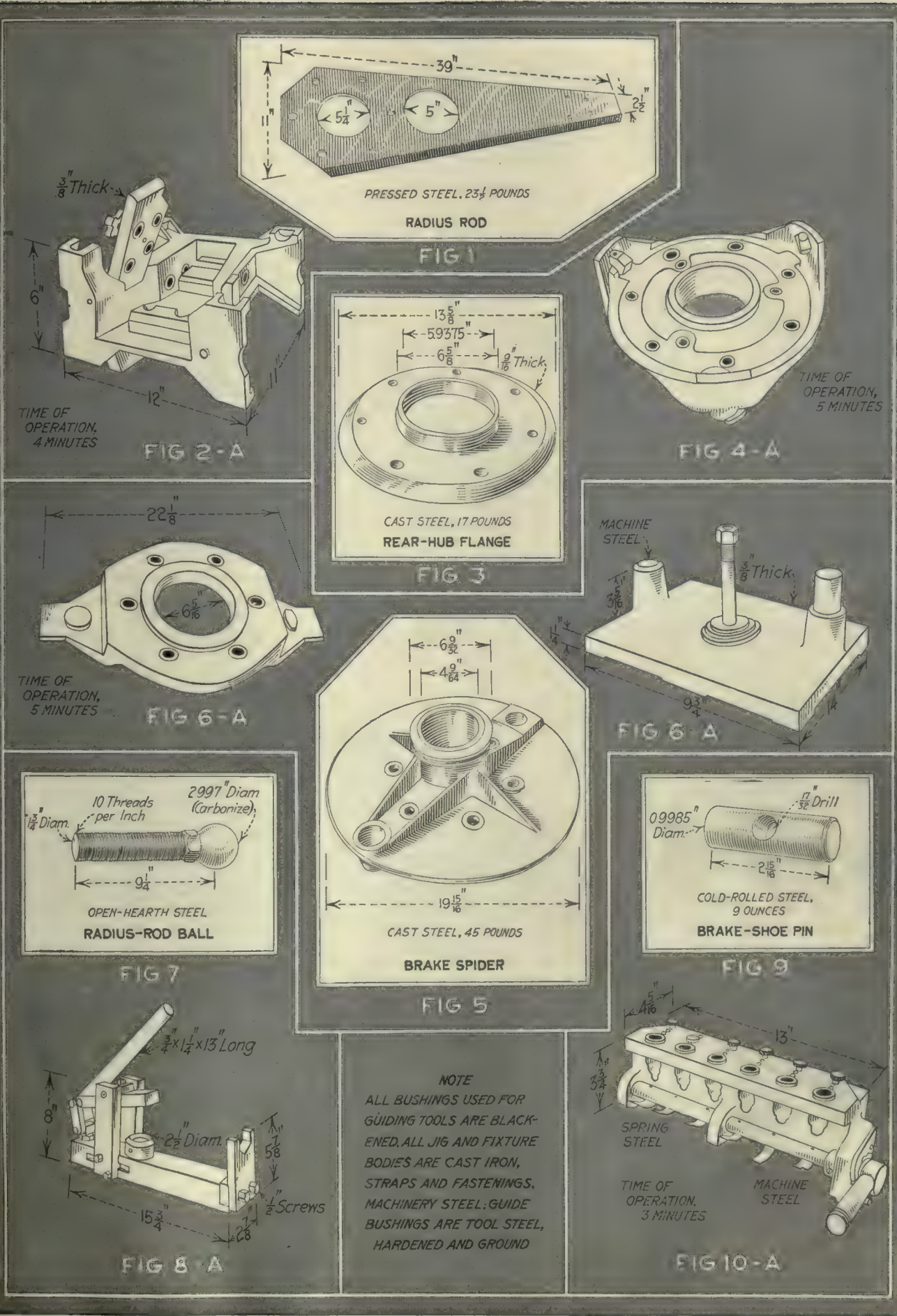
Operation—Milling the hexagonal surface of the radius-rod ball, Fig. 7. The turned and threaded piece is placed in a cup bushing of the fixture after the hexagonal sleeve nut has been screwed on the end of the piece. The lever is then pushed down and, acting through a toggle, forces the clamp on the ball and holds the piece in position. The hexagonal sleeve nut fitting in a recess, as shown, acts as the locating means.

Surfaces Machined—Hexagonal shoulder, using a $2\frac{1}{2}$ -in. end mill operating at 180 r.p.m. with a speed of 9.02 in. per revolution.

FIGS. 10 AND 10-A

Operation—Drilling jackshaft lower brake-shoe pin. Fig. 9. The jig is designed to hold three lengths of pins, which are located by a knurled-head screw pin. Springs operated by the handle at the end of the tool force the pins back into position. These springs are sufficiently strong to hold the pins being drilled in position against the locating pins. The handle is also fitted with a rack and pin, which provides additional assistance in holding the parts in position.

Holes Machined—One $\frac{1}{8}$ -in. drilled in each pin, the jig being designed to hold six.



DETAILS OF JIGS AND FIXTURES USED IN MACHINING AUTOMOBILE PARTS

Making a Two-Piece Drill

Many drills have been made with mild-steel shanks and brazed or welded-on tips of either tool or high-speed steel. The drill described in this article, however, is so made that not only is the tip not brazed or welded, but it is actually detachable and may easily be replaced when worn out, or others of different sizes may be used on the same shank. At *A*, Fig. 1, is shown a mild-steel shank

steadies the outer end. After the end is milled as shown, the clamps are loosened, the work is turned over and the other half of the fork is milled to correspond.

FORGING AND MILLING TIPS

The tips are forged from high-speed steel in the dies illustrated in Fig. 3. These dies represent the two parts of a set for one size of tip. The breakdown is indicated at *A*, the rougher at *B* and the finisher at *C*. After being

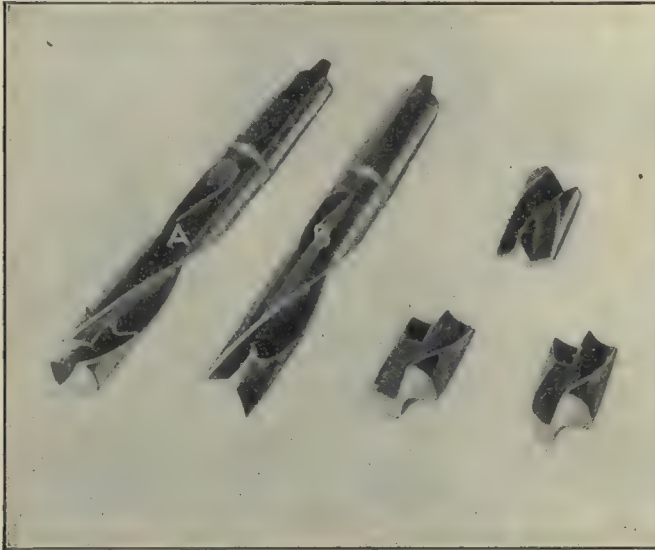


FIG. 1. PARTS OF A TWO-PIECE DRILL

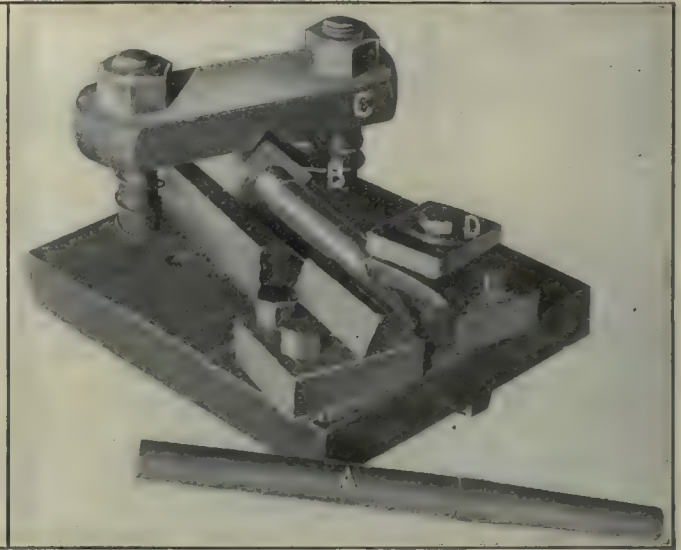


FIG. 2. JIG FOR MILLING SHANK FORK

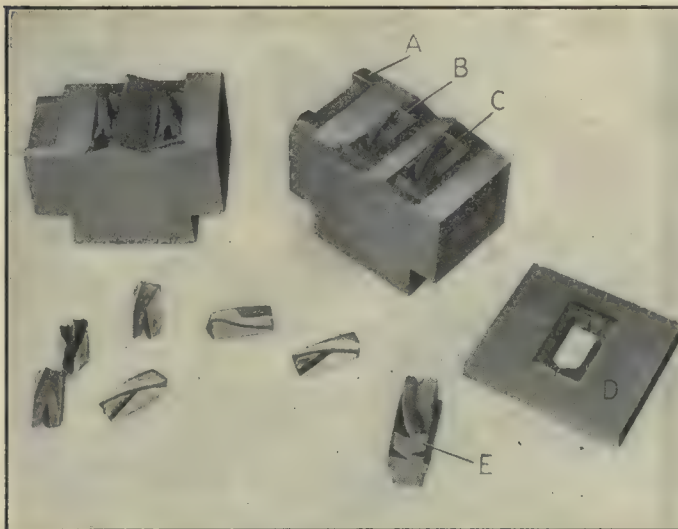


FIG. 3. TIP-FORGING AND TRIMMING DIES

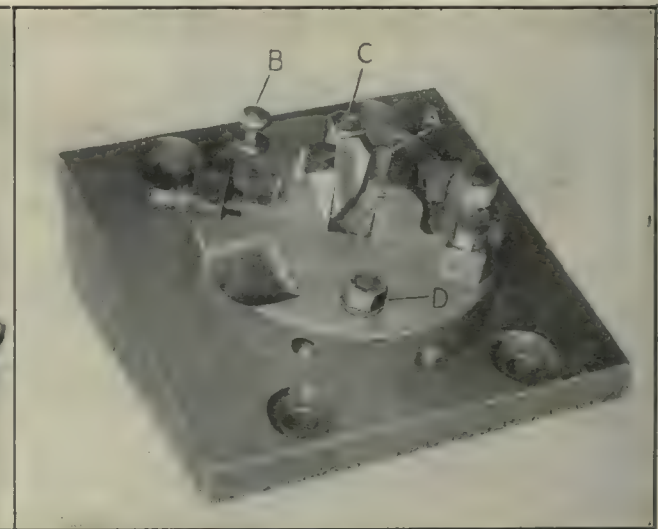


FIG. 4. INDEXING JIG FOR MILLING TIPS

with a high-speed steel tip in place, while at *B* a shank is shown with the tip removed. At the right of these are shown several tips. The method of placing the two parts together holds them securely, with no tendency to loosen under strain and no splitting of the forked end of the shank. These drills are made by the Campbell Manufacturing Co., Chicago, Ill.

Either fluted or straight shanks of any length may be used, according to the work in hand. The forked end of the shank is milled in the jig shown in Fig. 2. A taper-turned, unfluted shank is shown at *A*. In milling the fork, a taper-bored block like *B* is placed over the end, and the combination is placed in the V-groove of the jig. The clamp *C* holds the block securely and the clamp *D*

forged the flash is trimmed off in the die *D*, using the shaped punch *E*. A number of forged and trimmed tips are shown at the left.

The forged tips are next milled so as to exactly fit the fork of the shank. This is done in the indexing jig shown in Fig. 4. The tip is clamped between the jaws as shown at *A*. After one cut has been made the pin *B* is pulled up and the work indexed half a turn. The indexing head is clamped solid during the milling by means of nuts *C* and *D*, which tighten bolts set into a circular T-slot in the base. It will be noted that this base is made on a bevel so as to give the indexing head the correct angle for the milling of the tip, thereby obviating an additional operation.

Making the British Time Fuse Mark 80-44--I

BY FRED H. COLVIN

SYNOPSIS—The making of time fuses involves many interesting problems in production, as they are not only intricate in design and construction, but include the handling of steel, brass and aluminum. The need for accuracy in some parts is greater than with the detonating fuses, although the tolerances are not very different. The problem of inspection, however, is vastly more complicated, as no less than 266 gages are prescribed.

The time fuse embodies a greater variety of machine work than the detonating fuse Mark 100, as it includes the

in the projectile, either shrapnel or high-explosive shell, at a predetermined time after leaving the gun, or to explode on impact either before or after the time set. It is in reality a combined time-and-detonating fuse. The principal parts are shown in Fig. 1 and their names are given in the caption for Fig. 2.

The time element is governed by the burning of a train of standard fine-grained pistol powder, the length of the train being varied by turning the time ring. The detonator works practically the same as in the Mark-100 fuse already described. The safety element of the time portion consists in turning the rings so as to block the passage in the powder train. Safety against explosion by

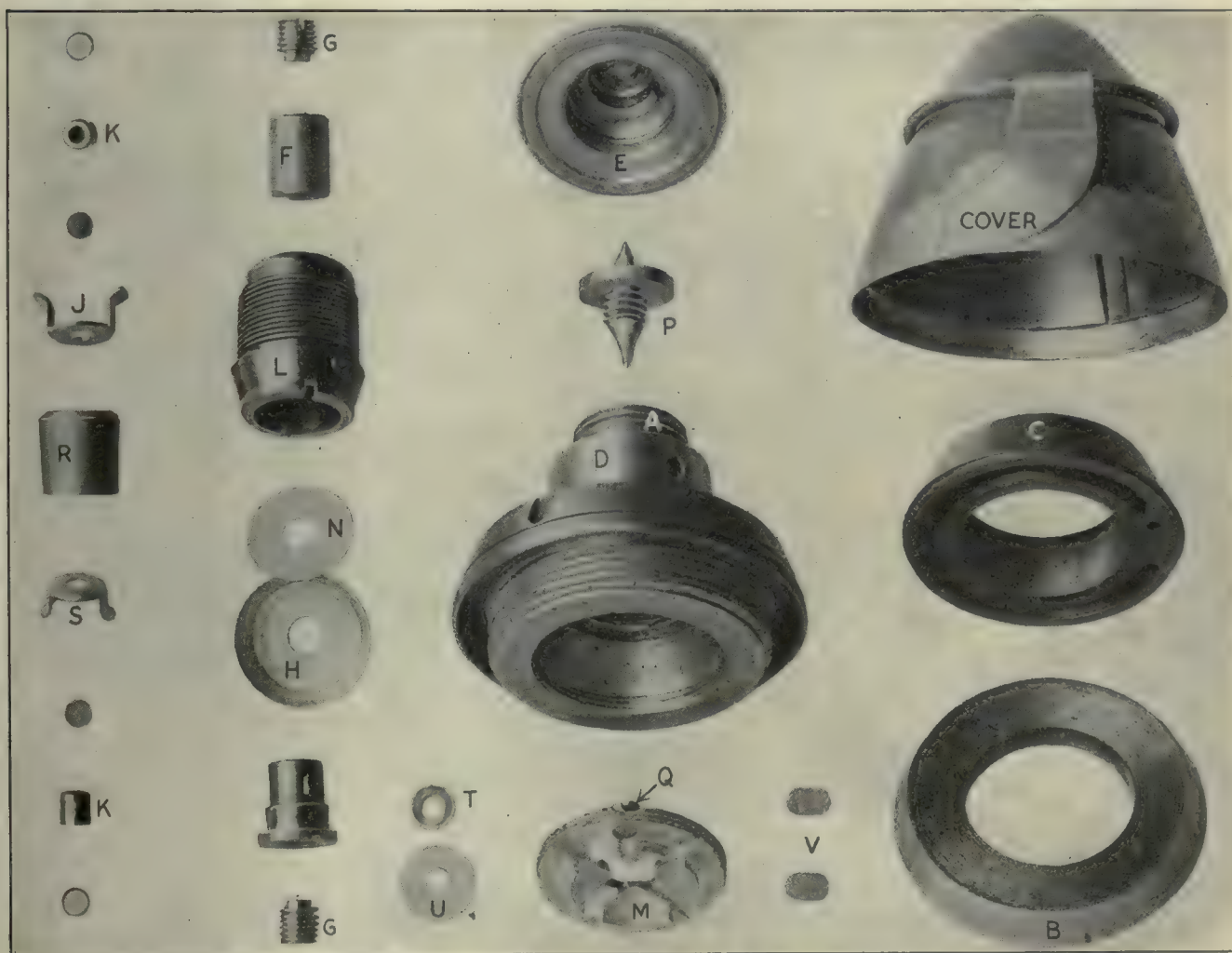


FIG. 1. BRITISH NO. 80 TIME FUSE DISASSEMBLED TO SHOW PARTS

stamping of sheet metal into springs, cups and washers. Several of the parts are made of aluminum, while one—the percussion-mechanism holder (*L* in the illustration)—is made of steel, hardened and tempered. All threads are Whitworth and recessed the same as the detonator fuse already described.

The time fuse illustrated herewith is, or was known as Mark 80-44; slight modifications in design change the designation at times. Its mission is to explode the charge

shock is obtained by means of the stirrup springs *J* and *S*. The operation is as follows:

The rapid acceleration of the projectile as it is fired from the gun literally shoots it away from the time pellet *F*, the inertia forcing up the side ears of the spring stirrup *J*, even though it is made of hard-rolled sheet brass. The inertia of the pellet forces the detonator *K* against the steel needle *P* and explodes it in the chamber shown. The fire then shoots through *A'* and ignites the meal

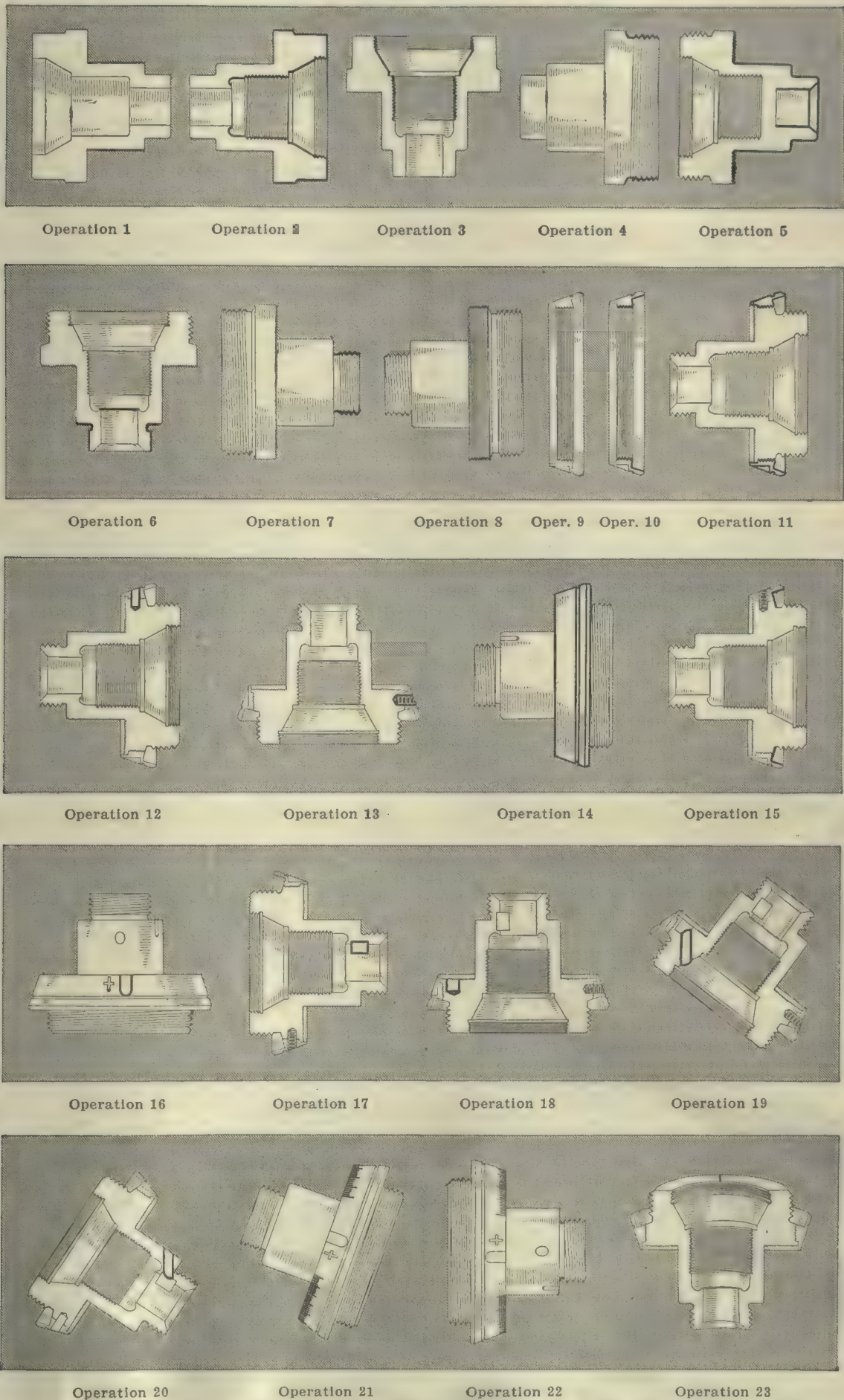


FIG. 4. SEQUENCE OF OPERATIONS ON FUSE BODY

The classification of metals, as well as their physical properties, is given in Table 3. The needle plug and the holder for the percussion device are to be made of steel hardened and tempered; or as an alternative, the needle plugs may be made of a softer steel and blued. The cover was originally specified to be of brass of the best

SUMMARY OF SPECIFICATIONS

The detonators are to be made of sheet copper, having a central hole covered by a copper disk, and are to be charged with the quantity of composition shown below. A pellet of pressed powder weighing 1.78 grain is to be placed on top of the composition and the detonator closed by means of a copper disk. In the time detonator a cardboard disk is to be pressed over the copper disk. The detonators are inserted in

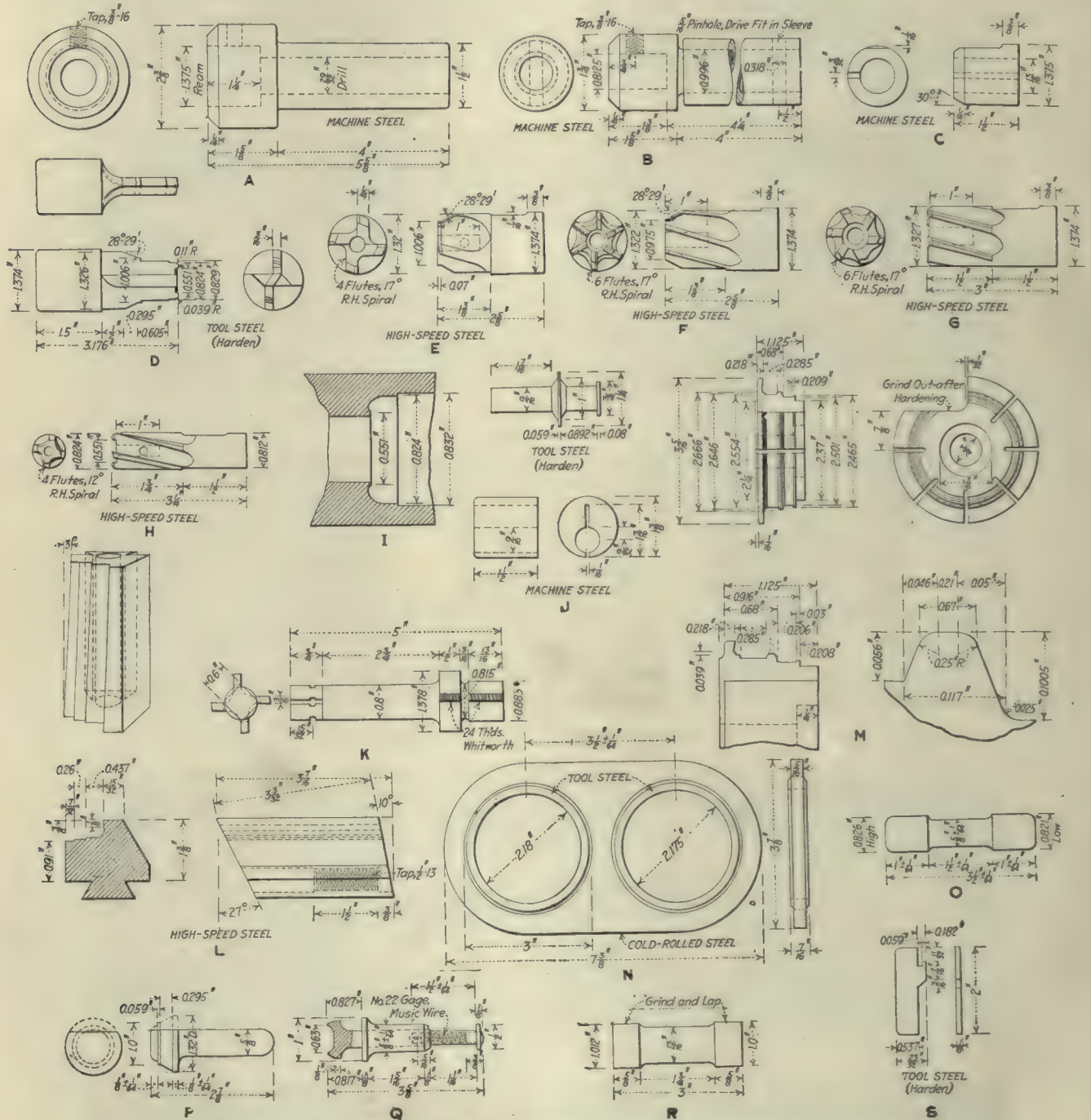


FIG. 5. TOOLS AND GAGES FOR OPERATION NO. 2. PRODUCTION, 15 PER HR.

A, holder for large tools; B, holder for small tools; C, adapter for use in large holder; D, drill for interior of body; E, angle reamer for magazine; F, finishing reamer for magazine; G, sizing tool for bottom plug hole; H, reamer for holder chamber; I, enlarged section of chamber; J, recessing tool for interior of body; K, machine top; L, outside forming tool and holder; M, finishing forming tool. Gages—N, outside of platform; O, diameter of bore; P, shape of magazine recess; Q, depth of bore from recess; R, depth of recess; S, body gages

quality and capable of being bent double under the hammer and straightened without a sign of fracture. In some instances, however, these covers are now being replaced with covers made of sheet lead and tinned on each side.

Further specifications, including the detonating compositions, varnishes and cements, follow:

the pellets and retained in position by the screw plugs, these being secured by three indents, the plug for the percussion pellet having a disk of paper placed over the axial perforation before being screwed home. The time detonator is to be charged with 1.28 grain of the following composition:

FIG. 1. TIME-DETONATING COMPOUND

Chlorate of potash.....	52.5 parts by weight
Sulphide of antimony.....	36.5 parts by weight
Fulminate of mercury.....	11.0 parts by weight

The composition is to be put in dry and pressed with a pressure of 600 lb. The percussion detonator is to be charged with 1.39 grain of the following composition:

TABLE 2. PERCUSSION-DETONATING COMPOUND

Chlorate of potash.....	45 parts by weight
Sulphide of antimony.....	23 parts by weight
Fulminate of mercury.....	32 parts by weight

The composition is to be put in dry and undergo a pressure of 600 lb. As an alternative, a time detonator containing 0.75 grain of the composition given above for this detonator and a

minimum test: The time-detonator pellet spring will be required to stand a pressure of 100 lb. and the percussion-detonator pellet spring a pressure of 60 lb. The percussion-detonator spring is to be gaged, after having been subjected to a load of 60 lb. in a steel counterpart of the fuse pellet and ferrule to mean dimensions, and the time-detonator pellet spring after having been subjected to a load of 100 lb.

The cloth washers are to be made from waterproofed drab woolen material, weighing 13½ oz. per sq.yd. Holes are to be cut in the washers so as to expose the powder pellets in the body and ring, also a hole to clear the brass pin in the body

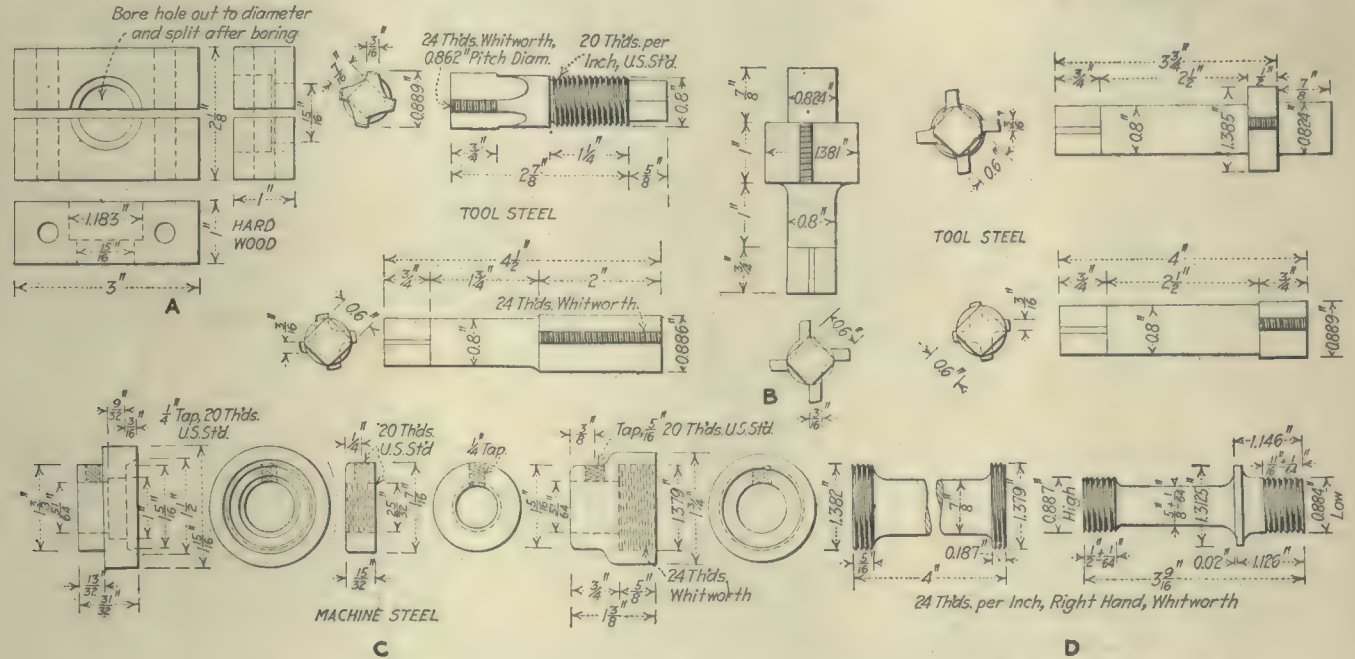


FIG. 6. VISE JAWS, TOOLS AND GAGES FOR OPERATION NO. 3

A, vise jaws for hand tapping; B, hand tap for interior of body; C, stop collar for hand taps. Gages—D, diameter and depth of screw recess for base plug; E, diameter and depth of screw recess for holder

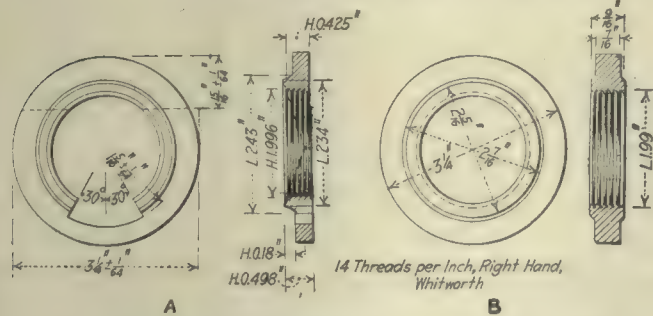


FIG. 7. GAGES FOR OPERATION NO. 4. PRODUCTION, 30 PER HR.

A, main thread on nose, low limit; B, combination high diameter, cone, length of thread and shape of recess under platform

pellet of pressed powder weighing 0.87 grain may be used, in which case the cardboard disk over the copper disk and the sectors of vegetable paper over the lighting points of the rings should be omitted. The lighting hole in the top ring

TABLE 3. PHYSICAL REQUIREMENTS OF METAL

Metals	Tenacity, Tons of 2,240 Lb. per Sq. In.		Percentage of Elongation in a Test Piece 2 In. Long and 0.564 In. in Diameter or Such Test Piece as Can Be Furnished, Provided that Length = $\frac{4*}{\sqrt{\text{Area}}}$	
	Yield	Breaking		
Aluminum alloy....	7.75	12		7
Delta metal.....	20	30		20
Hard rolled brass..	6	12		10
Class A metal.....	20	30		20
Class B metal.....	12	20		30
Class C metal.....	6	12		10

*This was explained in detail on page 750, Vol. 43.

should have a pellet of pressed powder inserted instead of mealed powder.

The stirrup springs are to be made of hard-rolled sheet brass. All the stirrup springs will be subject to the following

The interior of the fuse, aluminum cap and washer and inside face of base plug are to be coated with shellac varnish consisting of:

TABLE 4. INTERIOR FUSE VARNISH

Shellac, finest orange.....	5 lb.
Spirit, methylated	8 lb.
and stoved at a temperature of 170 deg. F. for not less than 3 hr. Spirit lost by evaporation is to be replaced as required.	

After the holder for percussion arrangement has been screwed into the body, the holder and inside of cap are to be coated with shellac varnish. The exterior of the time rings and brass ring on body, the time pellet and stirrup, exterior of ferrule for percussion pellet, interior of composition grooves and flash hole in body are to be lacquered with a lacquer consisting of:

TABLE 5. LACQUER FOR FUSES

Shellac	1 lb.
Turmeric	8 oz.
Spirit, methylated	8 lb.

The screw threads must, unless otherwise stated, be of the British Standard Whitworth form, cut full.

Perforated pellets of pressed powder are to be inserted in the fire-escape holes of the top and bottom composition rings and the holes closed by brass disks. A pellet is also to be inserted in the hole on top of the bottom composition ring and in the flash holes of the body. The lighting hole in the top ring is to be filled with loose mealed powder covered by a patch of silk or tycoon paper. A cloth washer is to be secured on the face of the body and on the top of the bottom ring with shellac varnish containing a small quantity of Venice turpentine. The grooves on the under side of the composition rings are to be charged with the composition pressed into them to give the required time of burning. The under faces of the composition rings are then coated with the varnish previously referred to, and are to be covered with vegetable paper washers secured with shellac varnish consisting of best orange shellac dissolved in methylated spirit containing a small quantity of Venice turpentine, vegetable paper tablets being previously placed over the lighting points.

In assembling, the threads, the percussion-arrangement holder and base plug are to be coated with Pettman cement before being screwed into the body. The cap is to be screwed

down so that a turning moment of 144x12 in.-oz. will just turn the ring, the cap being secured by means of the set-screw.

The bench or table upon which the tensioning apparatus is fixed is to be jarred by tapping with a mallet to assist the turning of the ring. The fuse cover is to be attached to the fuse in the following manner: Press the fuse cover into position and solder it to the brass ring of the fuse, using pure

TABLE 6. PETTMAN CEMENT

Gum, shellac	7 lb. 8 oz.
Spirit, methylated	8 lb.
Tar, Stockholm	5 lb.
Venetian red	20 lb. 12 oz.

The spaces between the cap, time rings and body and set-screw recess in top are to be filled with waterproofing composition consisting of:

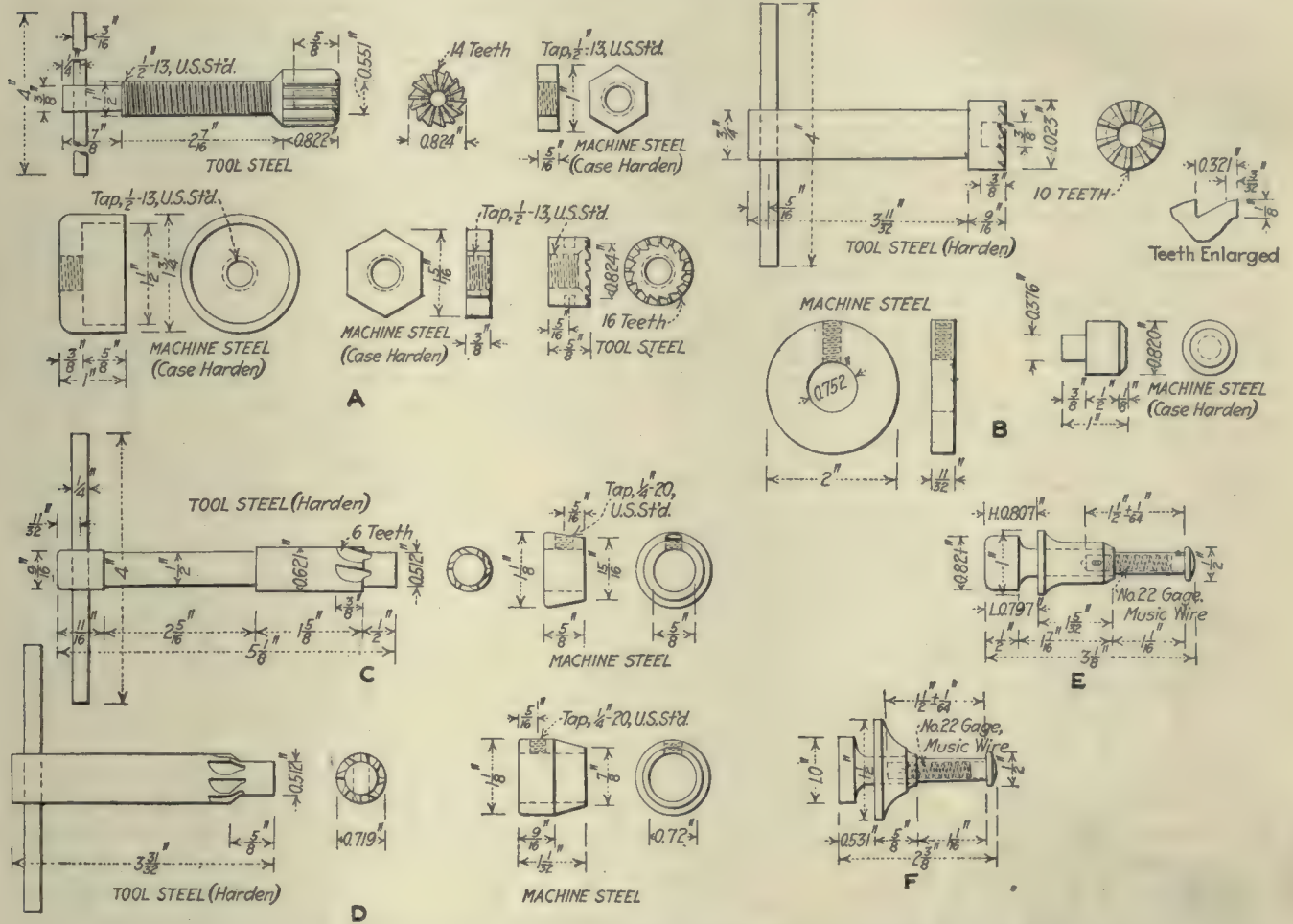


FIG. 9. FACING TOOLS AND GAGES FOR OPERATION NO. 6. PRODUCTION, 45 PER HR.

A, hand reamer for inner shoulder; B, hand reamer for outer shoulder; C, hand reamer for inner seat; D, hand reamer for rounding inner corner. Gages—E, depth of bore for steel holder; F, depth of base of shoes to shoulder of holder

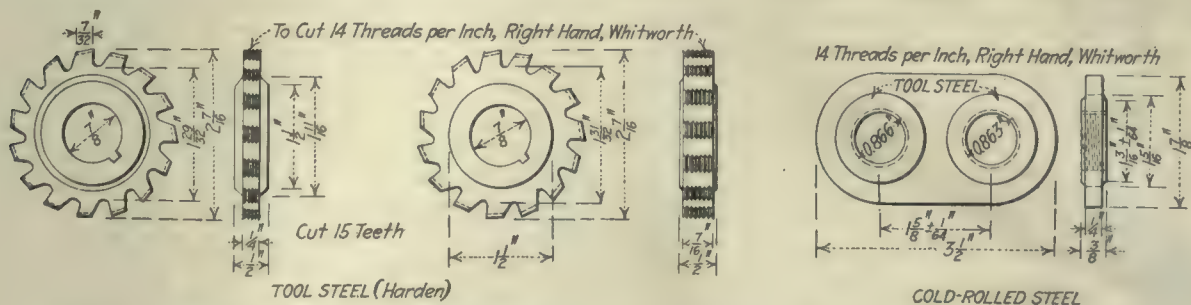


FIG. 10. THREAD-MILLING CUTTERS FOR MILLING THREADS ON ENDS OF TIME-FUSE BODY AND LIMIT GAGES USED FOR OPERATION 7

resin as a flux, the surplus solder being removed. The fuse is set at safety before the cover is soldered on. The fuse with cover attached is then to be vacuum-tested to insure its airtightness. After testing, the base plug is to be screwed into the body and the magazine filled with fine grain powder through the filling hole. The hole is to be closed with the screwed plug, the threads of the latter being previously coated with Pettman cement. The bottom of the fuse is to be coated with shellac varnish. A leather washer soaked in melted mineral jelly is to be placed under the flange inside the brass ring. The Pettman cement is to consist of:

TABLE 7. WATERPROOF COATING

Beeswax	2 parts by weight
Mineral jelly	1 part by weight
French chalk	2 1/4 parts by weight

The escape-hole disks in the time rings are also to be covered with the above composition. The flash hole in the center of the base plug is to be coated with a varnish consisting of:

TABLE 8. FLASH-HOLE VARNISH

Amyl acetate	91 parts by weight
Nitrocellulose (soluble in ether alcohol)	5 parts by weight
Castor oil	4 parts by weight

The cap is to be made of brass, formed to shape, with a projection. The strip is to be made of sheet brass, annealed and tinned all over. A ring made of brass wire, with brazed joint, is to be secured at one end of the strip by turning over the latter and securing with solder. The strip, with ring attached, is to be soldered to the cap and the brass ring is to be held in position by means of a brass strip also soldered to the cap. In addition to the tests previously provided for, a percentage of the covers may be selected during manufacture and tested in the following manner:

The cover will be securely held in a press with the open end against an india rubber pad and tested for airtightness either by immersing the whole apparatus in water at 100 deg. F. or by means of a vacuum process. Any escape of air will entail rejection. The fuse and cover are to be stamped and stenciled.

The fuses are to be delivered into bond in lots of 2,000, with covers complete, to await the results of proof. An additional 40 is to be supplied free for proof with each 2,000 or any less number supplied; in the event of further proof being required the fuses will be taken from the lot supplied. If the results of proof are satisfactory the fuses will then be forwarded as described for final examination and testing.

The fuses selected for proof will be tested as follows: Ten will have the percussion arrangement removed and will be fired in an electrical testing machine to determine the mean time of burning at rest. The mean time of burning, set full, when corrected for barometer will be 22 sec. + 0.2 sec. The constant to be used when correcting for barometer is 0.023 of the mean time of burning. For every inch the barometer reads above or below 30 in. it is + when above and — when below. If the lot fails to pass this test a further proof will be taken while spinning in a lathe at 2,500 r.p.m. The fuse must burn within the limits specified above, otherwise the lot will be rejected. Should the detonator fail to ignite time ring a second proof will be taken; should a similar failure occur at second proof, or should there be more than one such failure at first proof, the lot will be rejected. Twenty fuses will be fired at the same elevation in any of the following guns, with full charges.

The mean difference from the mean time of burning of the 20 fuses is not to exceed:

In 18-pdr. gun	If set full.....	0.14 sec.
	If set 16.....	0.11 sec.
In 13-pdr. gun	If set full.....	0.2 sec.
	If set 14.....	0.13 sec.

The difference between the longest and shortest fuse is not to exceed:

In 18-pdr. gun	If set full.....	0.75 sec.
	Omitting one fuse.....	0.6 sec.
	If set 16.....	0.6 sec.
	Omitting one fuse.....	0.5 sec.
In 13-pdr. gun	If set full.....	0.9 sec.
	Omitting one fuse.....	0.7 sec.
	If set 14.....	0.7 sec.
	Omitting one fuse.....	0.5 sec.

If there is one blind fuse, a second proof will be taken. If there is a blind at second proof or more than one such failure at first proof the lot will be rejected.

THE SEQUENCE OF OPERATIONS

Details of the fuse body are shown in Fig. 3 and the sequence of operations is illustrated in Fig. 4. These may be listed as follows:

1. Rough-turn outside of stem to fit collet.
2. Bore, recess and tap inside and turn outside for the two threads.
3. Hand-tap inside threads.
4. Mill thread on outside of large end.
5. Finish outside of stem, bore and counterbore small end and serrate upper side of platform.
6. Hand-ream inside for upper and lower shoulders.
7. Mill thread on end of stem.
8. Mill fine thread for graduated ring on large end.
9. Rough-turn outer edge of graduated ring casting to allow easy chucking.
10. Bore and tap graduated ring.
11. Screw ring on body.
12. Drill ring and body for screwed plug.
13. Tap ring and body for screwed plug.
14. Turn outside of graduated ring.
15. Face under side of graduated ring.
16. Mill key slot in graduated ring.
17. Mill recess for flash hole.
18. Drill powder hole in platform.
19. Drill magazine hole.
20. Drill flash hole.
21. Roll graduations in ring.
22. Turn neck on small end.
23. Stamp base line on bottom of body.

The bodies are machined for the most part on hand turret machines of various makes. The rough-turning of the stem in operation 1 makes it easy to hold the bodies in spring collets and has been found more satisfactory than gripping in an ordinary chuck. This is done at the rate of 50 per hour.

The cutting speed for turning tools on the body is about 142 ft. per min., while a tapping speed of 55 ft. per min. is found very satisfactory. A mixture of kerosene and lard oil is used as a cutting lubricant.

The tools and gages used in operation 2 are shown in Fig. 5. This shows the main dimensions of the various tools, and in some cases, notably in *I*, the work they perform. It will be noted in *M* that the circular forming cutter is provided with radial slots. This has been done to prevent the cutter warping out of shape and has been adopted in nearly all circular cutters.

For hand-tapping the bodies are held in special wooden vise jaws, these being shown in Fig. 6. These hold the body firmly for tapping, and do not crush or mar the stem.

In the fourth operation the body is held in the special milling fixture similar to the one shown in Fig. 10, and the thread is milled on the large end of the body. This is done in a simple fixture in which the body is held inside of a screw having the same lead as the thread to be milled. The milling cutter has no lead, but is simply a cutter, set at the proper angle and having enough teeth to cover the entire length of the thread. In this way one revolution of the body in the hand fixture shown mills the thread on the entire circumference. A stop for the cross-slide allows the work to be fed in the proper depth, so that the right diameter is easily secured. The gages are shown in Fig. 7.

For the fifth operation the threaded end of the body is held in the chuck shown at *A*, Fig. 8. When screwing the body in place the central stop or pusher plug is moved to the position shown and forms the stop for the body. As soon as it is desired to remove the body the plug is withdrawn slightly, so that the body may be easily unscrewed from the chuck.

While in this position the outside of the stem is turned to the proper size for the rings and the threaded portion in front. The upper surface of the platform is also serrated by means of the flat forming tool shown at *H*, Fig. 8. This has taken the place of the circular serrating tool shown at *I*, which was originally used. The flat tool has proved to be simpler and more desirable.

One of the essential features is the shoulder distance between the upper and lower recesses, these surfaces being hand-reamed in the sixth operation by the tool shown in Fig. 9.

The next operation is milling the thread on the end of the stem, this being done on the fixture shown in Fig. 10. This also shows the thread gages for the stem.

(To be continued)



Products of the Electric Furnace and electric cell will be made the subject of a special session at the forthcoming convention of the American Electrochemical Society, to be held in New York from Sept. 27 to Sept. 30. It is an interesting fact that whereas other chemical industries, such as the coal-tar dye industry, are distinctly European, the electrochemical industry is decidedly American. It is here in America that the production of aluminum was invented and put on a commercial basis. The first plant for the electrical synthesis of the elements of the air and the production of artificial fertilizer nitrate was erected at Niagara Falls.

Economic Value of Good Shop Illumination*

BY G. H. STICKNEY†

SYNOPSIS—The economic value of good day and artificial light is pointed out and good illumination defined. The recognized systems of lighting are outlined, the various forms of lamps described and their uses pointed out. Maintenance and cost are also discussed.

While the necessity for providing some sort of illumination is admitted, the real economic value of good illumination in increasing the earning power of a plant is not so generally recognized. As a result many manufacturers look upon artificial illumination as an unwelcome expense and deal with it in a grudging manner, which secures neither effectiveness nor economy of cost.

The economic advantages of good illumination are: (a) Larger production, (b) better workmanship, (c) fewer defects, (d) fewer accidents, (e) cleaner and more cheerful workrooms.

Investigation in the factories of a large manufacturing company disclosed the fact that many of the workmen were losing over an hour during each of the short winter days on account of inadequate artificial illumination. In other words, these workmen were wasting more than 10 per cent. of their time for the lack of artificial illumination, which would have cost less than 1 per cent. of their wages. The relation between the value and the cost of artificial illumination is dependent upon conditions, and variations over a wide range may be expected. In the case of a paper mill it has been reported that a five-minute shutdown cost more than lighting for twenty-four hours.

The effect upon the workman is very important. With good illumination his movements are more sure and accurate, the mental effort is less, so that he does not tire so soon. This means not only a better grade of finished product, but fewer defects, with their attendant waste of time and material—not to mention that undesirable product known as "seconds."

The prevention of accidents should be a moral responsibility of the manufacturer; it is an economy. Injuries to machinery involve direct financial loss, and in case of injuries to employees the lack of proper illumination has been treated as contributory negligence on the part of the employer. That poor illumination is a prolific cause of accident is indicated by a report presented by John Calder, to the American Society of Mechanical Engineers¹. This report covered the investigation of fatal accidents in shops in the United States during a period of three years. In general, it showed that the number of accidents in the dark winter months was about 40 per cent. higher than during the light summer months. The indications were that this excess was practically due to inadequate illumination. Similar conditions were re-

ported more recently by R. E. Simpson, of the Travelers Insurance Co., to the Illuminating Engineering Society at the Washington convention, September, 1915.

The influence of good illumination in attracting good workmen and securing activity, tidiness and discipline cannot be over-estimated. These points are coming to public attention, and there seems to be a tendency to make legal requirements for industrial lighting.

A code of lighting recently prepared by committees of the Illuminating Engineering Society proposes certain specifications and makes suggestions for their application. In England a committee appointed by the Home Secretary has reported on this problem of legal requirement.

WHAT IS GOOD ILLUMINATION?

The best illumination is not necessarily the most intense or most brilliant, as many apparently assume. While a certain intensity is required, diffusion, proper direction, steadiness, reliability and color of light are almost equally essential.

No fixed intensity of illumination can be established as a standard for all purposes. The intensity of daylight is constantly changing, both with the position of the sun and the condition of the atmosphere, the maximum intensity being enormously higher than it is practicable to furnish with artificial illumination. Fortunately, our eyes are so constituted as to see satisfactorily under a wide range of intensities; and since the cost of artificial lighting varies with the intensity, it is good practice to furnish the minimum that will insure good results. This amount varies with processes and depends upon the fineness and rapidity of vision necessary, as well as on the color and texture of the surfaces to be seen.

Some of the largest manufacturing companies have carried on extensive investigations for the purpose of standardizing their practice and determining the most economical intensity to adopt for the artificial illumination of each of their various processes.

In replacing an older installation with a modern one it is sometimes possible not only to make a considerable improvement in the illumination, but utilizing the newer illuminants, actually to reduce the operating costs. Usually, however, the former standard of illumination has been so low that it is generally better practice to avoid any serious attempt to reduce the lighting cost at the sacrifice of intensity.

A glaring light, with strong contrasts of light and shadow, blinds the eyes so that one cannot see detail as well as with diffused illumination, even of lower intensity.

It is important that the light should be directed so that a relatively high intensity falls upon the parts of the machine or work which the workman has occasion to observe. In general, the light should be directed downward at an oblique angle. With properly directed light, a relatively low intensity is required and diffusion becomes less important. In workrooms with high, dark

*Prepared for W. Rockwood Conover's forthcoming book on "Industrial Economics." Copyright, 1916, Hill Publishing Co.

†Illuminating engineer, General Electric Co.

¹Published in the "Journal" of the society, February, 1911.

ceilings, all upward light is wasted, as far as the ordinary processes of manufacture are concerned. It is usually desirable, however, to allow a small portion of the light to be directed upward, to illuminate the ceiling and render the room more cheerful.

THE ECONOMY OF DAYLIGHT

The natural illumination of a building is to a considerable extent affected by its surroundings. Where buildings are grouped closely together, a light-colored external finish on a building improves both the diffusion and the intensity of light in the adjacent buildings. Utilization of daylight so as to insure good daylight illumination throughout longer hours is an important consideration in designing a building. High ceilings, narrow buildings and large window areas all tend to conserve the natural light. In one-story buildings or on top floors skylights or saw-toothed roof constructions are often utilized. The latter is usually arranged with the windows facing the north, thus providing an obliquely directed light with a high degree of diffusion, uniform color quality and minimum variation of intensity.

In some buildings the proportions are such that there is ample light near the windows at times when the middle of the room is comparatively dark. This condition can be materially improved by the use of diffusing or prismatic window glass.

Light-finished walls and ceilings economize both the daylight and the artificial illumination, besides improving the diffusion. In machine shops and similar buildings where there is considerable dust and dirt it is desirable to whiten the ceilings and the upper parts of the walls and pillars. Whitewash can be applied once or twice a year without any considerable expense.

The maximum utility of daylight can further be secured by arranging the machines and processes so that those requiring the most light are near the windows and turned so as to receive the light from the right direction. It is of course possible to carry such arrangement too far, interfering with the train of manufacture. In other words, it may be more economical to provide artificial illumination rather than to suffer the inconvenience of interruption in the sequence of manufacture or waste valuable space.

Overhead belts and shafting cast shadows and reduce the effectiveness of both daylight and artificial illumination. One of the advantages of the present tendency toward the use of the individual motor drive is that it contributes to the conservation of light. With high machines the interference of shadows is more marked and greater care should be exercised in locating the machinery or providing suitable artificial illumination.

ECONOMY OF ARTIFICIAL ILLUMINATION

While we try to emulate daylight, the cost of artificial light and the conditions under which it is produced make the problem of economic utilization an entirely different one. We have the advantage, however, of being able to provide the illumination when and where we want it and as much as we wish to pay for.

The wonderful developments of the past few years and the discoveries that are being made almost from day to day have provided greatly improved lighting units, not only reducing the cost of light, but greatly enlarging the

possibilities. This condition has resulted in a very rapid growth in the application of artificial illumination and a remarkable advance in the standard. Most installations that were made over five years ago can be rearranged today so as to be more effective and more economical. In some cases it is merely a question of putting a modern lamp in place of the older form, but often a radical rearrangement, with a different type of lamp, is desirable to secure maximum economy.

Since the advent of the motor drive it has become possible to arrange machines transversely rather than longitudinally of the room. Such an arrangement of machines or work benches is highly advantageous from the lighting standpoint, because it not only eliminates facing the glare but permits the light to be received at the machine in the proper direction, avoiding shadows. This arrangement is being adopted as standard by a number of large manufacturers.

METHODS OF LIGHTING

The practice varies between two extremes—namely, localized illumination and general illumination. With extreme localized lighting a small unit, usually an incandescent lamp, is placed near the work so as to illuminate the parts that must be seen. If there are a number of points requiring illumination or the area to be lighted is considerable, several lamps may be used on a single machine. Localized illumination is most economical when illumination is required only over small areas widely scattered. Little or no engineering is used in selecting or locating the lamps. They are simply placed in the hands of the workman, to utilize as he sees fit. If the light is not sufficient, he calls for another or a larger lamp.

This method of lighting is very adaptable and, properly used, enables fine work to be done. For deep boring and very fine detail work it is the only satisfactory method of lighting. The objection to localized lighting is that a large number of inefficient lamps are required. Expensive wiring must be provided, while the wear and breakage are likely to be excessive. Lamps are often used without reflectors or directed so as to project a glaring light into the eyes of the operative or his fellow-workmen. Cases have been reported where workmen were demanding several times as much light as they really needed. This is undoubtedly due to the harsh contrast of light and shadow.

In general illumination an approximately even intensity is provided throughout the room, irrespective of the location of machinery. The total amount of light required is usually greater than with localized lighting, but the arrangement is often economical in large, high shops, since it permits the use of larger and more efficient lighting units, with reduced cost of wiring and maintenance.

For automatic machinery, such as screw machines, it is sometimes advantageous to provide a moderate general illumination supplemented by a few localized lamps that are not in general use, but which may be plugged in at various points to provide special light for inspection, adjusting and setting up. A similar combination of general and localized illumination is sometimes used where a few points in large workrooms require a more intense light than the rest of the area, owing to the nature of special work.

With the development of the high-efficiency incandescent lamp an intermediate practice has arisen, approaching general illumination, but with lamps arranged to correspond to the machinery or processes. This arrangement is particularly applicable to weaverrooms, machine shops and wherever an approximately uniform style of machine is regularly spaced, but can be applied to almost any workroom of the usual character. This practice is designated as "localized general" or "group" lighting and is probably being followed more than any of the other systems in new installations.

SOURCES OF INDUSTRIAL LIGHTING

The light sources used in industrial lighting are of three principal classes—electric incandescent lamps, electric arc lamps and combustion lamps. Under each of these classes are a number of different lamps, each with different characteristics. The principal forms in shop use are: Electric incandescent lamps—(1) tungsten filament (Mazda B), (2) gas-filled tungsten (Mazda C), (3) metallized carbon filament (Gem), (4) carbon filament; arc lamps—(1) inclosed-flame arc, (2) open-flame arc, (3) magnetite or metallic arc, (4) mercury-vapor arc (Cooper-Hewitt), (5) inclosed carbon arc; combustion lamps—(1) mantle lamps (with gas, gasoline or oil), (2) mantle lamps, high pressure (with gas, gasoline or oil), (3) gas (open-flame) lamps, (4) oil or gasoline (open-flame) lamps, (5) candle.

The remarkable gains in efficiency that have taken place within the past few years in lamps of all three classes stand out in contrast to the relatively smaller gains in regard to other engineering apparatus. For example: The vacuum tungsten-filament lamp (Mazda B) gives from two and one-half to three times as much light per watt as the best carbon-filament lamp, while the gas-filled tungsten-filament lamp (Mazda C) gives four to six times as much. The modern flame arc lamps and mantle gas lamps represent similar advances in efficiency over their corresponding predecessors. In spite of this, however, we are still far from the ideal efficiency of light generation.

Each of these illuminants has characteristics that adapt it for particular conditions. Favored by efficiency, adaptability and economy of maintenance, the tungsten-filament (Mazda) lamp has extended in use more rapidly than any other illuminant. Such lamps are available in sizes through a continuous range from the smallest to the largest for which any demand exists, while a wide variety of reflectors and other accessories provides for all classes of lighting. The open- and inclosed-flame arc and the magnetite arc have been used for exterior lighting and for the illumination of large, high interiors, especially where lamps are required above cranes. Recently the nonvacuum tungsten (Mazda C) lamps have been selected for these conditions. The mercury arc lamp, which produces a vivid green light, has also been favored to some extent in the lighting of rough processes where color selection is not important. Both types are suitable for photographic processes requiring actinic light. Of the gas lamps the mantle lamps are by far the most efficient and are installed to some extent for shop lighting.

In selecting and installing artificial illuminants the following are some of the features which should be considered in order to give economical and satisfactory

results: For low ceilings or where there are belts, shafting and high machinery, units must be spaced at short intervals in order to secure a reasonably even distribution of light and avoid objectionable shadows. Small units must therefore be used to avoid excessive cost, especially where but moderate illumination will meet the requirements.

With high-ceiled rooms a better diffusion can be secured by placing the lamps high. This plan, moreover, permits the choice of large units, which are in general more efficient than small ones and possess the further advantage of having a lower installation and operating cost. The improved appearance of a large shop with suitably proportioned units should also be considered. The efficiency of the system is to a considerable extent dependent upon the selection and arrangement of the lamps and reflectors, so as to project the light where it can be utilized to the best advantage.

While it is usually desirable to have the most intense light projected downward at oblique angles, the requirements of different conditions vary, depending upon the height and spacing of the lamps as well as the purposes for which the light is intended. Various types of reflectors—for example, intensive, extensive and distributing—deliver the light of the incandescent lamp over narrow or wide zones. The evenness and effectiveness of the illumination depend somewhat on proper selection.

Diffusion is introduced by means of reflectors and translucent globes or shades so arranged as to reduce the glare and lessen the contrast of light and shadow in the illumination. Since diffusion is usually obtained at the sacrifice of something in intensity, too much diffusion represents an unprofitable loss of light. When lamps can be hung high, the effect of glare and contrast is reduced, so that diffusing devices are less essential.

Lamp and reflector manufacturers furnish curves and instructions to facilitate the proper selection and arrangement of lighting units. Some of the larger companies furnish the services of experts to assist their customers. In making a large installation it is advisable to retain a competent consulting engineer with illuminating-engineering experience.

CARE OF GLOBES AND REFLECTORS

Too much care cannot be given to insure the cleanliness of the globes and reflectors. The loss of light, due to the accumulation of dust, smoke and filings, is much greater than is generally appreciated. Measurements on a number of installations supposed to be reasonably maintained showed losses of 30 to 50 per cent. of the light. In all large installations a regular periodic inspection should be made, the lamps and reflectors being cleaned and burned-out lamps replaced. If a convenient arrangement is made for interim replacements, it is good practice to inspect once a week when the plant is shut down on Saturday afternoon and Sunday. In this way the inspector does not interfere with cranes or other machinery, can do his work more rapidly and with less danger to himself. In many shops it is customary to wait until a lamp is in trouble before giving it attention. This practice results in poorer illumination, both through dirt accumulation and failure to replace superannuated lamps. The periodic method facilitates the keeping of cost records for comparison, from which extravagances are frequently discovered.

It is often found that more lights than necessary are kept burning. The task of controlling these matters in large factories is difficult and often unsatisfactory in its results. The delegation of one or two assistants in each department to limit the number of lights burned to those actually required will effect a valuable reduction in annual lighting expense. To reduce breakage, all portable lamps should be protected by steel reflectors or wire guards.

COST OF ARTIFICIAL LIGHTING

A proper basis of cost estimate is necessary to facilitate the selection of the most economical illuminant and properly to evaluate the various features of illumination, as in determining the relative cost of higher or lower intensity. Comparisons based only on efficiency or energy consumed are likely to be misleading on account of the difference in maintenance or the investment required. Comparisons are usually based on the cost of operation for one year. The fairest way of comparing illuminants is to determine for each unit the equipment necessary properly to illuminate a typical area or room and then figure the operating cost for the probable number of hours of burning for one year. The cost of operation is made up of the following items: (1) Energy, (2) maintenance material, (3) labor for maintenance and inspection, (4) repairs, (5) depreciation and interest.

The cost of energy is usually based upon a fixed rate per kilowatt-hour for electric current or on the cost per thousand cubic feet for gas. Where current is purchased, this is easily determined; but where it is generated, it is the practice to calculate it from records or to estimate it. The cost of energy for a particular installation depends upon the wattage consumption of the lamps, the hours of operation and the rate. With long operating hours or a high rate for current the efficiency of the lamp selected becomes an important feature of the cost of operation.

Maintenance material includes the renewal of incandescent lamps, arc electrodes, gas mantles and other parts consumed or impaired by the operation of the lamp and for which an approximate operating life can be assigned. Globes and chimneys are sometimes included under this head. It is often necessary with parts requiring frequent renewal to replace them before they are entirely consumed, in order to avoid the inconvenience of cutting out the light while in use. This point should be taken into consideration in calculating or estimating the operating life. It is usual to estimate the number of trims or renewals for a year and multiply by the cost per renewal, making a reasonable allowance for shrinkage or breakage.

The labor, in general cases, is based upon a fixed price per renewal, with an allowance for the cleaning of globes and reflectors, but in particular instances it is often more accurate to determine the number of men required and their wages. If part of the time of these men can profitably be employed in other work, a proportional allowance is made. Where trimming is likely to interfere with production by delaying cranes or other machinery, some manufacturers add to the maintenance a charge based upon the time lost.

Adjustment and repairs to mechanisms and sometimes accidental breakage of globes are charged to repairs. There is no established basis for estimating the cost of

repairs. Where records are available, the annual cost can be approximated quite closely; otherwise, it is customary to assume a reasonable figure. In comparing different lamps the more delicate and complicated mechanisms are likely to have higher repair costs than the simple sturdy designs. Standard parts invariably cost less and avoid the delay incident to obtaining special parts.

Depreciation and interest are figured as an annual percentage based upon the first cost of the installation. Where any charge is made for insurance and taxes, it is usually included with these items. Interest is usually figured at 5 or 6 per cent., to cover the use of the money. Depreciation covers a sinking fund for the replacement of the installation at the expiration of its useful life. The percentage, therefore, depends upon the probable useful life of the apparatus. With lamps it is customary to use a fairly high percentage, on account of the possibility of their becoming obsolete through improvement in the art. It is common to figure 10 or 12 per cent. and sometimes 15 or even a higher percentage.

By summing up the various items an approximation of the operating cost is obtained. The results will usually show the fallacy of comparisons based on any one item. A lamp having a low current cost may have a relatively high maintenance or depreciation cost and thus be more extravagant than another lamp having a lower candlepower efficiency. What may be economical at one price for power or certain hours of operation may be expensive at another price or different operating hours. While cost comparisons are exceedingly valuable and should have an important influence on the selection and planning of an industrial lighting system, the other features previously discussed should not be neglected.

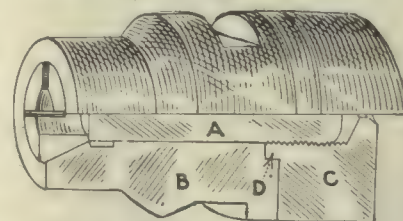
It will be observed that practically no definite mention has been made of the quantitative element of lighting—that is, candlepower, foot candles, lumens, etc. For some classes of lighting it is practicable to plan lighting on the basis of watts per square foot. Values in practice are changing, and the reader is referred to the various handbooks on electrical engineering for quantitative data.

■

Expanding Driver for 4.5-In. High-Explosive Shells

By S. R. HARRINGTON

The illustration shows a driver that I have designed for driving 4.5-in. high-explosive shells in the lathe to finish-turn the body. It consists of three parts: A is a



EXPANDING DRIVER

that is used to expand the driver. Four slots are cut in B to allow it to expand. The nut C screws on A and has a spigot to fit the recess at D. A square is milled on the end to fit loosely in a square hole on the driving plate of the lathe. We use the centers in the headstock and in the tailstock.

Making the 18-Lb. Cartridge Case--II*

BY ROBERT MAWSON

SYNOPSIS—This is the second and last installment of the article on the manufacture of the 18-lb. cartridge case. The second trimming, heading, tapering, machining the head and inspection methods are described. This installment is also fully illustrated by means of halftones and detailed illustrations, and thus completes the record of the practice of one of the largest makers of this type of case.

The case is now transferred to the lathe, Fig. 32, and trimmed to $11\frac{1}{16}$ in. in length over all. The tools used for this operation are shown in detail in Figs. 33 and

*Previous installment appeared on page 319.

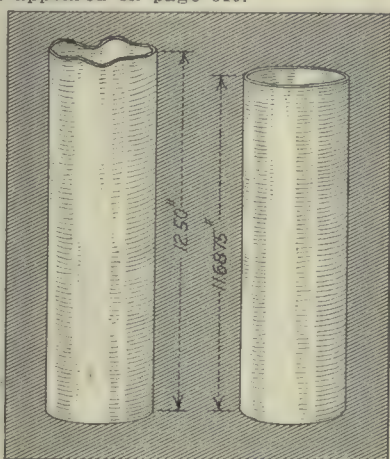
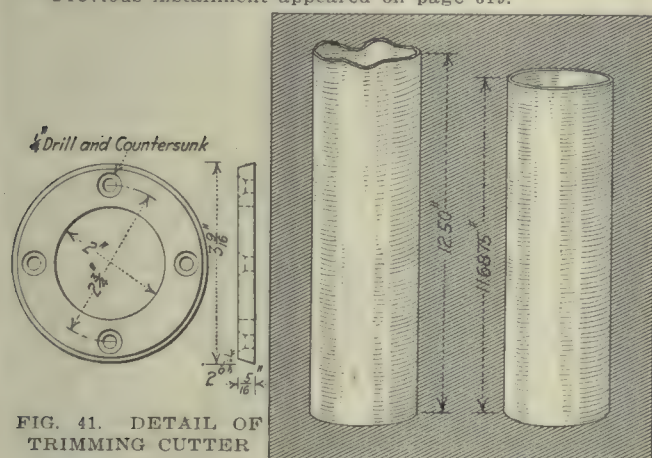


FIG. 42. OPERATION 19: SECOND TRIMMING

Machine Used—Bliss trimmer, speed of spindle 585 r.p.m.
Note—Case trimmed dry to $11\frac{1}{16}$ in.
References—Figs. 32, 33 and 41.

41. The operation is also shown in diagrammatical form in Fig. 42. The case is then dipped in a sulphuric-acid bath. The tongs shown in Fig. 36 are used to hold the case. The bath is composed of a mixture of sulphuric acid and water in the proportion of 300 gal. of water to 2 gal. of acid and is kept at a temperature of 210 deg. F.

The next operations are the first and second headings performed in the press shown in Fig. 43. This machine carries two sets of heading tools, one set performing the first and the other the second heading operation. In front of the press is the stripper which, by means of two latches, raises the case from the die after it has been headed. The illustration (Fig. 43) shows one of the cases being raised by the latches.

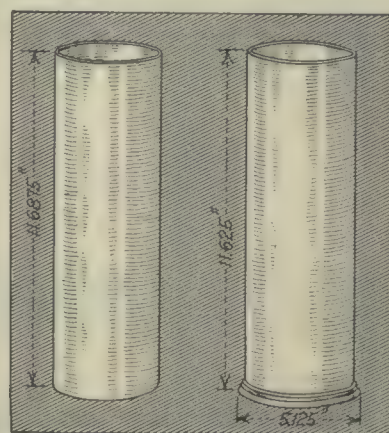


FIG. 45. OPERATION 21: FIRST AND SECOND HEADING

Machine Used—Bliss embossing press No. 27.
Production—300 per hr.
Lubricant Used—Lub-a-tone.
Pressure Required—800 tons.
References—Figs. 43 and 44.

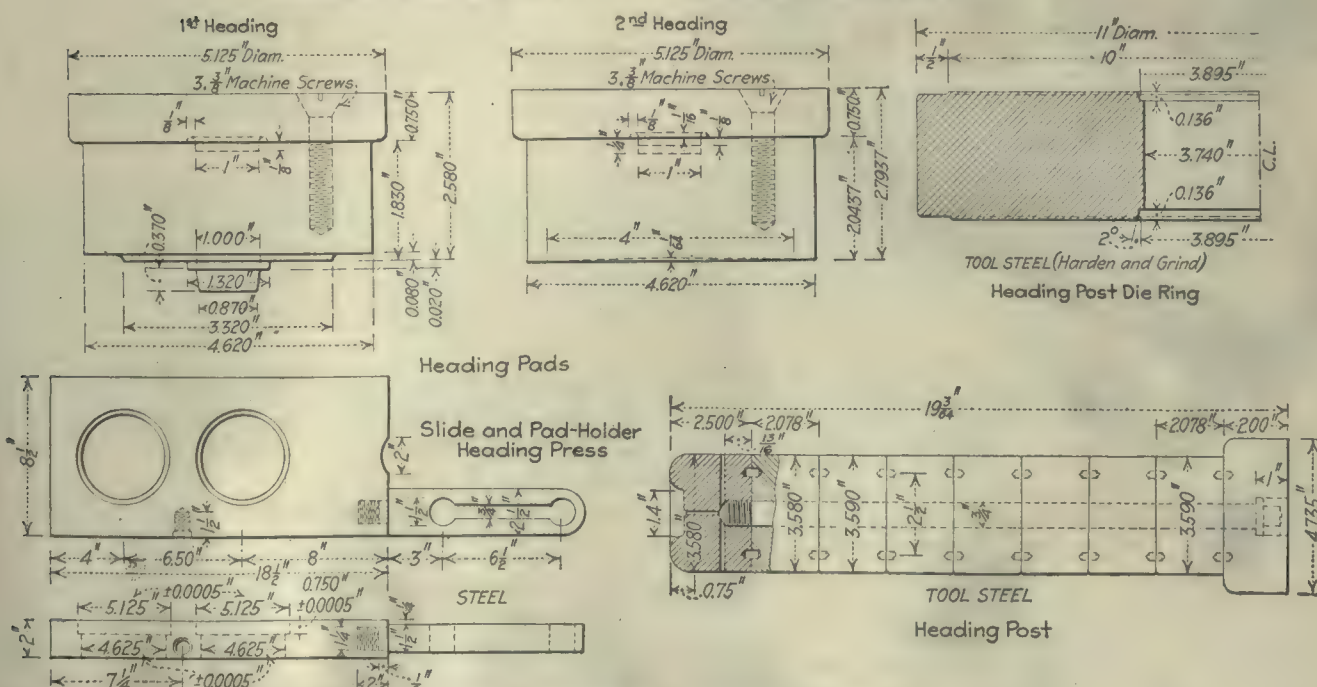


FIG. 44. DETAILS OF HEADING TOOLS

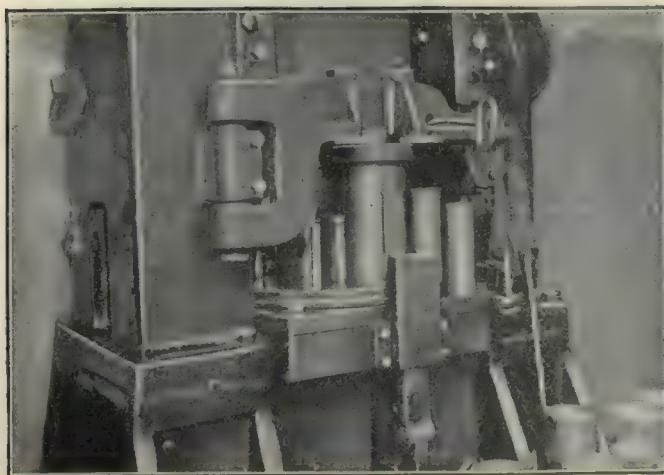


FIG. 43. THE HEADING OPERATIONS

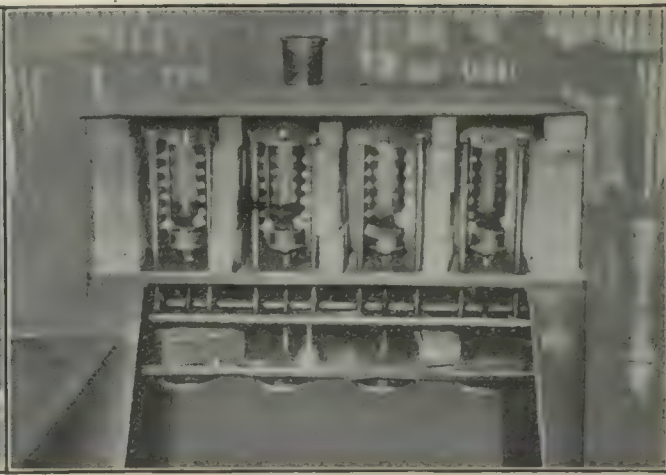


FIG. 46. MOUTH-ANNEALING FURNACE

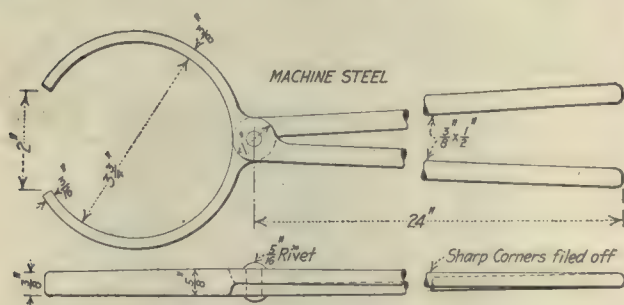


FIG. 47. DETAIL OF TONGS

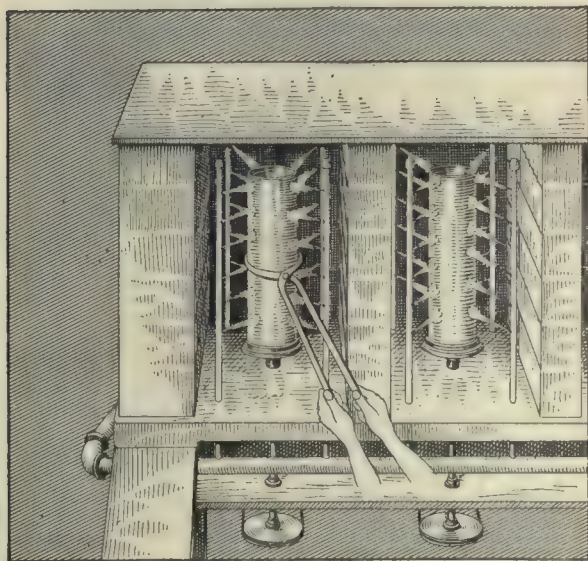


FIG. 48. OPERATION 22: FLASH ANNEALING

Machine Used—Special four-burner gas furnace.
Production—200 per hr.
References—Figs. 46 and 47.

Details of the heading post, heading-post die ring, slide and pad holder and heading pads are shown in detail in Fig. 44. The operation is also shown in diagrammatical form in Fig. 45. The case is then taken to the gas furnace, Fig. 46, and mouth-annealed. It will be seen that the furnace holds four cases, which are kept revolving by means of pulleys driven by belts at the lower end of the device.

Jets of gas flame are allowed to play against the outside of the case until it becomes low red hot, after which it is removed with the tongs, Fig. 47, and allowed to

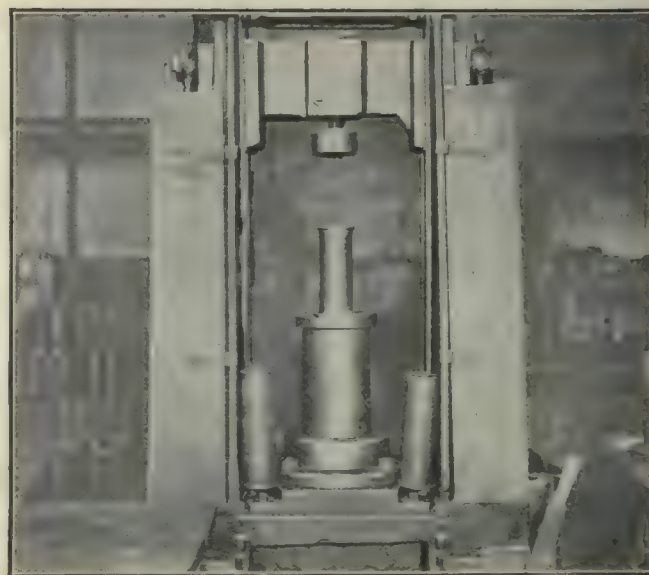


FIG. 49. THE TAPERING OPERATIONS

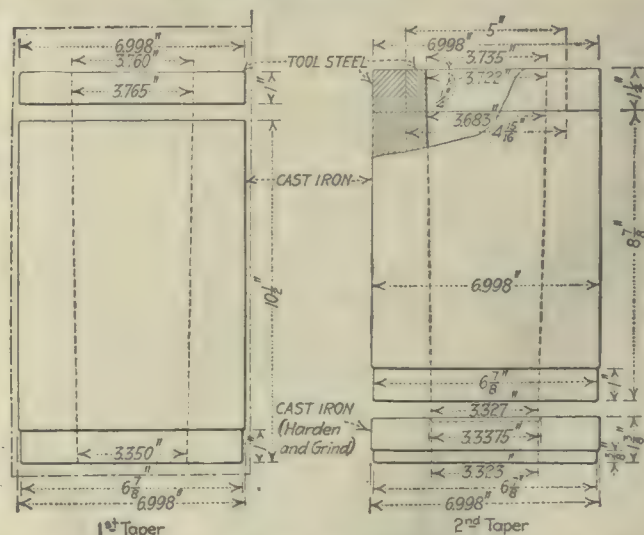


FIG. 50. DETAIL OF FIRST TAPERING DIE FIG. 53. DETAIL OF SECOND TAPERING DIE

cool in air, as is shown diagrammatically in Fig. 48.

The next operation is the first taper, which is performed in the press shown in Fig. 49. A detail of the tapering die is shown in Fig. 50. The die holder and the reinforcing ring are shown in detail in Fig. 51. The

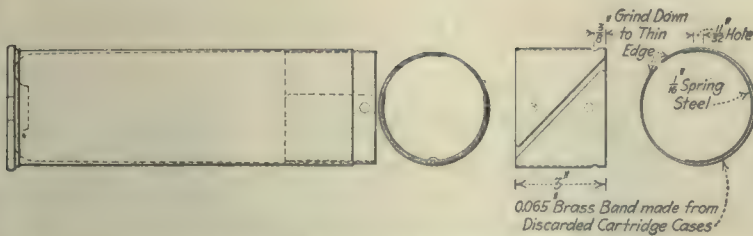


FIG. 51. DETAILS OF DIE HOLDER AND REINFORCING RING

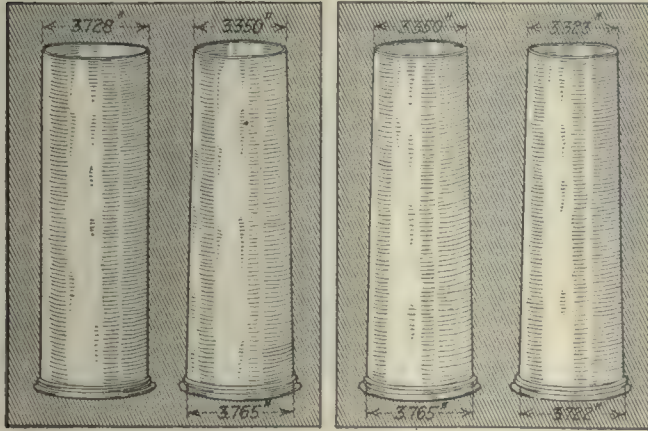


FIG. 52. OPERATION 23: FIRST TAPER

Machine Used—Bliss wiring press No. 2W, 16-in. stroke, operating at 16 r.p.m.
Production—900 per hr.
Lubricant Used—Neatsfoot oil.
References—Figs. 49, 50 and 51.

FIG. 55. OPERATION 24: SECOND TAPER

Machine Used—Bliss wiring press No. 2W, 16-in. stroke, operating at 16 r.p.m.
Production—900 per hr.
Lubricant Used—Neatsfoot oil.
References—Figs. 49, 51, 53 and 54.

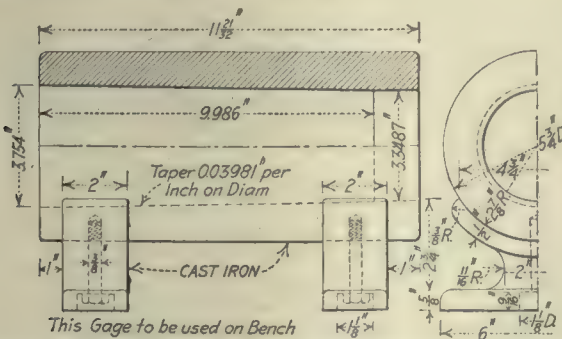


FIG. 54. DETAIL OF GAGE FOR TAPERING OPERATION

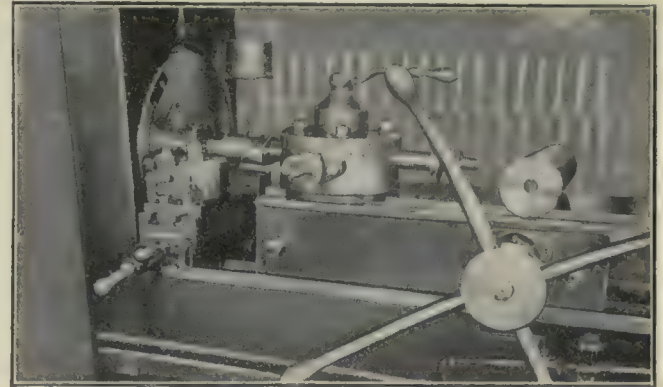


FIG. 56. MACHINING THE HEAD OF THE CASE

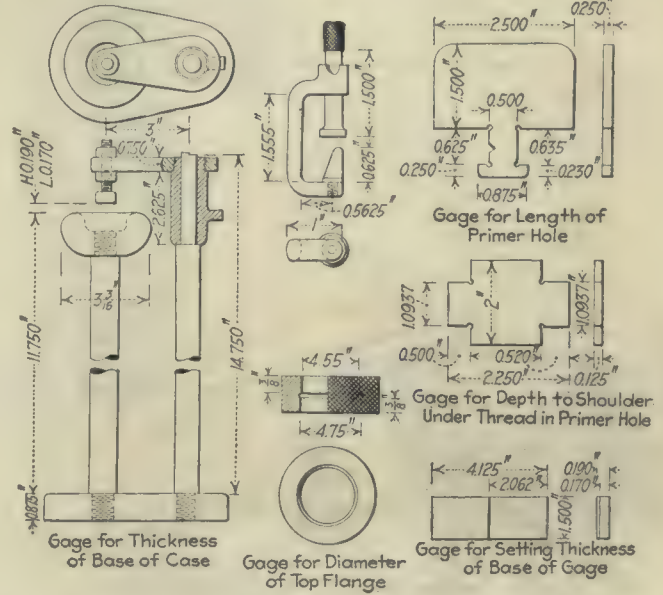


FIG. 59. DETAILS OF INSPECTION GAGES

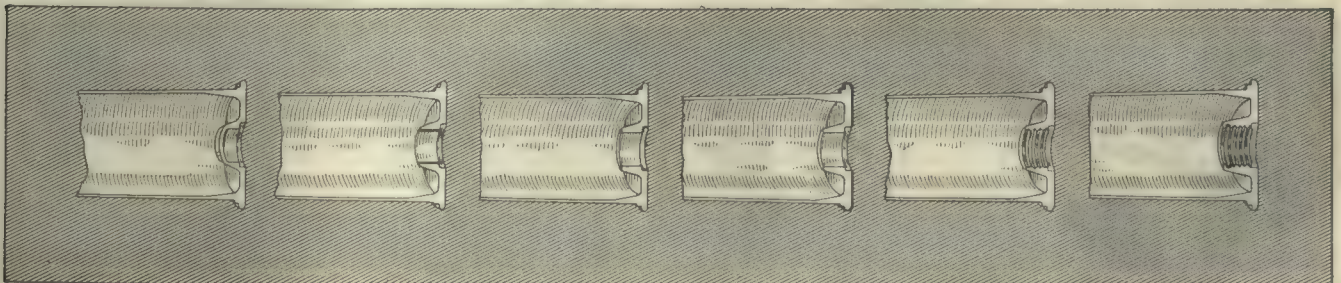


FIG. 58. OPERATION 25: MACHINING HEAD

Machine Used—Bullard cartridge lathe operating at 570 r.p.m., for tapping.
Production—55 per hr.

Note—All machine work performed dry except threading, where lard oil is used.
References—Figs. 56 and 57.

reinforcing ring is placed on the inside of the case to prevent distortion during the tapering operation. The operation is also shown in diagrammatical form in Fig. 52.

The second tapering, which is the next operation, is performed in a press similar to the one shown in Fig. 49.

and the case itself is faced to length. The sequence of operations performed in the lathe is:

1. Drill
2. Form recess and face boss on inside of case
3. Face flange to diameter and thickness—using cross-slide, at the same time face the shell to length with the outer at rear end of the machine
4. Tap
5. Ream and counterbore

Details of the tools used for these operations are shown in Fig. 57. The operations are also shown in diagrammatical form in Fig. 58 in the standard sequence.

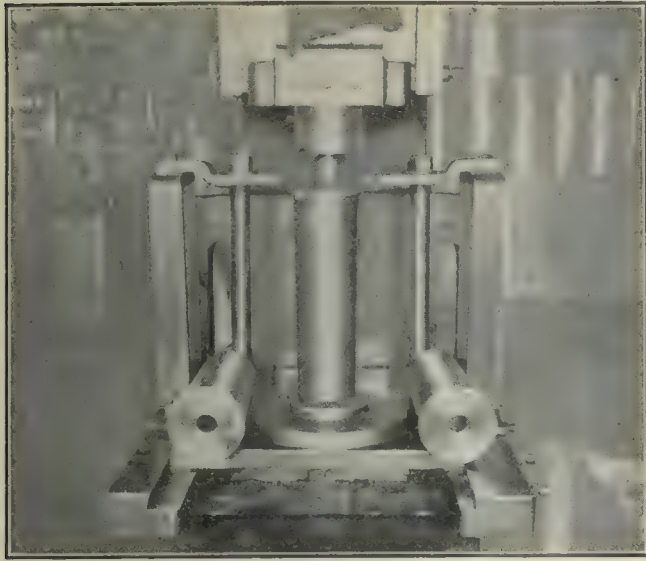


FIG. 60. BROACHING AND STAMPING THE CASE

of seven inspectors test the dimensions, the case being passed along the line until all the surfaces have been examined. With a gang of seven men about 700 cases are inspected per hour.

The case is then conveyed to the machine illustrated in Fig. 60, the hole broached, and the flange stamped. For this operation the case is placed on a steel post which fits on the inside, the case resting on the upper end. The fixture is made to slide forward, enabling the operator easily to place the case in position. The fixture and case are then slid back against a stop, the punch

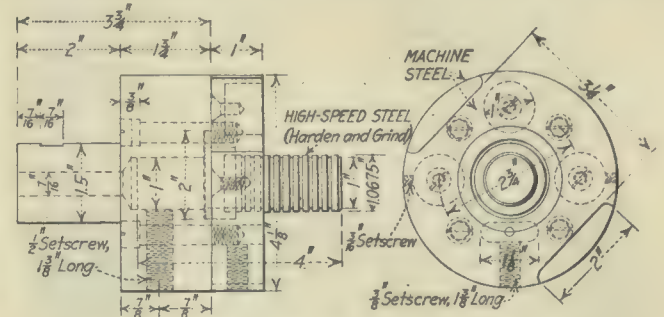
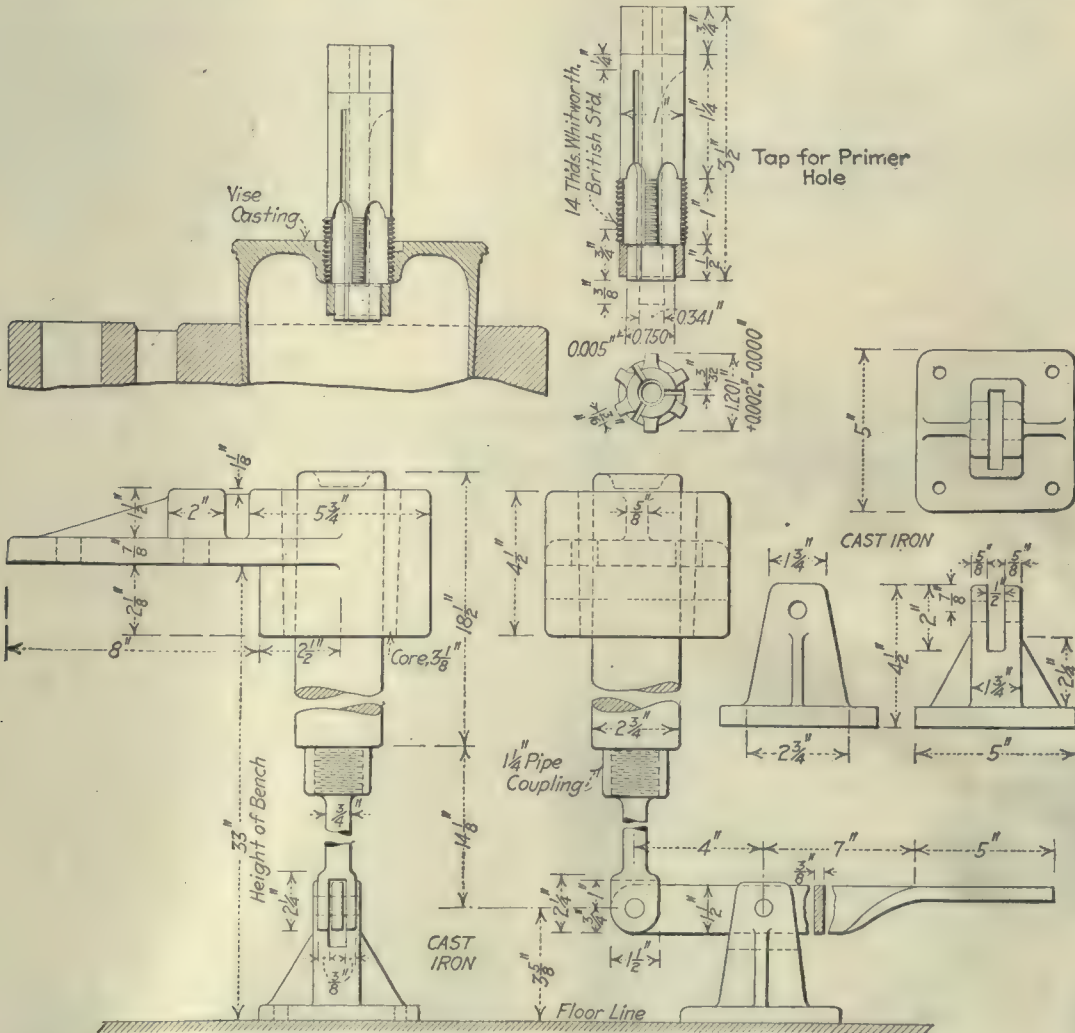


FIG. 61. DETAILS OF BROACH AND STAMP



The next operation is the hand-tapping of the primer hole. To do this the fixture is fastened to the bench, and after being tapped the operator pushes down a treadle with his foot and forces out the case.

Details of the tap and holding fixture are shown in Fig. 63. The operation is also shown in diagrammatical form in Fig. 64. The case is then given a final wash through four vats. The first of these consists of a mixture in the proportion of 8 oz. lye (Ford's alkali special) to 1 gal. of water; the second, hot water at 210 deg. F.; the third, a solution of 4 oz. of sulphuric acid to 1 gal. of water and, finally, in a vat of hot water at 210 deg. F.

The inspection of the tapped and broached holes in the head, and also of the flange, is the next operation, using the gages shown in Fig. 65. The average for this operation is 1 man 120 cases per hour. The case is then transferred to the Government inspection depart-

ment where it is again inspected, using gages similar to those shown in Fig. 59.

Several cartridge cases have been tested for hardness with the Shore scleroscope and the average was found to be as given in the accompanying tabulation.

The average weight of a finished case is 3 lb. 2 drams, and the contents 94.80 cu.in. with a slight variation.

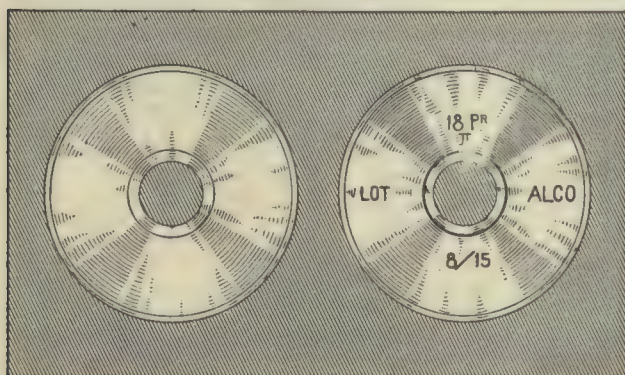


FIG. 62. OPERATION 27: STAMP AND BROACH

Machine Used—Bliss No. 39B marking machine.
Production—1,200 per hr.
Lubricant Used—None.
References—Figs. 60 and 61.

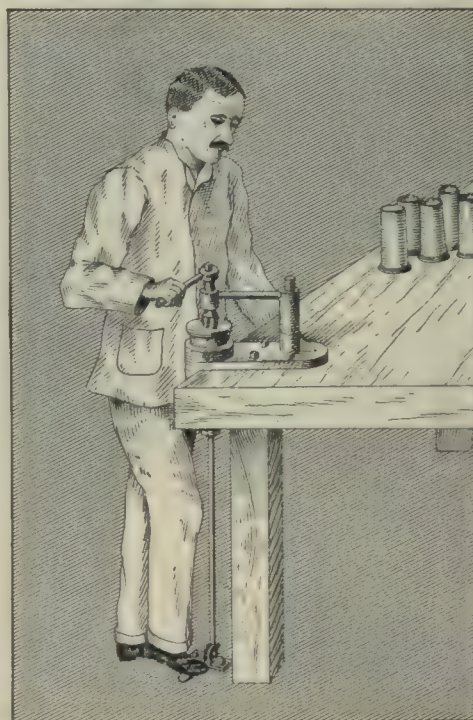


FIG. 64. OPERATION 28: HAND-TAPPING FOR PRIMER

Machine Used—Holding fixture with wooden ejector.
Production—150 per hr.
Lubricant Used—Lard oil.
Reference—Fig. 63.

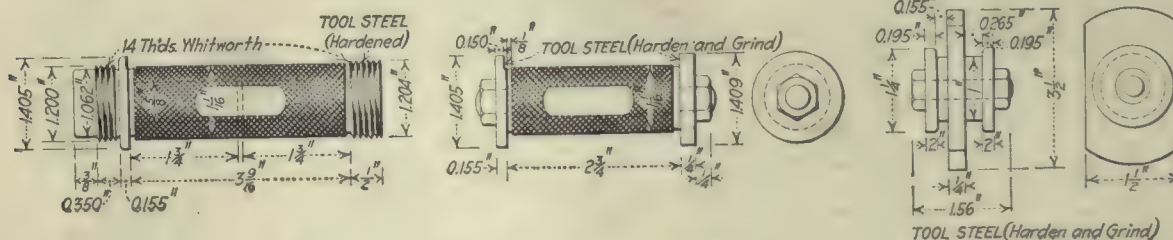


FIG. 65. DETAILS OF GAGES

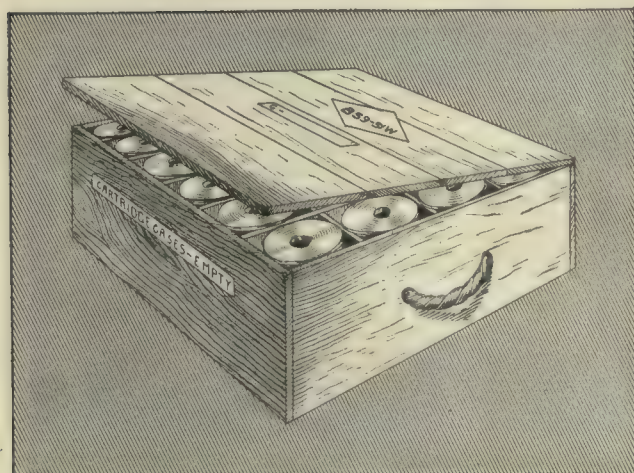


FIG. 66. OPERATION 31: PACKING

Production—Seven men pack and five men fasten boxes together at the rate of 700 in 10 hr.

It might be of interest to know what weight is lost by the case while it is passing through the various stages of

CARTRIDGE-CASE HARDNESS TESTS

At flange	45-55	5 in. from flange	35-40
1/4 in. from flange	40-50	10 in. from flange	30-35
2 in. from flange	40-50		

manufacture. For this purpose the company took about 50 specimens at different times and the average obtained was as follows:

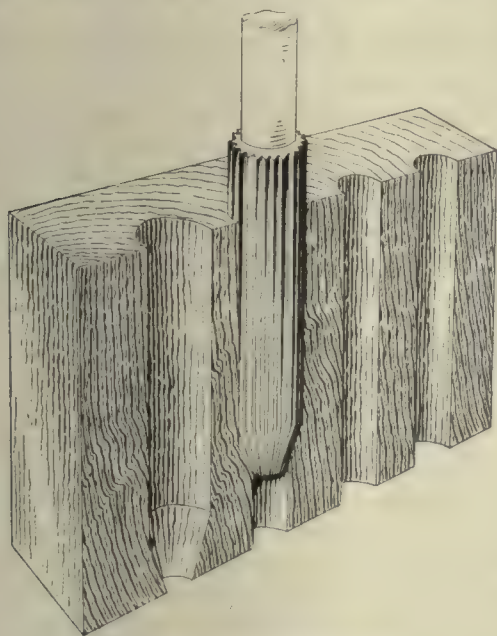
	Lb.	Oz.	Drams
Average weight of disk	3	11	8
Average weight before first trim	3	11	11 1/4
Average after first trim	3	9	11 7/8
Average before second trim	3	9	5 1/2
Average after second trim	3	7	12
Average before machining head	3	7	12
Average after machining head	3	0	9 1/2

After the Government inspection, those cases that are accepted are packed into boxes the covers of which are fastened down and marked on the outside. They are now ready for shipping. The operation is shown in diagrammatical form in Fig. 66.

Letters from Practical Men

Core-Box Reamers

The idea has recently occurred to me that a standard set of reamers from $\frac{1}{4}$ to $1\frac{1}{4}$ in. in sixty-fourth sizes, with standard tapered ends, would save a great amount of time in the pattern shop. When a pattern with a tapered end core is used, most pattern makers make a special tool for the job, which takes much time. This



CORE-BOX REAMERS

set of reamers could be used in the ordinary way, when there is a straight hole to ream, by simply pushing the reamer through the hole above the taper. A set of these reamers in any pattern room would soon pay for itself.

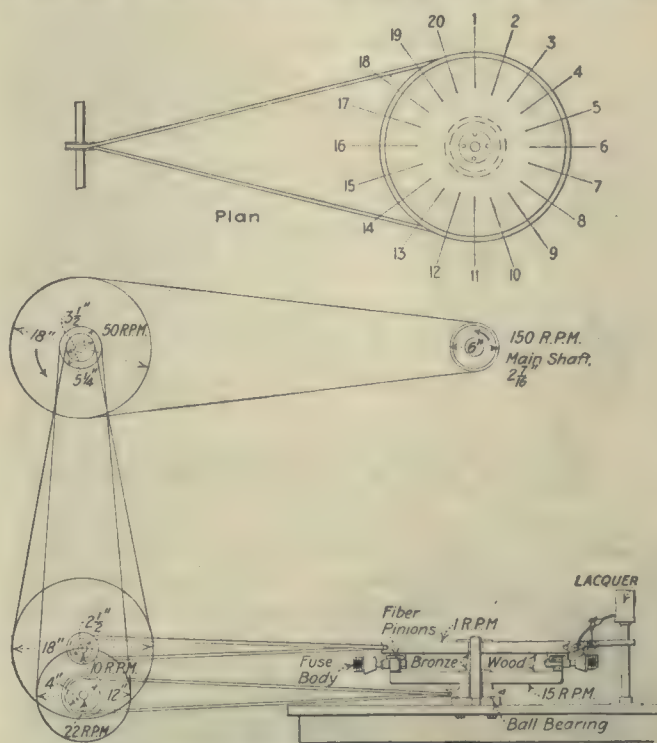
Naugatuck, Conn.

A. E. HOLADAY.

Semiautomatic Machine for Lacquering Fuse Bodies

The illustration shows a semiautomatic machine for lacquering fuse bodies. It consists of two wooden tables made of three thicknesses of $\frac{1}{2}$ -in. wood glued together and turned, to keep it from warping. The bottom table has a cast-iron pulley, grooved for $\frac{1}{2}$ -in. round belt, and a ball race on the under side. This ball race with $\frac{1}{2}$ -in. balls carries the weight of the whole machine. The upper table is driven by a round belt with a groove on its edge and has 20 spindles set radially around its under side. They each have bearings and a fiber pinion. This fiber pinion runs on a rubber friction that is secured to the lower table. The lower table runs at about 15 r.p.m. and the upper table at 1 r.p.m. in the opposite direction. The illustration shows the arrangement for reducing the speed from the mainshaft drive. The spindles will run at about 200 r.p.m. The fuse bodies are to be lacquered on the outside only, of course, and they have a $\frac{1}{16}$ -in. hole in the center which is used for chucking.

The spindles are split and hardened, and the bodies can easily be put on and taken off. Two brushes are used set at the correct angle. The lacquer is fed by gravity from the lacquer tank. One boy can stand at a point just in front of the brushes and place the bodies on and remove the lacquered ones from the spindles. The bodies then have almost one minute to dry before they are handled, and as they are heated slightly by passing through a warming oven, this is more than long enough for them



SEMI-AUTOMATIC LACQUERING MACHINE

to get thoroughly set. Twenty per minute is the capacity of the machine and it can be speeded up slightly if necessary. The machine is simple and inexpensive to make.

FOSTER B. COOLEY.

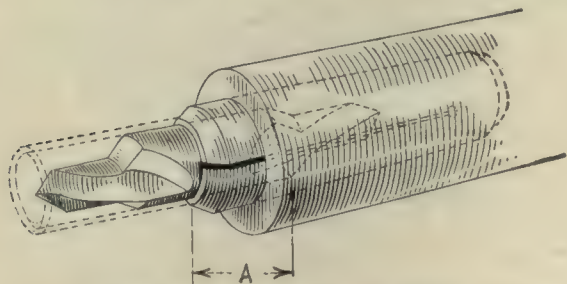
Trenton, N. J.

A Center Drill Chuck

A convenient spring collet, in which badly worn or broken lathe centers can be used to advantage, is shown in the accompanying illustration. It is not advisable to use hardened centers, as they would have to be annealed, machined and then re-hardened. If the collet is to be permanent much time can be saved by choosing a soft center, drilling and slitting as shown, then hardening and grinding.

The collet shown is exceedingly convenient for all small drilling and centering operations and may be used in either the live spindle or the tailstock. As far as speed is concerned, I rather think it beats a regular spring collet with draw-in rod; for in using this device you simply choose a collet and drill of corresponding size.

insert the drill, place the center in the spindle bore and drive it home by means of the small section of tubing and a soft hammer. The piece of tubing is placed over the drill, as shown in the drawing. A light blow with a soft hammer, on the end of the tubing, secures both collet and drill, ready for service. The whole arrange-



OLD LATHE CENTERS USED AS DRILL CHUCK

ment is removed just as is an ordinary center. The bearing upon the drill, reamer, etc., is also mechanically correct as shown at A.

The collet may be elaborated somewhat, to its advantage, but if too much work is to be expended upon it, it would be better to make a standard spring collet, out and out; for that reason the collet is shown here in its simplest form.

As to whether this form of collet will "hold," it will probably be sufficient to remind ourselves that large cutting centers are regularly held in the same way.

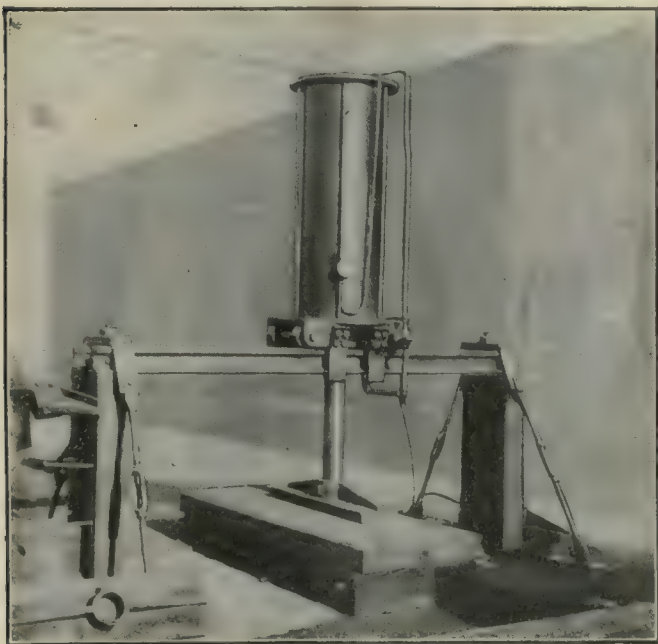
Plainfield, N. J.

J. B. MURPHY.



Air Press for Car-Repair Work

At the Middletown, N. Y., shops of the New York, Ontario & Western Ry. the car-repair department has in use an air-operated press that has proved particularly handy and efficient in straightening and flattening out



AIR PRESS FOR CAR-REPAIR WORK

damaged steel-car sheets. A number of foot pieces of different shapes and sizes enable its use for simple forming as well.

The press is a simple air cylinder with extended piston rod and was constructed from material and fittings readily secured in the shop. It is mounted on two lengths of rail, which are rigidly supported by timbers on a solid foundation. The faceplate is an iron casting. It will be noticed in the illustration that the press is mounted on rollers. This enables its lateral adjustment when the unhandy nature of the work makes such a position more convenient.

The operation of this press is controlled by a standard three-way valve. A gage enables the operator to determine the pressure exerted. The maximum air pressure used is 80 lb., the supply being taken from the yard air line.

Great Neck, N. Y.

H. L. HICKS.



My First Shop Experience

One Saturday morning, three of us, a professor from the University of Cincinnati, a fellow "coöper," and I, left the station at a neighboring city and took a little green car to the scene of what was to be our first job. Here we were introduced to our immediate superiors and assigned places. After it had been intimated to us that we might find quarters at the Y. M. C. A., George and I were left to our own resources. At the Y. M. C. A., we were informed that the best they could do for us would be a room at \$3.50 per week. Our earnings would come to \$9 per week with the prospects of short time ahead. This room meant, moreover, a car ride in the early dawn, with a cold lunch at noon, and another car ride at night, so we concluded to try elsewhere.

After a house-to-house canvass near the factory, we at last found a place that seemed clean, had furnace heat, was ten minutes' walk from work, and had a bath. I had insisted on a bath. At one house where we inquired, the woman resented my fondness for a tub, informing me that she and hers had always done very nicely with a bowl and pitcher and that they were just as clean as anybody.

Monday morning the alarm clock, being mechanically perfect, went off at half past five. I had not been out of bed so early since as a small boy I rose to see the circus unload. I thought of this and laughed as I hurried into my clothes. Downstairs a greasy breakfast awaited us. My egg had been fried long since, and now looked and acted like a huge cold oyster. I finally downed some muddy coffee and started off, thinking of the nice breakfast which presently would be served at my own home. My coöperation had begun.

The first thing at the factory was a time clock, and after punching my card I donned my brand-new overalls and jumper, and presently the foreman turned me over as a helper to one named Rodgers. Rodgers was a good mechanic, and a bright, likeable chap to work with. We worked that morning on a small steam engine, assembling the various parts. My duties were to hand up tools, get drills and taps from the toolroom, drill an occasional hole, and make myself generally handy. I became so interested that I soon forgot the depressing discomforts of the early morning, and before I could realize that the time had passed, the noon whistle blew.

George, who had gone to work in the foundry, met me in the yard and we hurried home to dinner. It was a modification of the serve-self plan. The food was in huge dishes along the middle of the table and each of

the twelve boarders could help himself to all he wanted of anything that he could reach. I soon discovered that it was not good manners to ask for anything that one could possibly reach himself. Each man hunched over his own plate and the food traveled in the shortest possible line from his plate to his mouth. The only conversation was the demand for some dish which was out of range. Each finished as soon as possible—as though it were a bad job well over with—grabbed a toothpick, and departed. In the morning I could not have touched such food. Now I was tired, greasy and ravenously hungry, and I ate as I had not done within my memory. I, too, grabbed a toothpick and ran.

That afternoon I learned, among other things, that it was not shop practice to thank anybody for anything. Rodgers tipped me off to the fact that my politeness was becoming a source of humor. It seemed if one desired expression of any kind that swearing was the medium.

That night found me in bed as soon as my supper was down. Every muscle had a particular and separate ache, but in spite of it all I felt rather proud that I could do a man's work as well as any of them.

The week passed rapidly. Each morning I was just a little bit more stiff and hated a trifle more to get up. George was now suffering from acute homesickness and was about as miserable as a boy could well be. We compared notes each night and found that we were picking up information at a surprising rate. I have been told that the only way to learn a language is to go and live among the people that speak it, and I found that we were being steeped in the language of the factory. Each day I memorized the names of objects unfamiliar to me, much as a child does in kindergarten.

I had one bit of bad luck at the start. Rodgers and I were weighing springs. The "weight" of a spring is the weight which is required to stretch the spring one inch. We would fasten plugs in the ends, suspend the spring from a hook by one end and pile weights on the other till the required stretch was reached. An inadvertent joggle landed a heavy piece of iron on my instep. The pain fairly made me scream, but Rodgers thought it was a good joke so I forced a smile and we went ahead. That night, however, I could hardly get my shoe off. Another day the operator of a boring mill nearby was making a long bore. He stuck his finger in the sleeve to see how far the drill had progressed. Just at that moment the drill went by and took his finger with it. These two occurrences taught me to be careful.

I did not always work for Rodgers, but was handed around wherever needed. There was an old fellow in particular that soon incurred my dislike. His job was to cover certain portions of the engines with sheet-iron bonnets to keep the oil from splattering. I held the heavy cover while he wiggled it around to a certain place. Then he would discover that he had left something on his bench and would be gone fifteen minutes while my arms ached from the strain of keeping one position. Seeing me scowl one morning, he decided that I was dissatisfied with my job and should be cheered up a little. He knew nothing of my university affiliations nor my engineering ambitions. To him, I was simply a flunky. Well-meaningly, he pointed out an operator at a radial drill and informed me that this man had been a helper only seven years and now he had his own machine. I thought of Jacob serving seven years for Rachel and commenced to

laugh. I never could bear resentment against the old man after that.

An interesting part of the work was the babbitting of the bearing. Steel forms were hung over the casting, which was drilled full of holes to offer a hold for the metal. The intersections were filled with clay. Then the pot of babbitt was taken from the little charcoal stove and poured with great splashings. The forms were anxiously stripped off to see if the bearing was clean or if sink holes would appear in the cooling. Rodgers, who had his own way of pouring, was very proud of his success. I usually prepared the clay. The first time when told to bring clay I simply went to the box and brought a handful. I was sent back with instructions to mix it. I rolled it around a bit and again brought it back. This time I was escorted and shown how it should be done. The lump was beaten with an old file, thumped up and down, mixed with dry clay if too wet, or wet clay if too dry, until just the proper consistency was reached. It was some time before I could get it in a satisfactory shape, and I sometimes wondered if somebody was not getting a bit of fun out of the trips I made to the clay box.

The Dean said to me when I enrolled, "You will learn a lot of things not on the program." By the end of the week I began to understand what he had meant. With this reflection there came a dim realization of the big game in which I was playing my part, and the feeling that doing a man's work in a man's world is worth the trial.

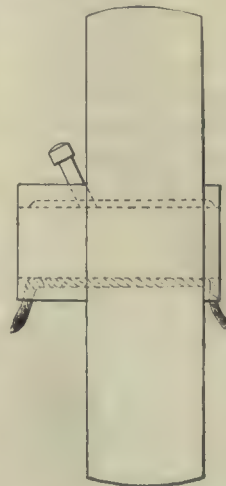
R. E. FIELD.

Cincinnati, Ohio.

Preventing Loose-Pulley Trouble

The high-speed loose pulley on the countershaft of a bench lathe frequently gives trouble from sticking and chattering if the oiling is not strictly attended to—

and it seldom is. Once it has been neglected and the shaft has roughed up, the oil holes are apt to fill with rubbed-off particles of iron and steel. It is then practically impossible to feed oil to it properly without first tearing down the whole countershaft and cleaning all the parts. After having had trouble of this kind a number of times, cut the oil grooves deeper, and tried both brass and wood bushings with no better success, I hit upon the following kink, which, from its simplicity and ease of application, may be of interest to my fellow mechanics. In addition to the oil groove cut on each side of the oil hole in the pulley, I cut another and deeper groove opposite, nearly to the ends of the hub. At each end



THE CURE FOR
LOOSE-PULLEY
TROUBLE

of this groove I drilled a $\frac{1}{8}$ -in. hole through the hub. I next took a piece of candle wicking and soaked it in a mixture of machine oil and graphite. This was threaded through both holes so that the wicking would lie in the bottom of the groove. Then the pulley was replaced on the shaft. The pulley repaired in this way was practically self-oiling, as the wicking gathered the oil and

only fed it to the shaft as needed, so that now I need not bother about the oiling more than twice a month. In experimenting, I once ran it a month without attention and with no ill results.

DONALD BAKER.

Jersey City, N. J.

✽

Cutting Rods in a Punch Press

We had rod wire from 0.078 in. to 0.75 in. to cut cold to specific lengths. We had to have the ends of the lengths almost square, in order to gage them accurately. Two methods were tried. The one shown at *A* cost more for steel, left too much scrap and was dangerous. The

that the holes were drilled out of center, even after attempts had been made to adjust the drilling jig.

The stops finally used were as follows: In the place of fixed stops a sliding stop of square section, as at *CD*, was secured to the jig plate by a clip. The inner ends were slightly tapered. By use of the taper bolt and adjusting nut shown, the stop was expanded if required, without altering the center line of the jig and the work. A spring secured to the two stop pieces kept them against the taper end of the bolt and also brought them into position when required for a small-sized casting.

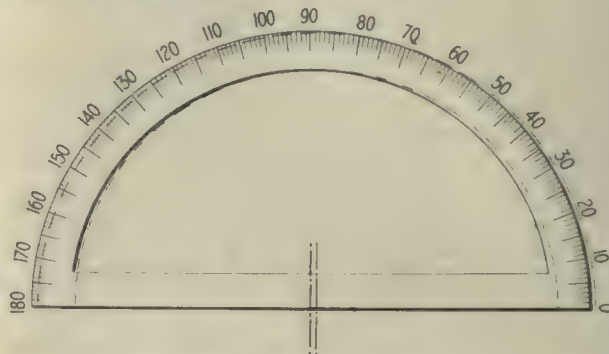
C. H. JACKSON.

Newcastle-on-Tyne, England.

✽

A Dividing Kink

The illustration shows a method of dividing an uneven number of degrees into any number of even parts by using a protractor and simply shifting it up or down to obtain the required divisions.



DIVIDING UNEVEN NUMBER OF DEGREES INTO EVEN PARTS

Example: How can 61 deg. be divided into 12 equal parts? Ans.: First lay off 61 deg., then slide the protractor down 1 deg. This will shift the center of the protractor from the center of the angle of the required degree, making it read 60 deg. Now lay off 12 points of 5 deg. each and draw lines to the center of the angle, giving 61 deg. divided into 12 equal parts.

Harrison, N. J.

C. E. MCCARTHY.

✽

A Query on Cross-Knurling

Being persuaded that your readers like to study out the "why" of things, I present the accompanying illustration. No doubt many have observed that the knurled grips on various tools, when revolved, sometimes have the appearance of rings *A* and sometimes of screw threads

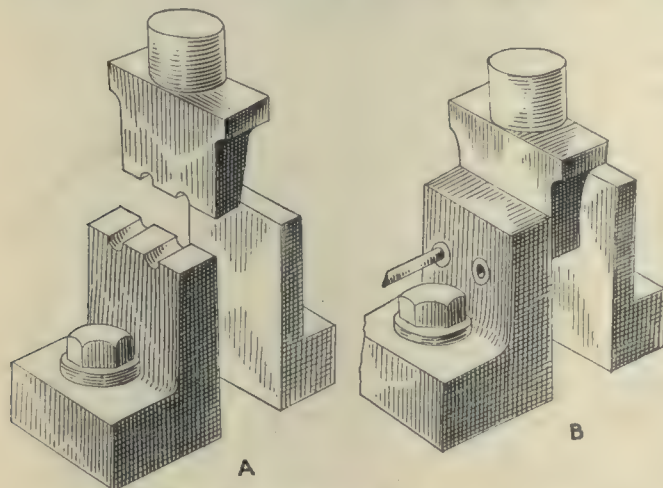


WHAT CAUSES THE DIFFERENCE?

B. This occurs when the pieces are knurled with the ordinary tool having two cutters, one right and one left. The question is, What makes the difference? Both *A* and *B* are made with the same tool under apparently the same conditions. I have asked many mechanics this question and never yet received the correct answer.

Springfield, Mass.

R. B. WARE.



SHEARING DIES FOR RODS

method shown at *B* gives us better work, more of it, less scrap, and there is no danger to the press feeder.

The dies are small steel bushings in a machine-steel shoe, so the high price of steel does not bother us. The wire is fed continuously against the stop. The ends of the cut pins are almost square, as the wire runs through a bushing only 0.002 to 0.003 in. larger than the pin. The press feeder can cut from two to four pins at each stroke of the press. The bushings are removable in case we need to cut larger or smaller wire. When we have wire about 0.0785 in. to cut, we have two holes drilled in each bushing and can cut four pins at each stroke.

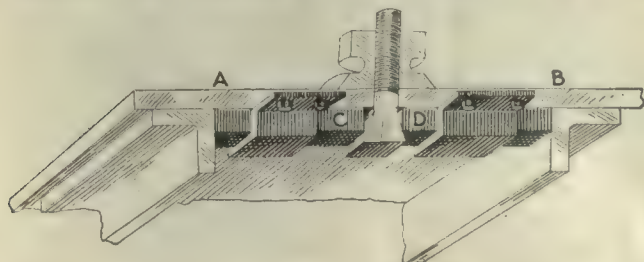
Philadelphia, Penn.

CHARLES M. VALDES.

✽

Self-Centering Jig

I experienced some trouble in drilling bolt holes in the castings partly shown herewith. This was owing to the fact that the distance between *A* and *B* varied. At the same time this difference did not materially matter when the castings were in service. Using any fixed stop for registering necessitated the stop being placed at one extreme. Any variation in the casting usually meant



A SELF-CENTERING JIG

Discussion of Previous Question

Metric System and Its Critics

Joel Tessitore, on page 256, sums up the situation in regard to the metric system and its critics almost word for word in the way that I was tempted to do a few weeks ago, when the furore was started by big headlines and exclamation points in your most excellent magazine.

The factory with which I am connected has several times had occasion to change standards which affected such a volume of tools and jigs that the company would have been nearly bankrupt had it been necessary to make the change in a day. Such changes however are not so made in practice. Should the metric system be determined upon as the proper standard, the logical method of application would be to lay out all *new* designs of the plant's production to the metric system of measurements, *continuing the old designs in inches* as long as there was a market for them. In this way the change from one system to the other and the corresponding education of the men, the large majority of whom nowadays work to gages anyway, would be so gradual that the change would be made almost before the majority of us realized it, and without any serious disorganization. It is perfectly true that for a time we would be compelled to work to two standards to a limited extent. Most of us who are doing any export work have to do this to a greater or less extent today.

If the metric system is a better system, as is admitted by many of its opponents, then costs when working under it are going to be lower after the change is made than they will be at the same time if the old standards are continued. If the change is a desirable one for some future time, why should we sidestep our responsibility by wishing onto our children or grandchildren a job which will be even more difficult for them than for us?

South Plainfield, N. J.

C. W. SPICER.

Side Shield for Emery Wheels

On page 960, Vol. 44, is mentioned the great convenience afforded by the installation of a small disk grinder, and in this connection several methods of attaching a grinding disk to an ordinary small grinding-wheel stand might prove of interest. The simplest attachment is shown in Fig. 1; here a steel disk $\frac{3}{8}$ in. thick and 7 or 8 in. in diameter (about an inch smaller in diameter than the regular grinding wheel) is clamped at the end of the wheel spindle between the nut and the clamp washer. In Fig. 2 the regular wheel is removed and a cast-iron (or hardwood) bushing is slipped on in its place. A cast-iron, flanged bushing is shown in Fig. 3. The outer end is threaded to fit the spindle, which when screwed up tight will allow the disk to come flush with the end of the shaft. These three attachments make use of the regular grinder spindle; in Figs. 1 and 2 the nut might be in the way in some instances, but they do very well for grinding the faces of nuts, screw heads, small wrenches, etc.

It is somewhat difficult to make the disk run perfectly true, but if once in position it will not be necessary to remove the disk for gluing on the emery cloth, as a hardwood disk can be clamped up against the face of the steel disk to hold the cloth until the glue dries. If it is possible to remove the grinder shaft without loosening the disk, and if the shaft is provided with centers, the disk can be trued up in the lathe.

In Fig. 4 a new shaft is turned up (with shoulders to fit the grinder head) to which is fitted a cast-iron bush-

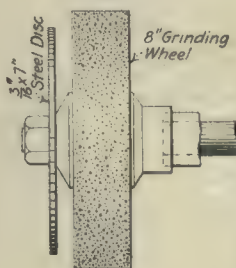


Fig. 1

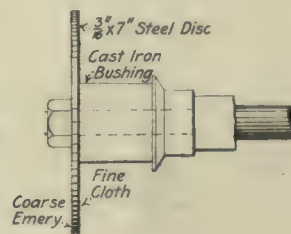


Fig. 2

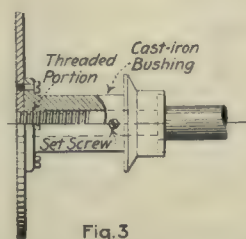


Fig. 3

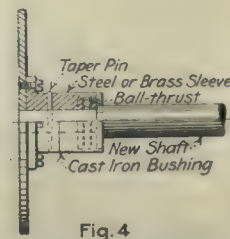


Fig. 4

FIGS. 1 TO 4. DISK GRINDER ATTACHMENTS FOR SMALL GRINDER STANDS

ing held by a taper pin and flanged to take the steel disk. A ball-thrust bearing is provided to take the end thrust, this bearing being protected either by a steel sleeve or a recess in the end of the bushing. This arrangement allows the flange to be permanently trued up. Any of these schemes permits the use of either one or two disks; with those shown in Figs. 2, 3 and 4 emery cloth may be glued on both sides of the disk—for instance, one side fine and one coarse—it being possible to grind many small articles on the inside face.

Ordinary emery cloth is used for the disks, it being cut to shape and glued on with pattern maker's or common liquid glue. The grade of cloth depends upon the material to be ground and the finish desired. If a wooden disk is used to clamp the cloth while gluing, it is best to place a sheet of iron or tin between the wood and the emery cloth.

No work rests are used on such a small grinder, but if the stand is provided with an L-rest this could be swung around in front of the disk. In Fig. 5 is shown a small one-disk grinder designed to be fastened to the end of a bench with the wheel projecting over the bench as indicated. The flanged bushing and thrust bearing are the same as in Fig. 4: the shaft is $\frac{3}{4}$ in. in diameter and

the steel disk $7\frac{3}{16}$ in. face. The pattern work for the base is simple, no core prints being required. The boxes are split and either bronze-bushed or babbitted. The base has a three-point support to prevent the bearings being thrown out of line. Tight and loose pulleys are

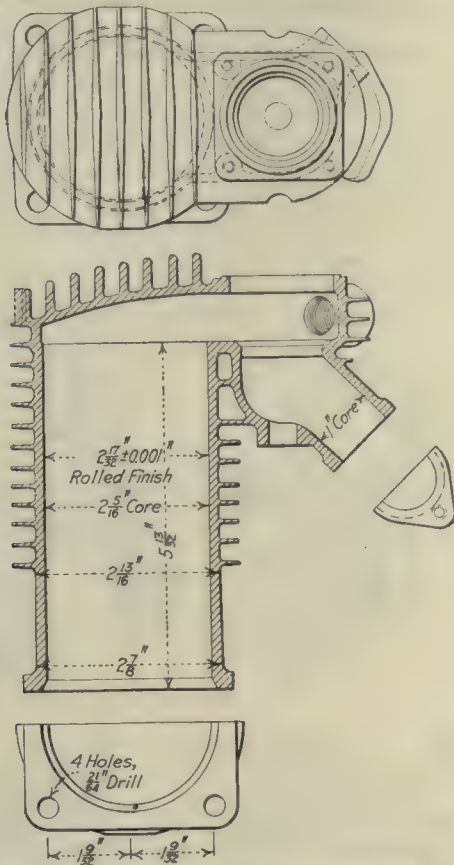


FIG. 5. 7-IN. BENCH DISK GRINDER

provided. The loose pulley has a long bearing, bronze-bushed, and is lubricated through a hole drilled in the rear end of the shaft from a grease cup at the end, as shown. The main bearings are also provided with grease cups.

H. H. PARKER.

Oakland, Calif.

Time and time again we hear and read discussions regarding the practice of grinding on the side of the wheel. Mr. Murphy, on page 121, mentions the shop rule by which he is governed, "Never grind anything with the side of the grinding wheel," and then in the course of his article tells how a certain job should be done—by using the side of a wheel, which by the way is constructed in such form that it is of little value for anything else other than side grinding. Surely the side of a dish wheel is the side, in spite of the fact that it differs slightly in shape from others.

In having a shop rule prohibiting the use of the side of the wheel the only effect accomplished is the promotion of disregard for rules. This rule will surely be disobeyed, especially if the tool maker knows that the firm is spending real money for the purchase of wheels that are intended for side grinding especially.

My practice in regard to using the side of the wheel (and from observation I will say it is the general practice) is to use the periphery of the wheel for all purposes except in instances where the side is more efficient.

In constructing snap gages the side of the wheel is so overwhelmingly superior to the periphery, owing to the difference in the size of wheel which may be used, that the use of the side of the wheel for such purposes is universal and beyond argument.

I do not mean this article as a criticism of Mr. Murphy in particular, but rather of the many who have unthinkingly taken up the cry against something that is practiced by all who have occasion to do so. I have quoted Mr. Murphy simply to illustrate that, even though he is apparently opposed to the use of the side of the wheel, he, like the rest of us, uses it when it seems proper.

Newark, N. J.

GUSTAVE A. REMACLE.

Where Are the Good Mechanics?

I have read Mr. Brophy's article on page 236, wherein he asks what has become of the all-around mechanics he used to be able to get. As I have read several other articles on this subject, I would like to advance my opinion from the ranks of the "specialist" machinists.

Here is where I think the trouble lies: When I first entered the machine shop they put me on a machine, and there I stayed. Gradually my pay was raised, and two years later I was doing the same work and getting fairly good wages. Finally I saw where I was coming to and went to the superintendent and asked him to give me a variety of work; he told me he would do it if I would go back to my old pay. I could not blame him for not wanting to pay me 45c. an hour to learn my trade; but I did not feel that I could go back to 20c., so I am a specialist.

Now this is what I think would help the situation: When a man first enters the shop he should be shoved around as fast as he can acquire a working knowledge of each machine, before he gets machinist's pay on any one. He will not become proficient in the specialist sense of the word, but I think all shop foremen will agree with me that they would rather have a man to whom they can say, "Go down to No. 3 lathe and make a piece from this print, then machine that die lying by the slotter," than to have an expert lathe or slotter hand who can work nowhere else in a pinch.

My case is not true of one shop only, because I have worked in three different shops, and every one was training its men to be "specialists." Then they kick because they cannot get an all-around mechanic. There are of course some shops that train good apprentices, and there are also some good all-around mechanics, but both are scarce.

LEON C. GROVE.

Berwick, Penn.

A Babbitting Problem

Referring to Mr. Williamson's article on page 190, relative to a babbitting job, I believe his trouble is caused by the unequal expansion of the arbor, the bottom side of the center being the hotter due to the contact with the melted metal when pouring a half-box. This causes the arbor to curl up at the ends, or down in the center, depending upon the location of the supports. If the center bearing cap can be poured at the same time as the lower half of the box, by means of pasteboard strips at the parting line and suitable gates for the babbitt, the trouble will probably disappear.

Poughkeepsie, N. Y.

HARRY W. JOHNSON.

Editorials

Practical Apprenticeship

The formation of a conference board on training of apprentices was mentioned in these columns something over a year ago. This board is now composed of members from six organizations—namely, the National Association of Manufacturers, the National Founders' Association, the National Metal Trades Association, the National Machine Tool Builders' Association, the United Typothetae and Franklin Clubs of America, and the American Foundrymen's Association.

The results of the first year's deliberation are agreement upon fundamental principles as the common basis of all apprenticeship training, recommendations to employers upon various phases of such training, a suggested form of indenture for use in all industries, a uniform certificate of apprenticeship, and the establishment of a bulletin called "Practical Apprenticeship."

The first issue of this bulletin is devoted to the necessity of apprenticeship, and employers are urged to secure copies for distribution among their superintendents and foremen.

This work promises great good. For years the technical journals have pointed out the nature of the apprenticeship problem and have placed the responsibility for industrial training fairly and squarely upon the employers. The formation of this board and the frank admission of the need for uniform action are encouraging steps in the movement.

This first bulletin discusses the necessity for apprenticeship, stating that one million young people are required each year to maintain the ranks of the nation's working population. It quotes the report of a congressional commission of 1914 to the effect that hardly 1 per cent. of the 14,250,000 persons engaged in manufacturing in mechanical pursuits have had, or at the present time have any chance to secure, adequate training in their chosen industry. The experience of management experts is referred to as proving that the lack of fundamental knowledge on the part of workers is the cause of an enormous factory waste from defective product, worn machinery and expense of supervision. And the experience of some large metal-working establishments where apprentices have been carefully trained is, "The production of defective parts has greatly decreased, the cost to machine repairs has been much diminished, and, because of the increased individual intelligence on the part of the workers, the cost of supervision has been materially reduced."

There are several pages of such facts that lead to this paragraph: "Today practically all employers, and all who are interested in the future of our country and in good citizenship, admit the importance of the apprenticeship question. *But what are we going to do about it?*"

The second part of the bulletin is devoted to the responsibility of the employer. This eloquently argues that the employer alone is the key to the situation.

The third part takes up the necessity for fundamental action and declares emphatically that uniformity of procedure by employers in a given trade must be practiced if any material success is to be attained. The possibilities of such efforts are indicated by listing some of the factors that enter into the problem, such as: "The length of apprenticeship, agreement of apprenticeship, apprenticeship wage, character of practical trade training, character of applied technical instruction, standards of craftsmanship, certificate of apprenticeship." Of course, these are only a few of many similar features which can be better answered by joint deliberation of many interested employers than by the action of a single one or a few.

This formation of the conference board and the beginning of its work constitute the most hopeful factor that has entered the apprenticeship movement for many a day. If, through the influence of this board, employers realize their full responsibility for industrial training, much will have been accomplished indeed.

■

The Laws of Success Are Elastic

The world is full of strange contrasts. Nowhere is this more evident than in the machine-shop field, where methods, men and machines in one shop are often diametrically opposed to the methods, men and machines in another that apparently operates with equal success.

Policies differ as broadly and as widely as do the men who originate them. One who has a favorite theory with regard to shop management may back himself up with many precedents, no matter how strange his theory may be. It is almost as rich a field for precedents as a lawyer finds in his records of past cases, which is saying a good deal.

Limiting ourselves to the consideration of successful plants only, the contrasts that one finds in policy and practice are enough to make one despair of formulating any laws of action for the successful conduct of a machine shop. Each one of us can probably call to mind the example of a shop notorious for its small wages and famous for its large profits. On the other hand, it is just as easy to recall the name of a shop which has as broad a reputation for its high wages as for its enormous profits. Here are contrasting policies diametrically opposed, and yet each road apparently leads to the same final results in terms of profit. Unfortunately, the former combination, having been in existence for a much longer period, has possibly the preponderance of evidence—something which we hope will be overcome before long, however, by the rapid accumulation of evidence of the success of the liberal policy.

Possibly this same plant that we have referred to above, which has been notorious for its small wages, has been housed in a dilapidated building which has been turning out profits for so many years that it is almost in the last

stages of senile decay. To make the contrast much stronger, the other shop, which has made large profits on the high-wage basis, is no doubt housed in the most modern type of factory building, with all the conveniences that can be added for the comfort of its employees. Again, in the matter of machine equipment the former plant has the well-known policy of never discarding a machine, and an inspection of its interior would remind one of a machine-tool museum. The high-wage profitable plant, on the contrary, reminds one almost of the exhibit room at a machinery convention, wherein the latest features in machine-tool practice are displayed. If anyone can find reason for the successful outcome of two such distinctly different policies, we would be glad to have light shed upon this dark subject.

If one is convinced that large quantity production is the only way to make money, let him search around a bit and his convictions may be shaken. He will find some plants working on a similar product in which small lots are the rule and in which the profits are possibly as great as he has anticipated with the larger quantities. If he believes that skilled help running fine machines is the proper way to conduct business, well and good. There are plenty of precedents for this belief; but he will also find profits being made on the same line of work by crude labor running simple, specialized machines. Even the policies regarding overhead are subject to this unbalanced condition of evidence. In some successful shops it will be found that money is being made by reducing the amount of supervision so that one foreman, for example, looks after 60 to 100 men. On the other hand, one can find shops in which the management will swear by the profitable policy of demonstrators, sub-bosses and gang foremen in the ratio of one to every six or eight producers.

Surely the laws of success in the machine shop are elastic!

✽

Losing Business by Economy in Catalog Distribution

Periodically evidence comes to hand to indicate that even in some of the most progressive manufacturing corporations, with well-developed sales organizations, business lapses are permitted the cost and ill-effect of which are not easily measured.

In national business organizations a common cause of complaint, for which little justification can be found, is the distinction, or more properly speaking, the discrimination, shown toward an inquiry coming from a source considered unlikely of immediate results. The discrimination often arises from a short-sighted policy that dictates "penny" economy in dealing with inquiries from individuals who are considered too small to warrant the same courtesy, time and attention accorded the bigger prospective buyer.

A case in point is recorded in the following communication received from a consulting engineer of high professional standing:

For many months it has been my task to pave the way for the formation of an extremely large corporation that will need all of those things that enter into the successful start of any uptodate manufacturing concern.

It is necessary, for obvious reasons, to keep the identity of certain men, who are always in the background of a big proposition like this, from the public. This is why the smaller "fish" are employed to do the preliminary work. It is the office of these smaller fish to get as much of the necessary

information as possible in regard to available plants, machinery, tools, stock parts, etc. This small fish—myself in this case—must know what is required, about where to look for it, what limits of cost are just, etc. It is best that his business connections be unknown, more easily to hide the identity of his principals, at least until he considers it wise to make them known.

In the course of looking for some hydraulic equipment I wrote to a firm which has been an advertiser in the "American Machinist" and whose product is recognized as unsurpassed. I knew about what I wanted, but thought it of advantage to have the general catalog so that a more careful selection might be made. Since I am an engineer, I knew the language well enough to express myself clearly; told in a guarded and general way the importance of the proposed purchase and asked for the general catalog. Instead, a letter came that was a mistake on the part of the sales manager. It was so evidently a "stall" to avoid the expense of the catalog that I took pity on him and asked another firm, got a catalog, a courteous and full reply conveying all the information I needed, and found what I wanted. The second concern is also an "American Machinist" advertiser, not quite so well known, but just as good. It will get the business.

The moral of this experience is apparent. To discriminate on the basis of a superficial analysis is a dangerous practice. It must not be forgotten that the "small" men of today may be the "big" men of tomorrow.

✽

Functions of Chemistry in the Shop

It is not so long ago that chemistry was looked upon as a purely laboratory science far removed from any useful application in the shop.

Recently, however, the tendency toward a greater recognition of chemistry as a practical shop aid has been marked, and it is generally conceded that this branch of engineering possesses undreamed of possibilities. When it is recognized that all material is subject to chemical laws and the properties and behavior of such materials can be to a greater or less extent influenced through a knowledge of these laws, the enormous field for applied chemistry in the shop needs no brief.

Possibly the most striking indication of the importance to which chemical engineering has grown is the comprehensive provisions made for that branch of industrial education—for chemistry has come to be more industrial than scientific—in the new Massachusetts Institute of Technology.

Here it is proposed to enter upon a line of research in chemistry as applied to specific phases of actual practice, and even from a casual survey the machine-shop opportunities for graduates from such a course appear unlimited.

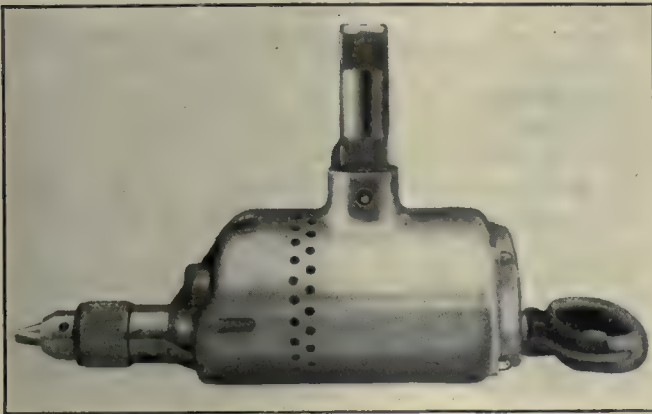
The corrosion of iron and steel is distinctly a chemical problem. To what extent heat-treatment or other induced chemical changes can enhance the cutting qualities of tool steel would be hazardous to guess. What new alloys are possible for a wide variety of machine-shop applications is indicated by the recent arrivals in this field. Every fracture of metal, every blow-hole in a casting and every premature failure of a part points to a possible line of constructive chemical investigation.

To continue the list of machine-shop problems that are largely problems in applied chemistry would be almost expressing the obvious, for in the reduction of iron and steel, from the moment the crude ores are removed from the earth until the last grinding or polishing operation is performed on the smallest finished part, the chemical influences are ever present.

Shop Equipment News

Portable Drilling Machine

The illustration shows a portable drilling machine built by the Electro Magnetic Tool Co., Chicago, Ill. The gears are of steel, casehardened and heat-treated. They run on bronze shafts immersed in grease in a separate gear

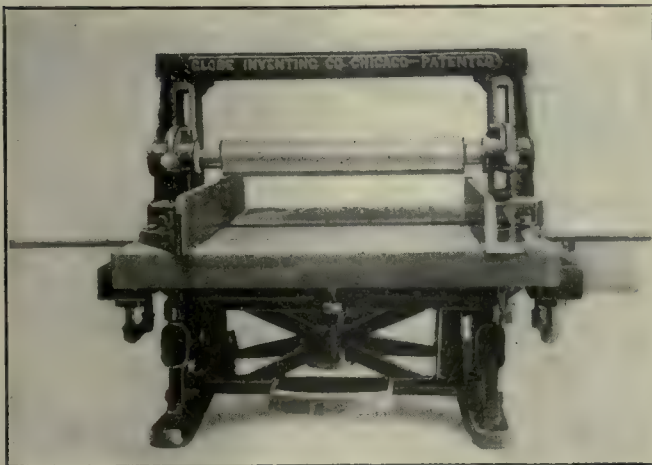


PORTABLE ELECTRIC DRILLING MACHINE

case. The thrust is taken by a ball thrust bearing. The device is air cooled by means of a ventilating fan on the spindle. With the spindle and chuck offset as shown, the tool will work close up to corners.

Combination Surface Grinder, and Sander

The bench machine shown was designed for finishing up any size surface and shapes on wood, metal and other materials. Various abrasive cloths can be quickly attached



COMBINATION SURFACE GRINDER, POLISHING MACHINE AND SANDER

Table, 18x17 in.; rotary wheel, 10½ in. wide; weight, 165 lb.

to the roller by unscrewing three small screws. Two kinds of abrasive cloth can be put on the roller at the same time by using each half of the roller.

The roller, or thickness, guide can be set, lowered or lifted up to 4 in. over the abrasive, or can be lowered at one end and set to any angle up to 15 deg. The roller guide is used to run in strips of metal and give the article a true bearing surface across its entire width; it is also a protection against the fingers.

The table can be lowered or raised at either side so as to get the correct parallel to the rotary wheel, can be lifted and swung up to the back when replacing the worn-out abrasive cloth, and can easily be raised or lowered and quickly adjusted by turning the screw up or down in front of the machine. Two large attached reservoirs will hold sufficient oil to last a considerable period.

The machine shown is a recent product of the Globe Inventing Co., 4877 North Hermitage Ave., Chicago, Ill.

Shell-Plug and Socket Millers

The machines shown in the illustrations were designed primarily for shell plugs and fuse sockets, although they may be adapted for external threading on other classes of work.

In Fig. 1 is illustrated a plug miller for milling threads on the base plugs after the latter have been machined.

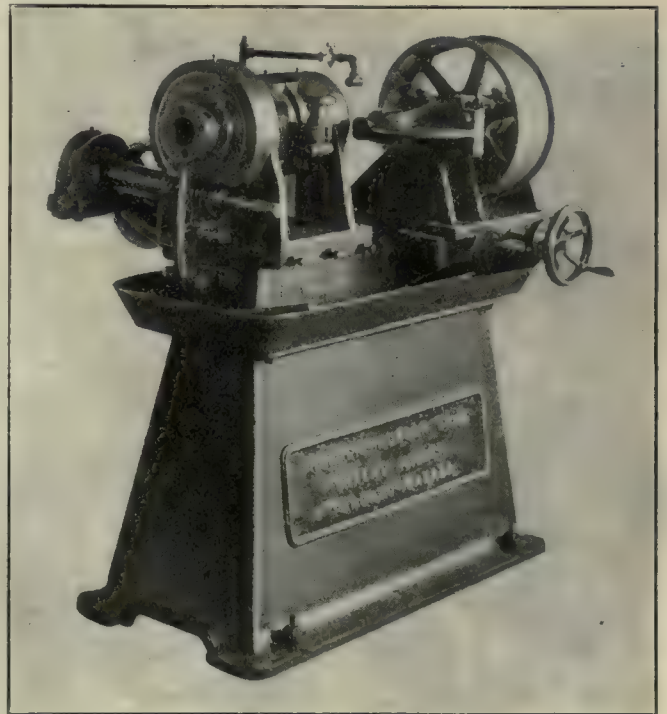


FIG. 1. SHELL-PLUG MILLER
Capacity, 7- to 12-in. shells; weight, 2,230 lb.

The plug is chucked in the machine by means varying with the type of plug. The thread is completely milled at one revolution of the spindle. It will be seen that the opening and closing of the chuck are controlled by a handle which is conveniently placed at the side of the machine and which is operated through a worm gear.

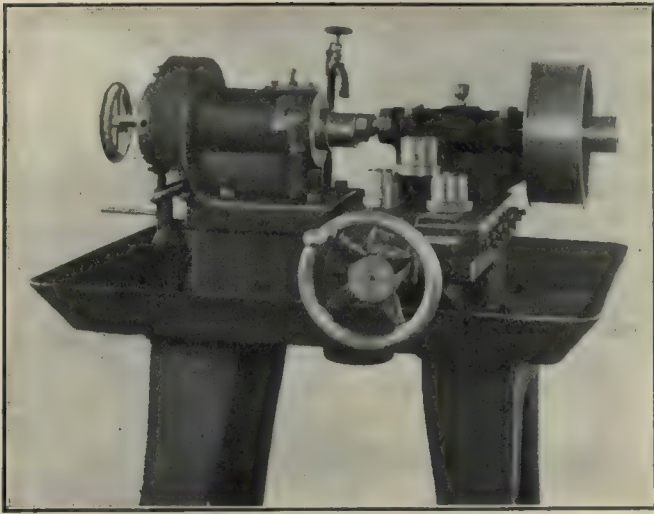


FIG. 2. FUSE-SOCKET MILLER
Capacity, 6 in.; weight, 900 lb.

The miller shown in Fig. 2 was designed especially for milling outside threads on fuse sockets, nose pieces and fuse bodies. A chucking device especially adapted for the various pieces is provided.

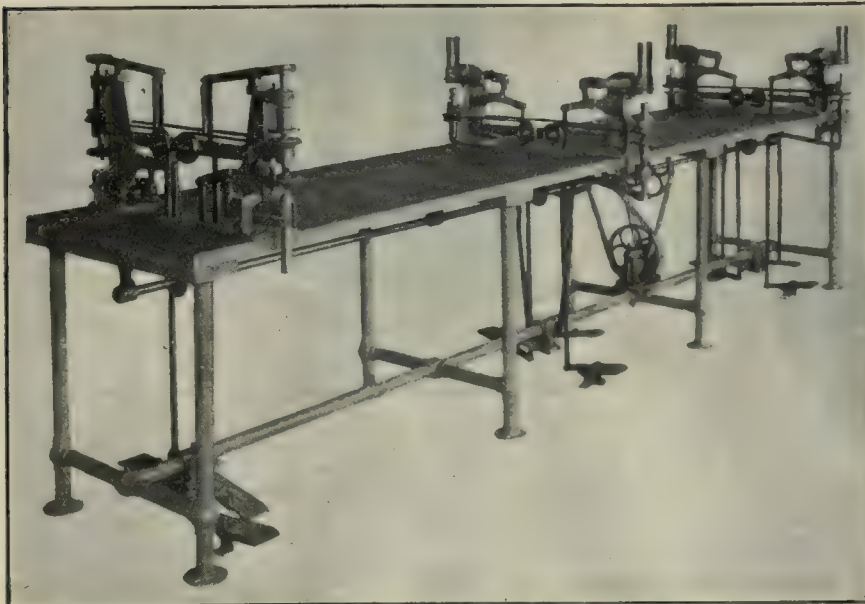
Both of the machines represent recent additions to the line made by the Holden-Morgan Co., Ltd., Toronto, Canada.

The two machines at the left assemble the steel head bushing in the bursting box. The operator inserts the steel head bushing in the spindle head with one hand, the bursting box in the clamping jaws with the other hand and closes the jaws by operation of a foot treadle. By the action of a second foot treadle the spindle carrying the steel head bushing is moved down. As soon as the friction flange on the spindle comes in contact with the constantly revolving pulley friction flange, the spindle begins to revolve. The spindle continues to descend; and when the steel head bushing has entered the bursting box by about two threads, the two levers that hold the head bushing start to cam-out, thereby releasing the head bushing. The operation is finished by the screwdriver blade in the spindle head. The friction flanges can be adjusted until the proper tightness of the head bushing is obtained.

The machines at the right on the table assemble the steel detonator bushing in the lower end of the bursting box. The two machines in the center of the table assemble the steel base bushing in the bursting box. The last two operations are very much the same as the first operation described, but the method of holding the parts to be assembled varies. The actual time taken for the three operations is 18 sec., which it is estimated will be reduced one-third after the operators have become expert in handling the different parts.

Ammunition-Parts Assembling Machines

The illustration shows a battery of machines designed and built by the Berggren & Pearson Machine Co., New York City, for assembling the bursting box for the contact detonator of 3-in. Russian shells. The battery consists of six machines, so arranged that the two opposite machines assemble the same parts in the bursting box and are driven with the same belt. The machines are all mounted on a table 12 ft. long by 30 in. wide, leaving ample room between the operators for loading and unloading the trucks, which are rolled up to the assembling table.



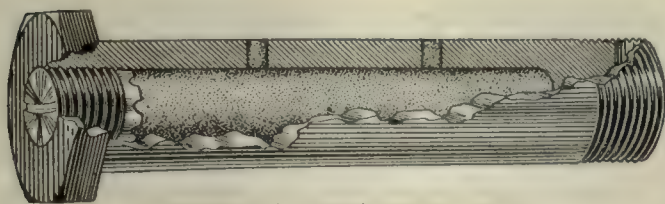
AMMUNITION-PARTS ASSEMBLING MACHINE

Automatic Lubricating Bolt

While intended primarily for use as a spring shackle bolt in automobile construction, the bolt shown can be adapted to all kinds of mechanism where moving parts are held by bolts.

The lubricating features of the device consist of a main reservoir wick of felt that is positively attached to a threaded cap plug and one or more feed or filter wicks. The reservoir felt when in position in the hollow shackle bolt is under a slight compression that forces all surfaces of the felt against the interior of the bolt. The feed and filter wicks rest against the main reservoir wick and carry

the oil to the bearing by capillary attraction or lamp-wick action. The reservoir wick is made a sucking fit in the hollow bolt and thus for filling of the bolt with oil is made into an efficient oil pump, the cap plug forming a handle for operating. The method of lubricating the bolt is as follows: The reservoir plug is removed and oil put in the bolt with an oil gun or squirt can; the wick is then inserted and worked back and forth like a pump plunger, enough pressure being exerted to force the oil by pressure through the cross-wicks and out to the end of the spring bearing. The wick in this manner becomes saturated with oil. When the wick plug is screwed in place against the bolt head, the reservoir wick is put under compression; automatic lubrication starts and continues until every drop of oil is exhausted from the felt. The marketing



AUTOMATIC LUBRICATING BOLT

of this type of bolt has been taken up by the Brown Co., Syracuse, N. Y., and it will be made in a large variety of sizes.

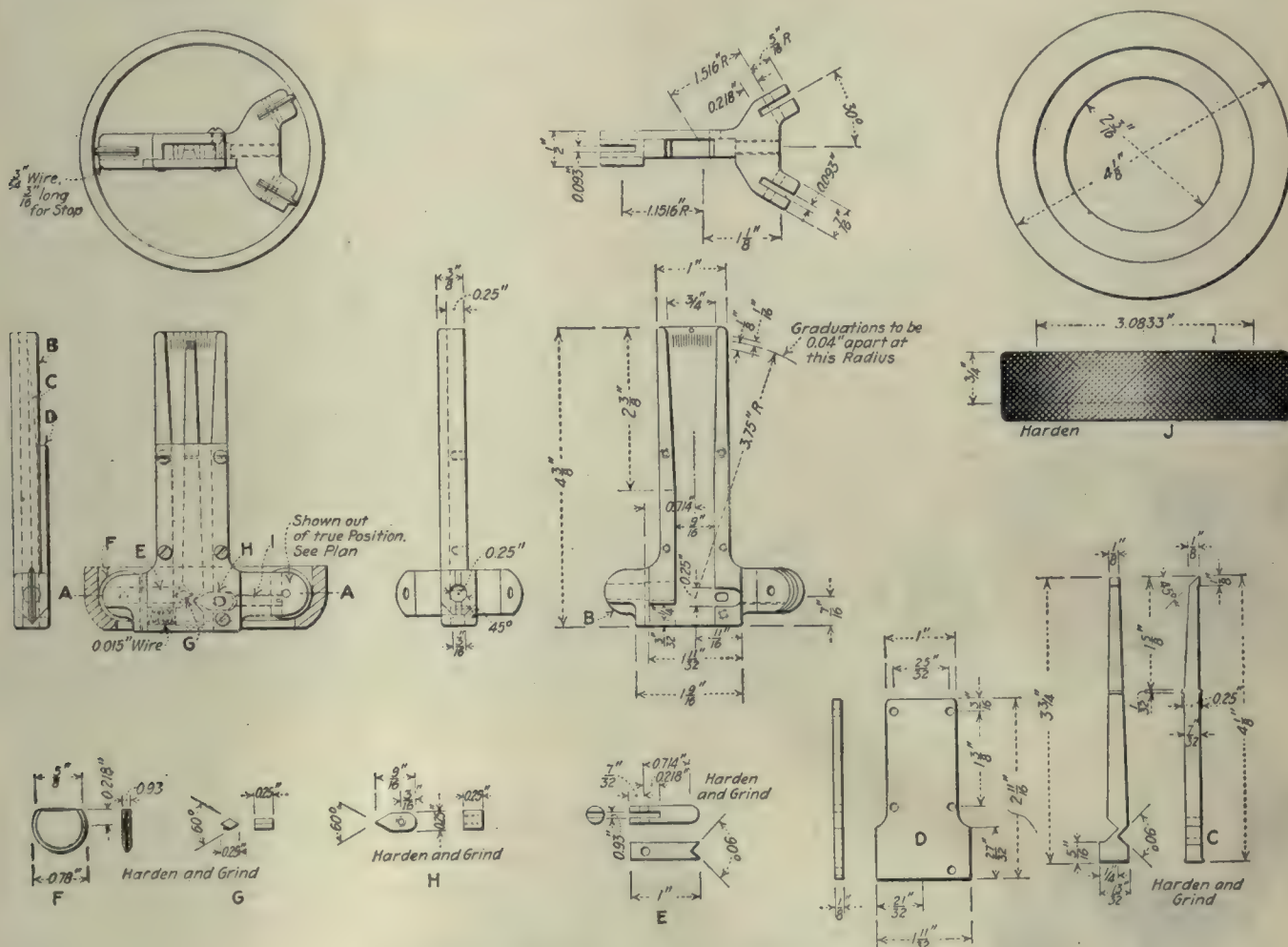
Indicator for Race in Ball-Bearing Cups

BY CHARLES E. HENDRICKS

In the manufacturing of a cup and cone bearing it is necessary that the center to center of radius be accurate. The accompanying sketch shows an indicator designed to

There are two lugs left on the pointer to eliminate friction and still give it a steady motion when in use. An aluminum cover *D* is provided for protection, and its removal gives ready access to the moving parts. The body is machined to serve as a protection also. A sliding pin *E* carries a hardened disk *F* with the diameter made to the size of radius of the ball race in the cup. The pin *E* has a slot in one end to receive the disk and hold it firm. The other end is machined with a V to engage the small diamond *G*, which is made of tool steel and hardened.

This diamond is used for an equalizer and has honed edges that give a sensitive action to the pointer. It engages a stationary pin *II*, with a V milled in one end and drilled to hold the locking screw, which comes through an elongated slot in the body. A screw *I* is inserted in the body at the back of this pin for adjustment. The graduations on the body represent a movement of 0.001 in. of disk. The body can be made of any length to give the graduations the desired spacing. A master ring *J* is made with an inside diameter measuring the sum of the center



INDICATOR FOR RACE IN BALL-BEARING CUPS

withstand hard use, yet to be sensitive and maintain accuracy. The radius in this style of bearing is less than 90 deg., with location at one side of the center line *AA*. This radius is first machined, then ground on oscillating grinders.

The body *B* is made of aluminum, which is firm enough and also light in weight. The pointer *C*, of tool steel, is hardened at the lower end, where the two *V*'s are cut.

to center of the radius and the diameter across the radius, which in this case equals 3.0833 in.

This indicator is now in service and has withstood severe treatment. To test it, I held the body in my hand and hammered on a wooden block, striking on the disk *F*, and did not throw the adjustment out 0.0003 in. This was done to see whether any injury would occur if the indicator was let fall on the floor. It will indicate for the

race being out of round as well as under or over size. This same idea can be applied to other indicators that receive hard usage.

War Importance of Platinum

Soon after the great European conflict began, and Russia, France and England had declared an embargo prohibiting the export of platinum, its price began to soar. From about \$40 per oz. just before the war the price jumped to about \$100 for a short time, but declined in recent months to from \$65 to \$85 per oz.

It is generally known that Russia produces 95 per cent. of the world's supply, which totaled some 300,000 oz. annually before the war, but decreased to 240,000 oz. in 1914 and to a little over 200,000 oz. in 1915. The domestic production of this country is comparatively insignificant, totaling only 400 oz. in 1900 and about 700 oz. in 1915.

It is commonly thought that the great increase in price resulted from the Russian embargo, along with its one-third curtailment of production, the popular idea being that platinum is used mainly in jewelry and electrical machinery with insignificant quantities employed in the chemical laboratory and in the manufacture of chemicals. As a matter of fact, the declaration of war brought the chemical manufacturing business to the highest pinnacle ever attained in its history. And for reasons now to be detailed, the demands upon the chemical industry led to an unprecedented use of platinum.

Platinum in late years has become indispensable in the manufacture of sulphuric acid so necessary in the production of enormous quantities of guncotton—smokeless powder and other high explosives. Some idea of our vast

domestic production is obtained from the fact that in 1915 the United States produced 3,868,150 tons of sulphuric acid, valued at nearly \$30,000,000. Of this amount, 1,056,830 tons, having a value of \$7,042,126, was produced as a byproduct at copper and zinc smelteries. While formerly the bulk of the acid production was made in the well-known lead-chamber process, in recent years the so-called contact process, employing platinum as a catalytic agent, has revolutionized the industry.

While the catalytic property of platinum was discovered in 1831 by Peregrine Phillips, an Englishman, it remained for Germans in recent years to seize upon the idea of utilizing it in sulphuric-acid manufacture and build up an immense and extremely profitable business. Today, the contact process is known and used in all countries. It consists simply in passing a mixture of SO_2 gas and air over finely divided platinum heated to about 450 deg. C. In contact with this hot platinum the oxygen of the air unites with the SO_2 , forming SO_3 in long crystalline fibers, which readily dissolve in water to form sulphuric acid.

Shop Health Supervision

The ill health of a workman dead-weights his earning power and mars his life; restricts industrial production and profits; retards national progress and prosperity. Intelligent health supervision strikes at the very root of this enormous, baneful waste. Every employer should therefore establish some method for keeping his workmen in good health. If he had only one employee, it would pay to look after the health of that one.—*The Spirit of Caution.*

Personals

O. W. Cook, works manager of the Canadian Cartridge Co., Hamilton, Ont., Canada, was recently appointed manager of the entire organization.

W. E. Schaeffer, until recently works manager of the Duluth Corrugating and Roofing Co., has become general superintendent of the Racine Mfg. Co., Racine, Wis.

Carl H. Schmidt, formerly connected with the Chicago branch of the Manning, Maxwell & Moore Co., has taken charge of the machinery sales division of the Dale-Brewster Machinery Co., Chicago, Ill.

Robert S. Alter, vice-president, American Tool Works Co., Cincinnati, Ohio, has just returned from a seven weeks' trip through the Pacific Coast section after having made a thorough investigation of business conditions in that territory.

C. A. Goodspeed has become factory manager of the Nelson-Blank Manufacturing Co., Detroit, Mich. Mr. Goodspeed was formerly manager of the Goodspeed-Detroit Manufacturing Co., and more recently connected with the Timken-Detroit Axle Co.

Harold Lomas, for over 13 years a member of the sales department of the Crocker-Wheeler Co., was killed on July 1 in the British drive, Fricourt, France. Mr. Lomas served the Crocker-Wheeler Co. as manager of its Denver office and also as manager of its Baltimore office. At the time of his death he was holding the rank of first lieutenant in the 20th Manchester Regiment.

Trade Catalogs

Block Gages. Wismuch & Ibsen, Milwaukee, Wis. Bulletin; pp. 4, 8½x11 in.; illustrated.

Centrifugal Pumps. Pelton Water Wheel Co., San Francisco, Calif. Bulletin No. 9; pp. 4, 6x9 in.; illustrated.

Hand Milling Machine. Standard Engineering Works, Pawtucket, R. I. Bulletin No. 12; pp. 8, 6½x9½ in.; illustrated.

Dayton Swaging Machine. The Excelsior Needle Co., Torrington, Conn. Catalog; pp. 30, 6x9 in. This catalog describes these swaging machines and contains data on the art of swaging.

Machine Tool Controllers. The Cutler-Hammer Manufacturing Co., Milwaukee, Wis. Folder; pp. 8, 8½x12 in. This folder, which was distributed at the recent annual convention of the master car builders, shows the application of the controllers to various machine tools.

Gun Taps. Greenfield Tap and Die Corporation, Greenfield, Mass. Catalog; pp. 12, 6x9 in.; illustrated. In addition to an illustrated description of this new tap designed to be especially effective in deep hole tapping, this catalog furnishes some engineering data on tap breakage.

Arc Welding Equipment. Westinghouse Electric and Manufacturing Co., E. Pittsburgh, Penn. Special Publication No. 7064. Pp. 8; 8½x11 in. This publication is entitled "Cut Your Repair Costs with a Westinghouse Arc Welding Equipment" and shows various applications of such apparatus.

Business Items

The New Britain Machine Co., New Britain, Conn., has opened an office at 812 Engineers Bldg., Cleveland. D. W. Patten, manager.

Brown & Sharpe Manufacturing Co., Providence, R. I., has opened an office at Room 2538 Henry W. Oliver Building, Pittsburgh, Penn. J. F. Lyon, representative.

The Brown Instrument Co., Philadelphia, Penn., has opened a branch office in the Chamber of Commerce Building, Detroit, Mich. William Printz, formerly assistant sales manager, will be in charge of the new office.

The Dale-Brewster Machinery Co., 547 West Washington Blvd., Chicago, Ill., has been formed to succeed Horne, Dale & Brown Co. The capital stock of the new concern has been increased to \$50,000 from \$5,000 capitalization of the old company. It will specialize in the sale of machine tools, small tools, and will carry in stock a full line of machine-shop equipment. J. J. Dale is president and William Brewster, formerly Chicago manager for the Bausch Machine Tool Co., is secretary and treasurer.

Forthcoming Meetings

American Foundrymen's Association and American Institute of Metals. Annual meeting, Sept. 11-16, Cleveland, Ohio. A. O. Backert, secretary, American Foundrymen's Association, Cleveland, Ohio.

National Machine Tool Builders' Association. Annual convention, Oct. 24-25, Hotel Astor, New York City. Charles E. Hildreth, general manager, Worcester, Mass.

American Society of Mechanical Engineers. Monthly meeting, first Tuesday. Calvin W. Rice, secretary, 29 West 39th St., New York City.

Boston Branch National Metal Trades Association. Monthly meeting on first Wednesday of each month, Young's Hotel. W. W. Poole, secretary, 40 Central St., Boston, Mass.

Providence Association of Mechanical Engineers. Monthly meeting, fourth Wednesday of each month. J. A. Brooks, secretary, Brown University, Providence, R. I.

New England Foundrymen's Association. Regular meeting, second Wednesday of each month, Exchange Club, Boston, Mass. Fred F. Stockwell, 205 Broadway, Cambridgeport, Mass.

Engineers' Society of Western Pennsylvania. Monthly meeting, third Tuesday; section meeting, first Tuesday. Elmer K. Hiles, secretary, Oliver Building, Pittsburgh, Penn.

Rochester Society of Technical Draftsmen. Monthly meeting, last Thursday. O. L. Angevine, Jr., secretary, 857 Genesee St., Rochester, N. Y.

Superintendents' and Foremen's Club of Cleveland. Monthly meeting, third Saturday. Philip Frankel, secretary, 310 New England Building, Cleveland, Ohio.

Western Society of Engineers. Chicago, Ill. Regular meeting, first Wednesday evening of each month, excepting July and August. J. H. Warder, secretary, 1785 Monadnock Block, Chicago, Ill.

Philadelphia Foundrymen's Association. Meetings first Wednesday of each month, Manufacturers' Club, Philadelphia, Penn. Howard Evans, secretary, Pier 45 North, Philadelphia, Penn.

Technical League of America. Regular meeting, second Friday of each month. Oscar S. Teale, secretary, 35 Broadway, New York, N. Y.

Machine Shops on the United States Repair Ship "Prometheus"

By FRANK A. STANLEY

SYNOPSIS—The machine tools on this ship are located in one main shop and two galleries, between which travels an overhead crane. There are over 50 tools in the equipment, including lathes up to 72-in. swing, vertical boring mill up to 6 ft., radial drill of 48-in. capacity and a complete line of standard equipment—all of which is driven by individual motors for each tool.

In an earlier article descriptive of the United States naval repair ship, the floating shop "Prometheus," illustrations were presented showing the positions of the differ-

ent general surroundings as to floor, bench and wall space, the provision for storing and hanging chucks, faceplates, steadyrests and appurtenances of other kinds, a considerable number of photographs have been taken in the machine department. Illustrations, reproduced herewith, along with floor plans, or rather deck plans, with the complete layout and position of the tools, give an excellent idea of the general arrangement in relation to the equipment and other details.

The machine shop proper on this ship, located a little forward of amidship on the lower platform deck, occupies a space about 51x51 ft. On the deck above, there are two galleries 16 ft. wide, which run the full length of the main

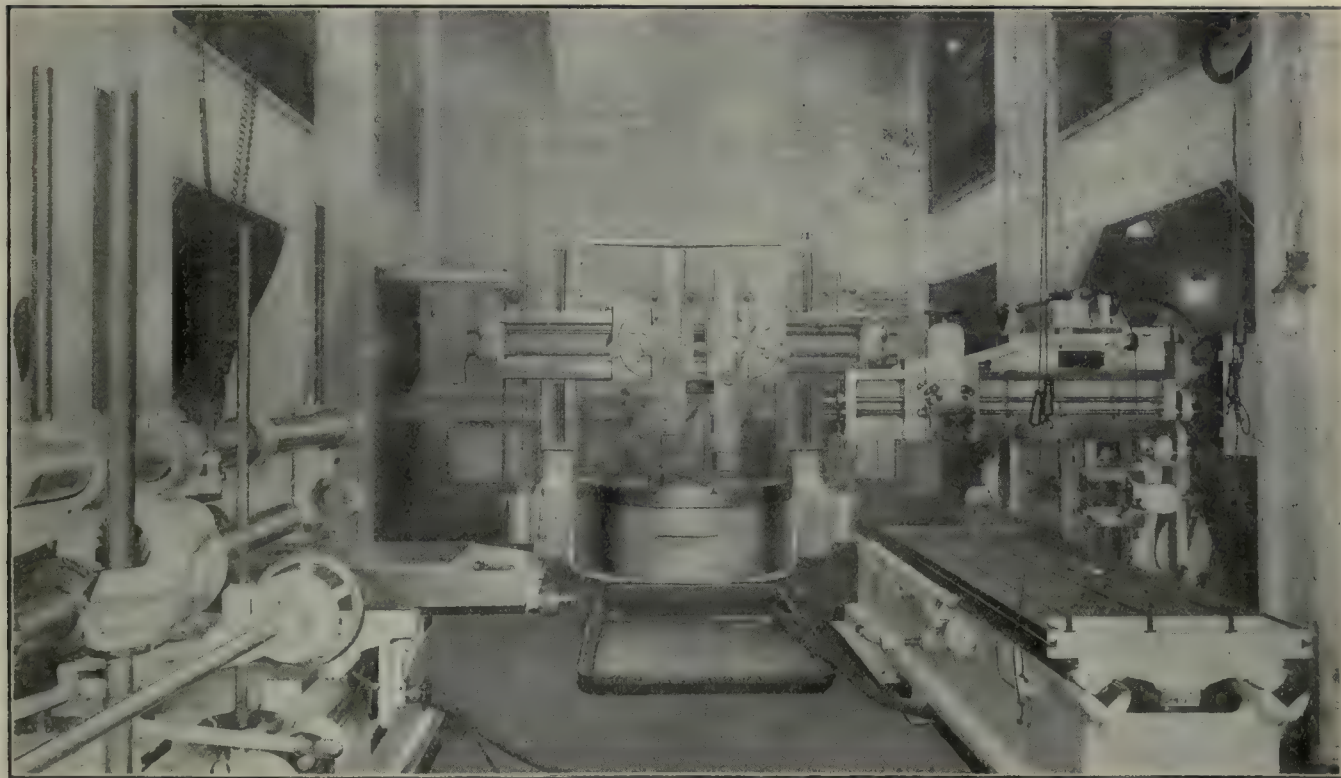


FIG. 1. MACHINE SHOP OF UNITED STATES REPAIR SHIP "PROMETHEUS"

ent machine departments in the ship's structure and giving a fair idea of the proportions of these mechanical departments, as compared with the rest of the vessel. It was at that time pointed out that the ship was fitted up with a machine-tool equipment valued at over \$56,000 and with equipment in the other departments, such as the pattern shop, foundry, forge and boiler shop, copper shop and so on, which would give a total for metal and wood-working machinery exceeding \$77,000. All of this machinery was installed with the direct purpose of handling at sea any and all repair jobs that may be necessary for any ship in the fleet to which the "Prometheus" is attached.

In order to give an adequate idea of the organization of these departments on board the repair ship after the installation of machinery, the character of equipment used, the

shop, with a traveling-crane runway between them. The shops having a position a little forward of amidship, as pointed out, are not exactly rectangular in form, the deck or floor area sloping inward slightly, forward, so that the true area of the main shop is approximately 2,500 sq. ft. A connecting gallery between the two machine galleries extends across the forward end, thus forming a sort of bridge across the main shop itself.

Two views on this deck, showing the arrangement of some of the heavy tools, are presented in Figs. 1 and 2. The third view, taken from the gallery, showing the tools under one of the side bays on the lower deck and the traveling crane spanning the open space between the galleries, is presented in Fig. 3. The fourth view, in the same department, taken under the opposite or starboard gallery, is shown in Fig. 4. These tools are all of fairly good size,

and their locations, together with the positions of other machines, are given on the deck plan, Fig. 5. Fig. 6, similarly, shows the tools on the galleries.

The placing of machine tools in a repair ship brings in not only the problem of fitting a considerable number of machines into a limited area, as a deck space, but what is an equally important consideration, the one responsible for the installation must keep always in mind the conditions as to pitch and roll to which the vessel is to be subjected under varying conditions of wind and weather. Where possible, the tools are located longitudinally, or athwart ships, according to what seems likely to be the best position for the proper operation of these tools when the ship is not resting upon an even keel. It is not pretended by anyone that there is sufficient definite knowledge upon the action in rough weather of

the ship's structure; nor is it definitely known just what the exact workshop limitations are in reference to rough weather, or what will be the worst possible weather in which, say, a grinder may be operated with entire satisfaction, or whether a lathe or planer may be kept in motion with satisfactory results while the tool is gyrating through

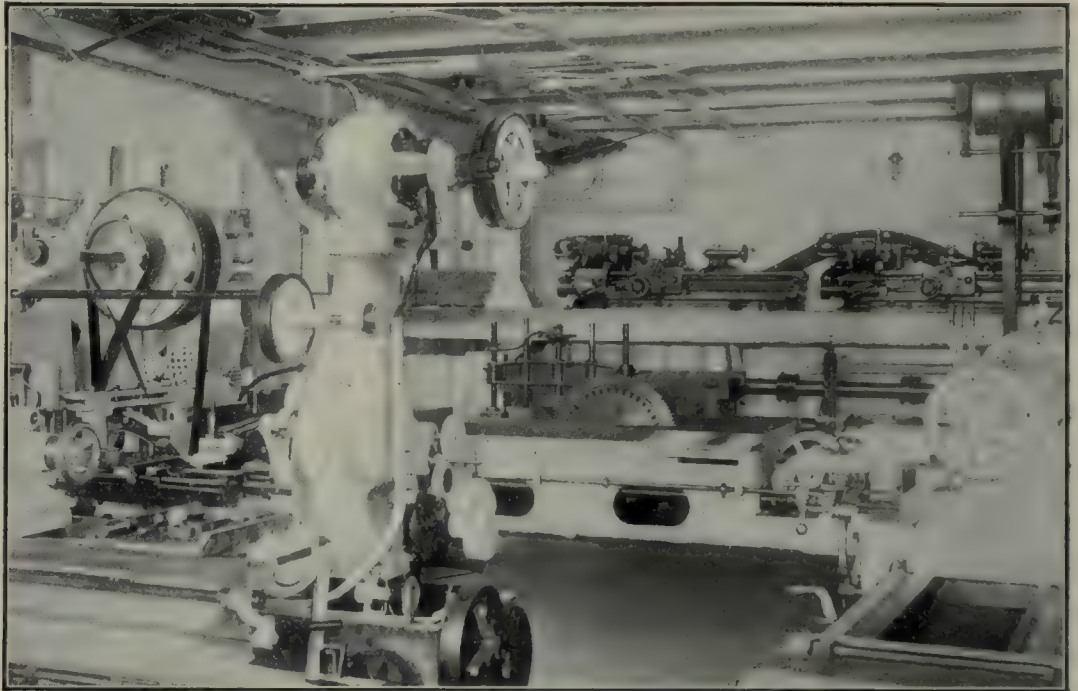
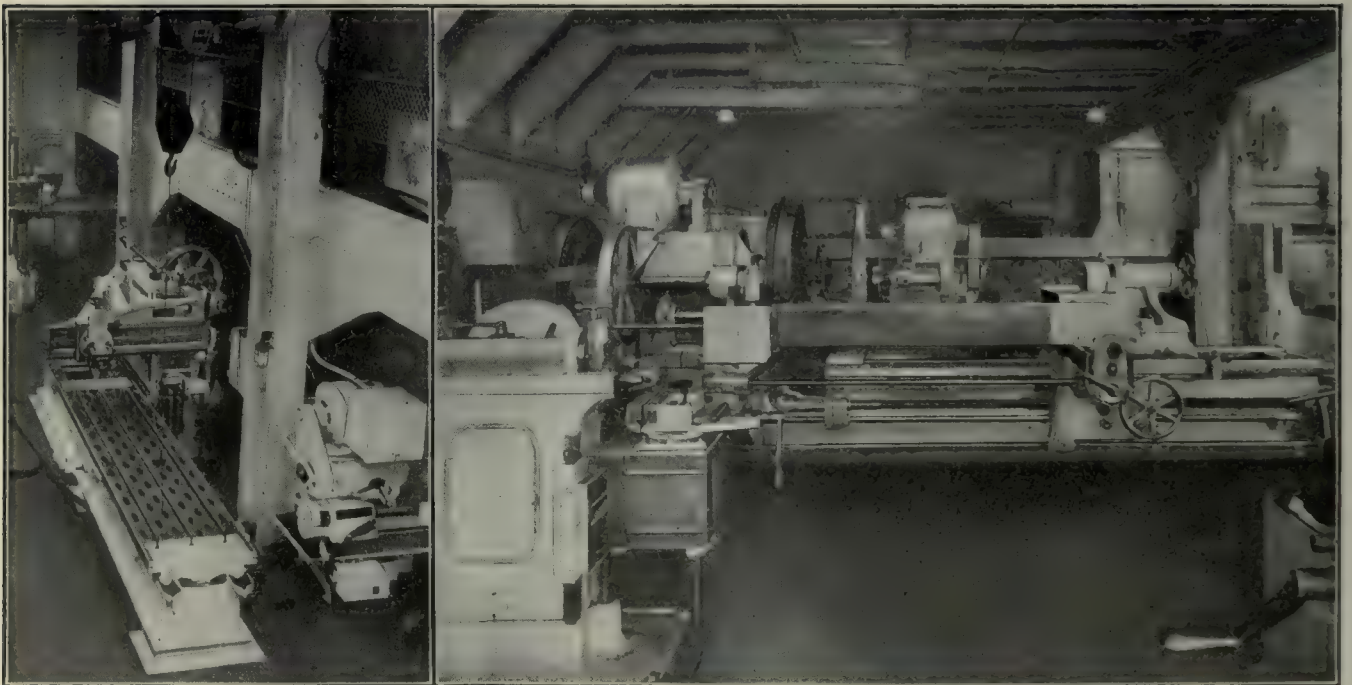


FIG. 2. ANOTHER VIEW OF MACHINE SHOP



FIGS. 3 AND 4. VIEW FROM GALLERY OF MACHINE SHOP

lathes, planers, boring mills and millers, to enable one to say offhand just which way a certain tool should stand, which way its platen should travel, what deviation may be expected, if any, from desired results, due to possible pitch and plunge of the ship, what disturbance in the work may be caused by vibration and the throb of the deck, due to the pounding of the sea and the consequent spring of

varying angles up to 30 or 35 deg. from the vertical, producing a peculiar set of conditions not only for the moving parts of the machine itself, but for the mechanic who is undertaking to do the work under these conditions. With the expansion of repair work afloat in our navy and with the consequent opportunities to study actual working conditions of machine tools on board ship under all sorts of

conditions, it is anticipated that some interesting and important data will develop.

One noteworthy point has been well established by the operation of tools afloat. It has been axiomatic in machine-tool manufacture that tools must stand upon a level foundation—that is, they must be level so far as their

From what has been said in explanation of the use of machine tools at sea, where a good deal of rough weather is always likely to be encountered, it is doubtful if such tools will be apt to be used in anything like a level position or with vertical surfaces at any time in a vertical plane. This refers of course to the times when the repair

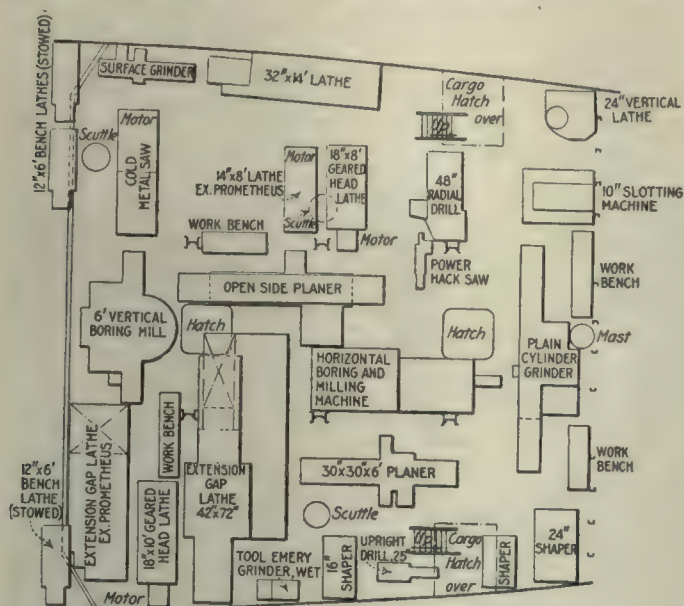


FIG. 5. LOWER-DECK PLAN WITH LOCATION OF TOOLS
IN MACHINE SHOP

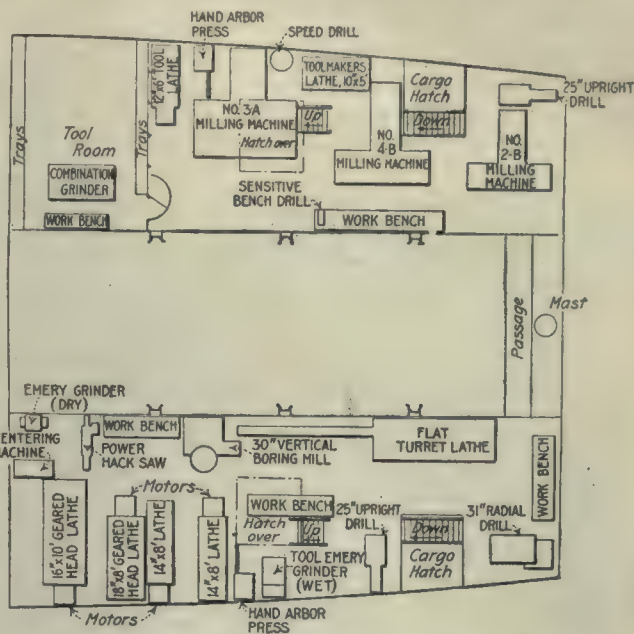


FIG. 6. GALLERIES PLAN WITH LOCATION OF TOOLS
IN MACHINE SHOP

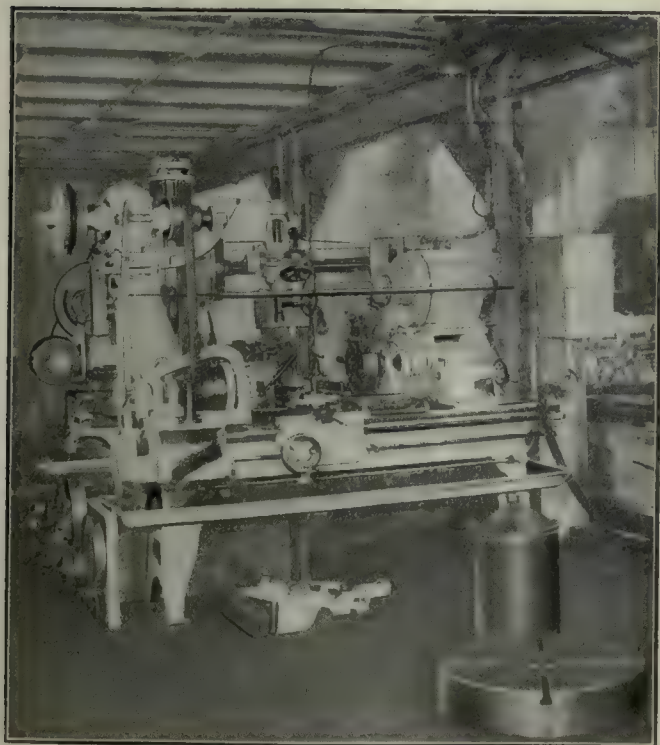


FIG. 7. VIEW UNDER ONE OF THE GALLERIES

working surfaces, such as shears and sliding bearing surfaces, are concerned. Later on, particularly in reference to such machines as the miller and still later the grinder, the idea of self-contained tools became conspicuous, and it eventually developed that such self-contained tools on a three-point bearing, so to speak, could be installed almost anywhere, no matter what the floor conditions were.

ship is not in still water at a naval base, where it is the intention to handle as much of the repair work as possible. Yet it is believed that probably not much difference in results may be expected between these tools afloat and the same tools ashore, assuming that the same materials are worked under the same conditions aside from stability.

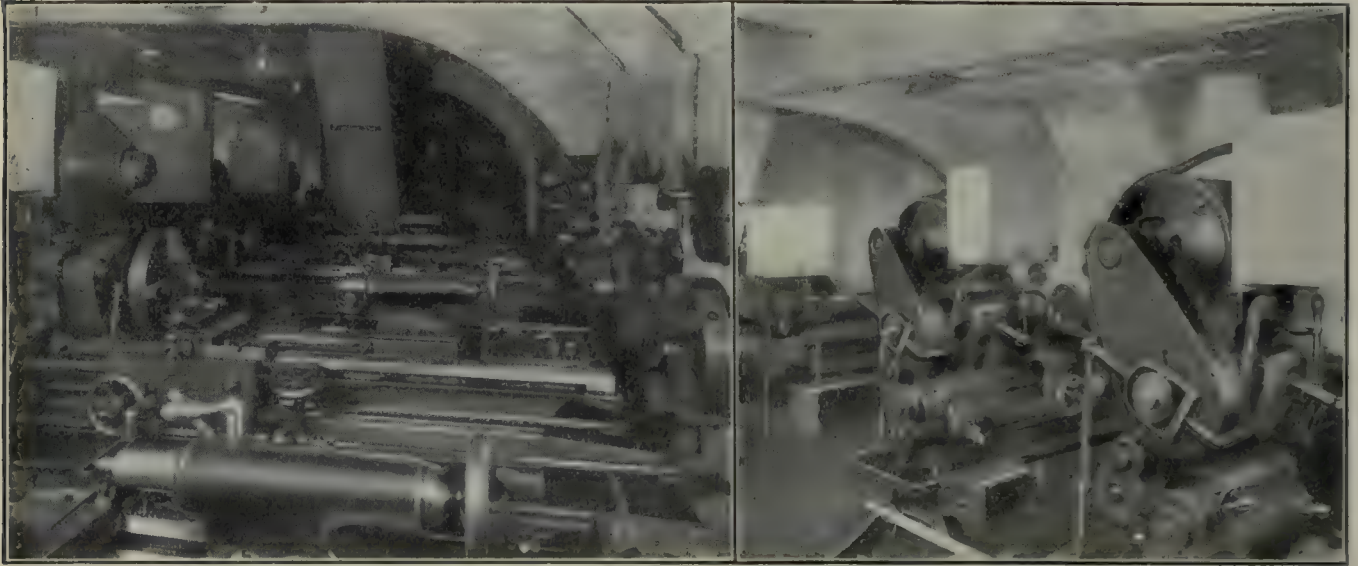
Anyone who has in rough weather undertaken for the first time to run a lathe, a shaper, miller, drilling machine, boring mill or planer, with the floor, or rather the ship's deck, rising and plunging, swinging and swaying in all directions, will find that at first he has to exercise considerable care to avoid falling against or away from the machine, sliding into benches or colliding with material that may fall off the machine—all this, assuming he is not so seasick as to make it impossible for him to stay below at all. It is nevertheless surprising how quickly one becomes accustomed to the swaying action of the shop deck and to the gyrations of the tools under operation. It is precisely like synchronizing oneself with the movements of a horse when one is riding horseback or becoming a part of an automobile when driving a car—that is, one becomes accustomed to feeling himself part of the moving object, part of the motor he is driving or part of the lathe which he has under operation. He swings with the roll of the machine; and if he does not glance about too often to notice objects whose movements do not correspond with those of the machine immediately in front of him, he eventually forgets that there is any special motion of the ship itself, except possibly when some tool falls on the floor to arouse him to the fact that he is no longer ashore.

Right in this connection it should be pointed out that every possible precaution should be and is taken on the repair ship "Prometheus" to take care that in rough weather lathe chucks, steadyrests, pipe centers, miller

vises and other appurtenances of various character do not fall from their supports to the deck, where they might slide around and injure the workmen as well as damage themselves. With this object in view, suitable wall supports have been provided, so that with the machine-tool attachments properly gripped on their wooden pegs or hung on their hooks there is little likelihood of their dropping to the deck.

However, one must always be more or less alert, to prevent cutting tools and the like from slipping off the lathes and trays. It is an easy matter when running a lathe in a shop to pile up the tray with cutting tools, calipers and

machine. In Fig. 2 a heavy coldsaw cutting-off machine is shown in the background, a 32-in. engine lathe at the right, a 16-in. and 18-in. lathe in the immediate foreground a little to the left of the center. Upon the bulkhead girders at the rear of the shop will be noticed two tool makers' lathes stowed away for emergency purposes, though not required as part of the present equipment of the ship. Fig. 3, which illustrates the arrangement of shop and galleries and shows the position of the overhead crane, also shows under one of the galleries the head end of an 18-in. motor-driven lathe. Fig. 4, taken under the opposite, or port, gallery, shows a 42x72-in. extension gap



FIGS. 8 AND 9. BATTERY OF LATHES IN STARBOARD GALLERY

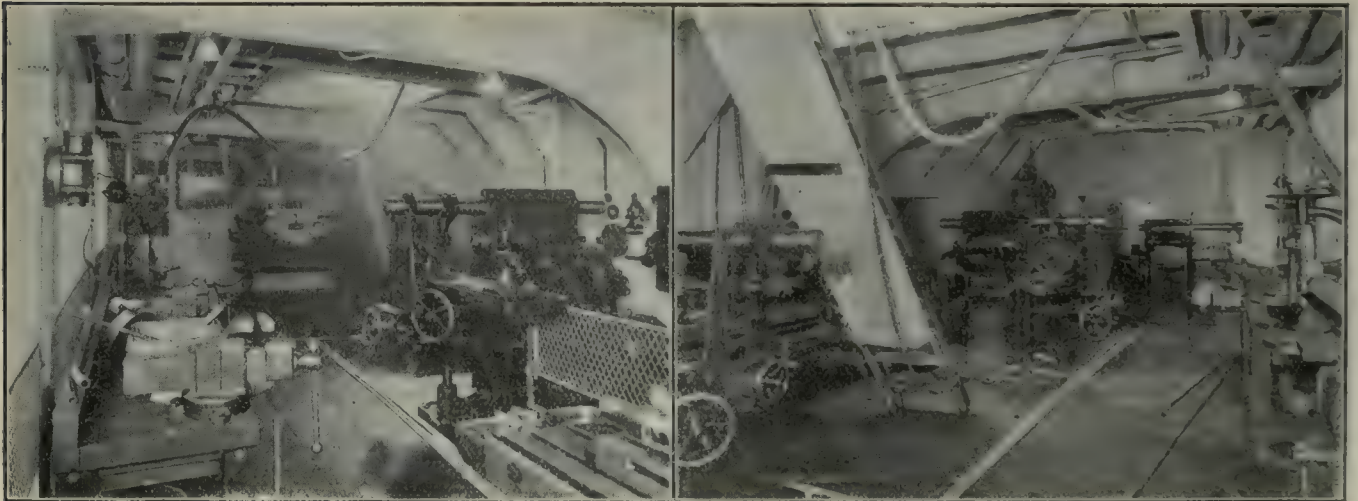


FIG. 10. PORT GALLERY WITH TOOLROOM AT FAR END

FIG. 11. MILLERS AND DRILLS ON THE PORT GALLERY

so on, and the first thing one knows several of these tools slip off to the floor, usually doing little damage. On the steel deck of a ship it is not always so pleasant to have these tools drop. These possibilities themselves soon teach the workmen to take pains that tools do not accumulate upon the trays to such an extent as to be liable to be thrown off with any ordinary roll of the ship.

Referring again to Figs. 1, 2, 3 and 4, the machine in the background of the first view is a 6-ft. vertical boring and turning mill; the one at the right, a 36-in. open-side planer; the one at the left, a horizontal boring and milling

lathe, the largest lathe on the ship. In the foreground of this view is a 16-in. shaper.

The positions of these tools in the main shop on the lower deck are all brought out in Fig. 5, and each is indicated by size and name. Several other tools on the galleries, starboard and port, are represented in their respective positions in Fig. 6, and the photographs that follow illustrate some of these tools set up in working position.

Fig. 7 is a view taken under the port gallery, showing still another pair of 18-in. lathes. Like each of the other

illustrations, it brings out certain features in the design of the driving equipment, such as the motor installation, connection with the spindle, means of controlling the motor speed, special conduits through which the wiring is carried to the motors, boxes for motor starters, switches, conveniences for suspending chucks, faceplates, steadyrests and the like. In fact, each photograph is intended to bring out some special features of installation in an un-



FIG. 12. LATHE JOB UNDER WAY ON PORT GALLERY SHOWING METHOD OF CARRYING ATTACHMENTS

usual place, where each unit of space is of importance and where everything must be secured "shipshape" in order to prevent injury to itself or to workmen.

ADEQUATE CONTROL FEATURES

Each of these tools on the main deck, like all the tools on the gallery, has an independent motor drive. In most cases these are variable-speed motors, and in fact in all instances the switches are inclosed in the steel box attached to the front of the machine head, convenient to the operator, yet out of the way so far as the floor is concerned. The character of the controlling apparatus attached commonly to the front of the lathe bed varies somewhat with the size and type of machine driven by the motor.

In certain instances a continuous shift rod is used, extended from headstock to footstock of the machine and sufficiently high to clear the work and yet admit of being easily reached by the workman. In other cases a handwheel, large or small, is attached to the starter-box spindle for controlling the forward and reverse speeds, the starting and stopping. Which method is more convenient depends a good deal upon the personal experiences of the operator. In any event each machine is adequately and conveniently equipped in so far as driving apparatus goes and so far as concerns the actual controlling medium for starting, stopping and reversing.

A battery of 18-in. and 16-in. geared-head motor-driven lathes on the starboard gallery is shown in Figs. 8 and 9, which illustrate clearly the mode of mounting motors in-

closing gears, carrying the connections through conduits, etc. These views also illustrate the methods of controlling the motor drive and speed from the handwheels upon the carriage. Still further, they bring out clearly the manner of inclosing the starting apparatus in sheet-metal boxes at the front of the heads, just above the motors, and also illustrate the supports on the inner wall of the ship for mounting chucks, faceplates, large pipe centers and the like.

An inspection of Fig. 8 in particular will show how carefully details have been worked out to see that none of these lathe attachments shall be permitted to fall to the floor under any conditions of weather. The faceplates, instead of being slid over a simple support, have in addition two hook bolts that turn into slots in their faces, making it impossible for them to slide forward until these bolts are turned out of the way. Generally, chucks are slipped over wooden pegs of large diameter, on to which the jaws are set tight to grip them and make it impossible for the chuck to come away from the plate when the ship rolls. The pipe centers rest with their shanks in holes drilled in supporting brackets, which cannot give way, and lighter faceplates and chucks hang up on hook bolts with sufficient length of upturned end to make it impossible for the supported members to drop.

OTHER MACHINES AND OTHER EQUIPMENT

Figs. 10 and 11 are views on the port gallery, showing principally several millers of various sizes with tool lathes, bench drills, etc. These photographs also give a clear idea of the ship's structure in so far as it affects the machine installation in the department, the method of supporting pipe, conduits, hose, and the shop's ladder, which takes the place of the conventional stairway in the machine shop ashore. The method of supporting miller attachments in the open girders for their storage when out of use is seen in these illustrations, and in Fig. 10 in the background will be noticed the entrance to and some of the equipment of the toolroom.

Fig. 12, which is still another view on the port gallery, shows even more clearly the method of supporting faceplates, chucks, steadyrests and other tools on a wall board at the back of the lathe. In this lathe a handwheel for the operation of a valve is being finished, with the final cut across the wheel under way. The machine is a tool maker's 10-in. lathe, and the appurtenances are of course light enough so that they can be hung at a good height above and back of the machine. Ordinarily such appliances for lathes as big as 18 to 20 in. and larger must be suspended at a more convenient spot, nearer the deck, where they can be easily reached for removal and replacement.

Among other interesting tools not shown in the photograph may be mentioned a large plain cylindrical grinder, which stands under the forward gallery crosswise of the ship, a flat-turret lathe on the gallery, several shapers, millers, radial and vertical drilling machines of various sizes, a centering machine for bar stock, a slotting machine, a 24-in. vertical lathe, emery tool grinders, arbor presses, bench lathes, drill grinders and other auxiliary small tools.

As already pointed out, each of these machines is clearly shown in its established position on the lower deck and on the machine-shop gallery by the plan views in Figs. 5 and 6.

Jigs for Motor-Truck Parts

BY ROBERT MAWSON

SYNOPSIS—In this article are shown some jigs used in machining some of the details for motor trucks. These tools are of modern design and incorporate the latest ideas in jig design. They are provided with quick-acting devices and are designed to enable the parts to be placed in them easily and conveniently.

On page 364 were described some tools used by the International Motor Co., Mack Plant, Allentown, Penn., for machining elements used in building automobile-truck motors. In this article are described other tools used.

The jig for drilling the rear-spring clamping plate is provided with a latch fitted with a spring. After the casting has been placed in the tool, being located by adjustable screws, the cover is dropped down, and a knob-headed screw holds the casting in position. The brake-lever jig has a sliding V-block that forces the casting into a fixed V-block that locates the upper end.

The jig for the front-spring shackle is fitted with steel locating surfaces. The milled forging is slid between these locating surfaces, and two straps hold it securely in position. For making the steering gear and radiator bracket the jig is designed with adjustable locating screws, against which a knob-headed screw forces the part.

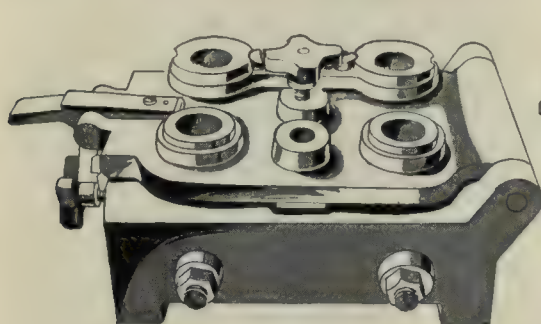


FIG. 2

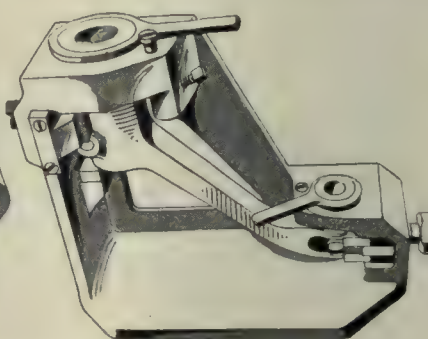


FIG. 4

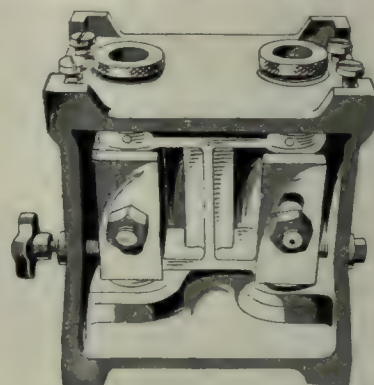


FIG. 6

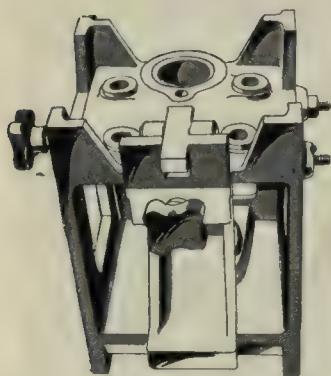


FIG. 8

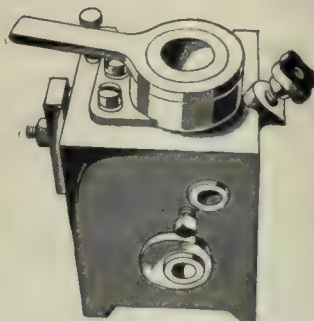


FIG. 10

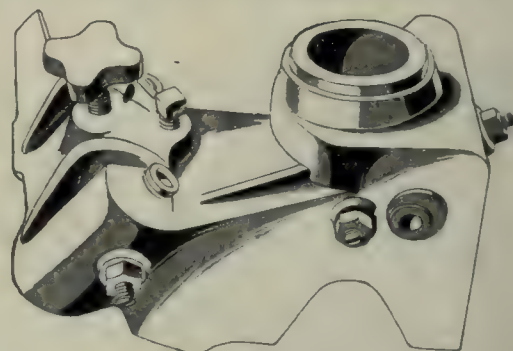


FIG. 12

JIGS USED IN MACHINING TRUCK PARTS WITH WORK SHOWN IN POSITION

FIGS. 2 AND 2-A

Operation—Drilling rear-spring clamping plate, Fig. 1. The rough casting is located against adjustable screws, a knob screw forcing the part against them. The cover is dropped down, and another knob screw holds the pieces securely in the jig.

Holes Machined—Four $1\frac{1}{2}$ -in. drilled.

FIGS. 4 AND 4-A

Operation—Drilling and reaming brake lever, Fig. 3. The rough casting is slid into the V-block at the upper end, and the knob-headed screw at the lower end of the jig forces another V-block against the casting, thus locating it. A setscrew at the upper end of the jig assists in holding the part securely.

Holes Machined—One $\frac{3}{8}$ -in. drilled and then 1-in. reamed; one $1\frac{5}{8}$ -in. drilled and then $1\frac{1}{2}$ -in. reamed.

FIGS. 6 AND 6-A

Operation—Drilling and reaming front-spring shackle, Fig. 5. The part is located by machined surfaces in the jig. The end location is obtained by a knob-headed screw forcing the part against an adjustable screw. Two straps are tightened against the piece to hold it in position.

Holes Machined—Four $\frac{3}{8}$ -in. drilled and then 1-in. reamed.

FIGS. 8 AND 8-A

Operation—Drilling and reaming service-brake frame bracket, Fig. 7. The machined casting is slid into the jig, and the correct position is obtained by forcing it against adjustable screws with a knob-headed screw. The cover is then dropped down, and another knob-headed screw holds the casting in position.

Holes Machined—One $1\frac{1}{8}$ -in. drilled and then $1\frac{1}{2}$ -in. reamed; four $\frac{1}{2}$ -in. drilled.

FIGS. 10 AND 10-A

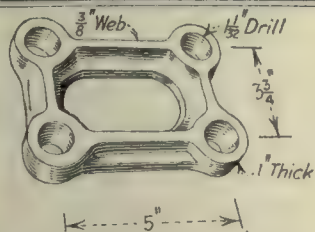
Operation—Drilling and reaming gear-shifter rod yoke, Fig. 9. The forging is located by a tongue that fits into the milled slot. Setscrews are tightened against the part to force it into position and hold it.

Holes Machined—One $\frac{5}{8}$ -in. spot-drilled and reamed; one $\frac{3}{8}$ -in. drilled; one $1\frac{7}{8}$ -in. drilled and then $1\frac{1}{2}$ -in. reamed.

FIGS. 12 AND 12-A

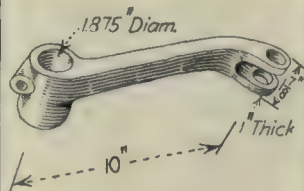
Operation—Boring and drilling steering gear and radiator bracket, Fig. 11. The rough casting is located against an adjustable screw. A knob-headed screw forces it against the screws and holds it. A screw through a swinging latch also assists in holding the casting.

Holes Machined—One $2\frac{1}{8}$ -in. bored; two $\frac{1}{2}$ -in. drilled; one $\frac{1}{2}$ -in. drilled.



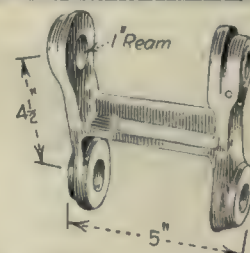
CAST STEEL,
4 POUNDS
REAR-SPRING CLAMPING PLATE

FIG. 1



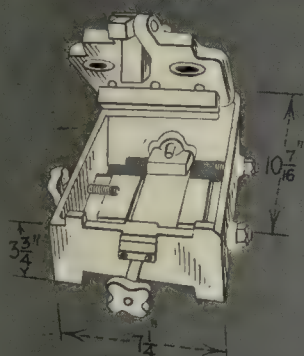
CAST STEEL,
7 1/4 POUNDS
BRAKE LEVER

FIG. 3



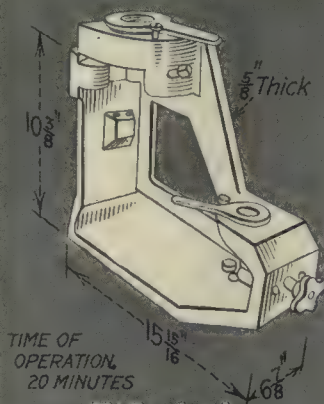
OPEN-HEARTH STEEL, 4 POUNDS
FRONT-SPRING SHACKLE

FIG. 5



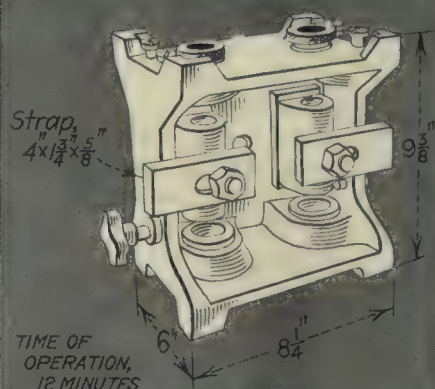
TIME OF OPERATION, 15 MINUTES

FIG. 2-A



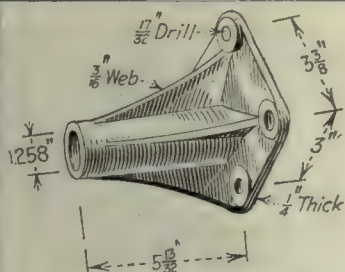
TIME OF OPERATION,
20 MINUTES

FIG. 4-A



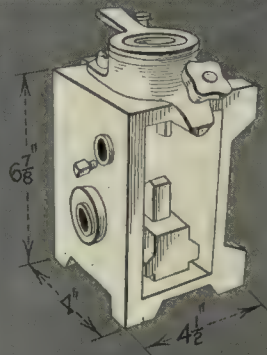
TIME OF OPERATION,
12 MINUTES

FIG. 6-A



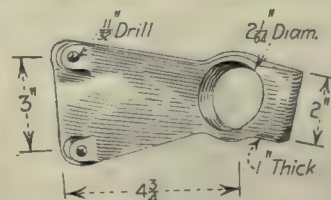
STEEL CASTING, 5 1/2 POUNDS
SERVICE-BRAKE FRAME BRACKET

FIG. 7



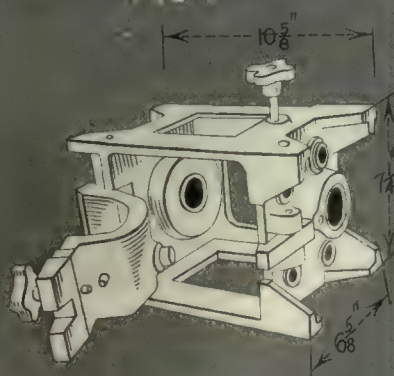
TIME OF OPERATION, 10 MINUTES

FIG. 10-A



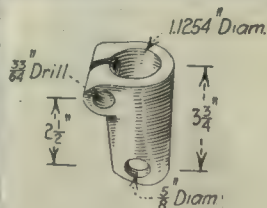
MALLEABLE IRON,
2 1/2 POUNDS
**STEERING GEAR AND
RADIATOR BRACKET**

FIG. 11



TIME OF OPERATION, 15 MINUTES

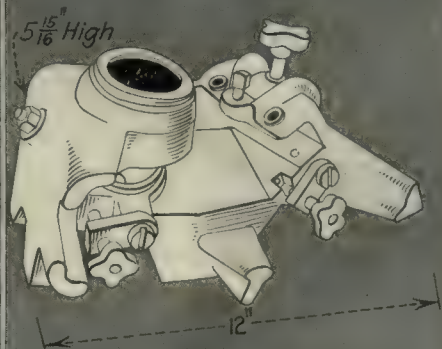
FIG. 8-A



OPEN-HEARTH STEEL,
1 POUND

**GEAR-SHIFTER
ROD YOKE**

FIG. 9



TIME OF OPERATION, 6 MINUTES

FIG. 12-A

ALL BUSHINGS USED FOR GUIDING TOOLS ARE BLACKENED. ALL JIG AND FIXTURE BODIES ARE CAST IRON, STRAPS AND FASTENINGS, MACHINERY STEEL; GUIDE BUSHINGS ARE TOOL STEEL, HARDENED AND GROUND

Making a Spiral Form Cutter

By WILLIAM A. HAWES

The forming cutter shown in Fig. 1 and the method used to manufacture it should prove interesting. It is designed to be used on aluminum.

If this tool were to be held and fed into the work in the usual way—the center of the forming tool parallel to the center of the work—one side of the cutter would drag. To prevent this dragging of the cutter the tool is tipped—that is, bolted to a 5-deg. (angle of spiral) angle plate—bringing the sides of the cutter square to the work.

A suitable piece of steel is cut off, and the largest diameter, length and bore roughed within $\frac{1}{16}$ in. of the finished size and carefully annealed. The hole and all turning not spiral are then finished. Next, the gap or cutout is completed, bringing the work to the shape shown in Fig. 2. As will readily be seen, this gap had to be finished before the spiral turning could be done, as the lathe tool could not be kept to the work for a whole revolution. There was too much stock to remove to turn the whole shape with a reverse form tool, so the only special turning tool used is one to make the 0.160-in.

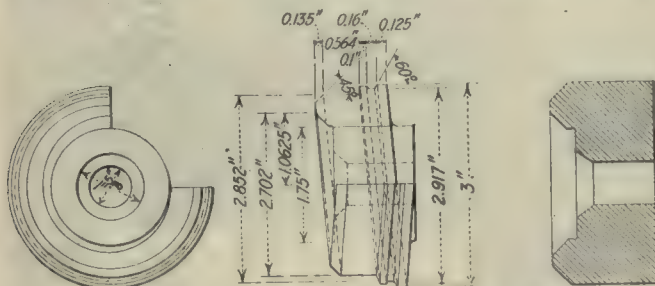


Fig. 1

Fig. 2

MAKING A SPIRAL FORM CUTTER

slot with the 90- and 60-deg. sides. The spiral turning is begun on the left end of the work. The compound rest is set at 90 deg., parallel with the cross-slide, and the cross-slide is brought forward to the same position to a stop. All cuts and the successive advances into the work are made by the compound screw, the tool approaching the work from the left, the spiral being left hand.

In this same manner the 45-deg. angle is finished, and also the diameter, 2.917 in. In finishing the 0.564-in. long surface, running the cross-slide in and out is not sure enough for good, smooth cuts, so the lathe has to be stopped when the tool reaches the gap and the carriage taken back by hand a proper distance to "pick up the thread." The advance, as before, is made by the compound rest now set parallel with the lathe. The indicator is used for each new setting of the rest to insure accuracy. The inner or under angle at the 45-deg. end of the tool not being spiral, it is finished before the spiral turning is begun. The side face between the two angles at the extreme left of the drawing varies in width, as shown by the involute curve in the end view.

The utmost care having been exercised in making the tool, extraordinary caution is called for to avoid spoiling the tool in the fire. The following "old-fashioned" method, which has been used in hardening extra-hazardous pieces for over 25 years, is successful.

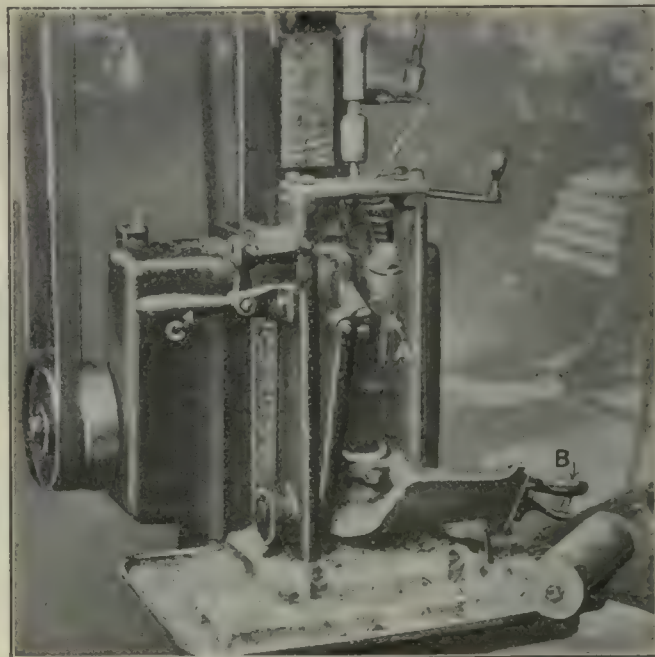
A large charcoal fire is made on a common blacksmith's forge. A block of iron is heated red hot. The piece to be hardened is then gradually drawn on this

block (the same as drawing the temper), first to a light straw, then deeper and deeper, until the piece is black.

This is to prevent shrinkage strains caused by heating too quickly at some point in the fire. A cave is now made in the heated charcoal, the blast shut off entirely and the piece to be hardened placed in this cavity. The fire should be of a sufficient size to retain enough heat to bring the piece to a proper temperature without renewing the blast. If a piece the size of this forming cutter reaches a proper heat in less than 15 min. the fire is too hot for the best results. The work after being properly heated is plunged into clean, cold water, kept immersed until black, then withdrawn from the water and plunged into oil. When taken out of the water the piece should still be too hot to handle with bare hands, but not hot enough to boil water. This condition can be ascertained by touching the work with the forefinger. The work is "drawn" a little on the same iron block to about boiling point and then cooled off in the oil, after which it may be polished and drawn to the color desired, or it may be tempered to a prescribed degree by more scientific methods.

A Centering Fixture

A fixture for centering the closed end of 3-in. shells is used in the shop of the Dayton Pipe Coupling Co., Dayton, Ohio. As shown, the holding mandrel has three steel pieces like A which are moved outward by means of an internal taper pin operated by the hand lever B. As can be seen, this lever works the expanding pin through a yoke and collar to which the lower end of the expander



A SHELL-CENTERING FIXTURE

is pinned. The lever is locked in holding position by a dog and ratchet close to the handle.

After the shell has been slipped down over the mandrel and locked central, the mandrel and bracket are pushed back so as to bring the center plug on the shell under the jig bushing. It is locked in this position by a latch pin operated by the lever C. The centering plugs on the shells are of course first ground square on the end.

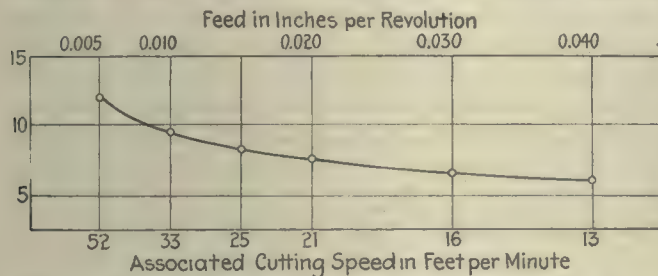
Cutting Speeds and Feeds

By W. A. KNIGHT*

SYNOPSIS—A careful study of experimental data in regard to cutting speeds, with particular reference to screw-machine work. Several simple formulas that seem to check well with the results of tests are given. The suggestion is offered to establish an index of cutting speeds for steels, making the figure for a specified screw stock 100.

In what follows there is no addition to the experimental data on the subject of cutting speeds. Rather is it a critical examination of the work of Taylor, Nicholson, Ripper and other investigators, with a view of harmonizing their results and putting them if possible in a more workable form.

On some of the more important laws governing the cutting of metals, there seems to be, taking account of



RELATIVE TIME OF TURNING WITH FEEDS FROM 0.005 TO 0.04 IN. PER REVOLUTION AND CUTTING SPEEDS

their different methods of investigation, a substantial agreement. On others there is some difference of opinion and further work of an experimental or observational character is needed to establish the truth or falsity of the various views. It is believed, however, that full advantage is not taken by the average shop man of those laws which may be said to have been fully established.

To illustrate: All investigators agree that high cutting speed is always associated with light cuts and low cutting speed with heavy cuts, and that the output of a tool increases with the area of cut.

The output of a tool is here defined (after Prof. William Ripper) as the number of cubic inches of metal removed during the standard life of the tool. It is not the number of cubic inches removed in a unit time, neither is it the amount of metal that it is possible to remove with a tool regardless of time. The cutting speed, feed and depth of cut may be such that a lathe tool would last three days, or the speed might be increased to such an extent that the tool would last but five minutes. In the first case, the tool would remove a great quantity of metal; in the second case, metal would be removed at a very high rate. Neither would be a measure of the output of the tool. The output must be the amount of metal removed during the standard life of the tool.

This standard life will be given consideration further on; suffice now to say that for an ordinary lathe tool on roughing work, it is from 60 to 90 min. It may

be for a reamer 50 to 100 hr., or for a box tool on turret lathe work anywhere from 1 hr. up. The important thing now is that the output of a tool increases with the area of cut.

Before proceeding with the illustration, it may be well to again digress and define the term "associated cutting speed." This term, also due to Ripper, is a happy choice of expression. It is that speed which for any given combination of depth of cut and feed will give a standard life to the tool. If the standard life of a lathe tool is found to be 90 min., then for whatever depth of cut and feed used the speed should be so adjusted that the tool would last 90 min. This would be the associated cutting speed for the given depth of cut and feed.

Consider now the effect on the output of say a screw machine or a bank of screw machines by increasing the feed. With a feed of 0.005 in. the associated cutting speed is 52 ft. per min. With a feed of 0.01 in. the speed drops to 33 ft. per min., while for 0.02 in. the associated cutting speed is further reduced to 21 ft. per min. These, of course, are only relative figures. Shall we use a feed of 0.005 in. with its associated cutting speed of 52 ft. per min., or 0.02 in. with its associated speed of 21 ft.? Either case implies the same life of tool and hence same cost of tool upkeep.

The answer is given in Fig. 1, in which the relation between feed, speed and time of getting out a certain piece is shown graphically.

It will be seen that with a cutting speed of 52 ft. per min. and feed of 0.005 in., the time of getting the piece out is 12 min. Increasing the feed to 0.01 in. with a reduction of speed to 33 ft. per min. reduces the time from 12 to 9 min. This would represent a gain in output of 33 per cent., but the actual gain would be greater than this because this increased output would be secured with the same overhead or machine rate as with the lesser output.

A further reference to Fig. 1 shows that if it were possible to increase the feed to 0.04 in., with its associated speed of 13 ft., the time would be reduced to 6 min. or the output doubled. In fact there is no limit to the reduction in time except as the strength of tool, strength of work, chip clearance or finish limits the area of cut that can be taken.

The increase in output has here been considered from the standpoint of increasing the feed alone, having in mind that class of screw-machine work where heavy reduction is the rule, but a greater proportionate rate of increase is to be obtained by increasing the depth of cut.

That the output increases with the area of cut is not a law in itself, rather is it a corollary to the law that the cutting speed varies inversely as the cube root of the thickness of chip squared.

This law, first determined by Taylor in 1906 (see Folder 16, Art of Cutting Metals), derived independently by E. G. Herbert in 1909 (*American Machinist*, Vol. 32, Part 1, page 1063) and verified for high-speed tools on steel, by Dr. Ripper in his experiments at Sheffield in 1913, is one of the most important and far-reaching

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laws of the cutting of metals. It will not tell for a given combination of depth of cut and feed, what speed to use, but having once obtained satisfactory results as to life of tool with the given combination and associated speed, it will tell whether or not the combination is the best.

This law has been shown by Taylor to hold exactly for lathe tools having a straight line cutting edge and practically so for tools with a radius of point of as much as $\frac{1}{4}$ in. Thus it is applicable to a large proportion of screw-machine work. It has never been demonstrated that it holds for drills and milling cutters, but there is reason to believe that it does. If so, the same gain can be made in drilling and milling, by increasing the feed, as in the case of lathe work.

The law will not determine the initial cutting speed, but it furnishes a powerful means of analysis for determining whether or not a given bank of screw machines, drilling or milling machines are working at their most productive rate. Further it indicates that drills and drilling machines should be designed for the greatest possible feed.

A DRILLING MACHINE EXAMPLE

One more example of this: Shop A in drilling a medium grade of steel is running a 1-in. drill at 240 r.p.m. and using a feed of 0.01 in. Shop B is drilling the same material, running the drill at 310 r.p.m., with a feed of 0.006 in. Assuming that drill A is doing satisfactory work, with a reasonable life or time between grindings, the first investigation shows that drill B should be running 336 r.p.m. instead of 310. For by the cubic law,

$$V_a = \frac{K}{\sqrt[3]{F_a^2}}$$

and

$$V_b = \frac{K}{\sqrt[3]{F_b^2}}$$

K is constant depending on material, tool and lubrication and, since these are assumed to be alike,

$$V_a \sqrt[3]{F_a^2} = V_b \sqrt[3]{F_b^2}$$

or

$$V_a = V_b \sqrt[3]{\left(\frac{F_a}{F_b}\right)^2}$$

hence

$$V_a = 240 \sqrt[3]{\left(\frac{0.01}{0.006}\right)^2} = 336$$

The second analysis shows that even if the drill of shop B be speeded up to the indicated speed of 336 r.p.m., shop A will still be doing 13.4 per cent. more work with 28 per cent. less speed. With the same life of tool T , or time between grindings, the output of A = $K_1 V_a F_a T$ and the output of B = $K_1 V_b F_b T$. Here K is the area of a 1-in. circle and T , 120 min. the same for both A and B.

Hence the output of A is to that of B as $V_a F_a$ is to $V_b F_b$ or as 240×0.01 ($= 24.0$) is to $336 \times 0.006 = 21.1$.

DEPTH OF CUT AS AFFECTING CUTTING SPEED

As affecting the cutting speed with a change in the depth of cut, Dr. Nicholson concluded that it was the same as that due to a change in the feed—that is, de-

pended on the area of cut alone and that for all practical purposes the relation could be expressed by $V = \frac{K}{(FD)^{\frac{1}{n}}}$,

in which for high-speed steel on steel $\frac{1}{n} = \frac{1}{2}$.

Professor Ripper found the same to be practically true for carbon tools, for the range of depth of cut and feeds which he used, but for high-speed steel tools his results

followed closely the law that $V = \frac{K}{\sqrt[3]{D \times F^2}}$.

From his experiments Taylor determined that for straight edge cutting tool $V = \frac{K}{D^{\frac{1}{2}}}$, for soft steel, but that the exponent of D increased with the radius of tool point, reaching a value 0.496 or practically $\frac{1}{2}$ in. for a radius of $\frac{1}{32}$ in. In passing then from a straight edge cutting tool or one having a small radius of point to one of large radius, the cutting speed varies inversely as from somewhat less than the cube root to the square root of the depth.

With every change in the radius of point there is, for each change in depth of cut or feed, a different effect on the thickness of chip, length of cutting edge and direction in which the chip tends to bend and slide over the top surface of the tool. So it is not to be wondered at that a change in the radius of point introduces many uncertain factors. It was no doubt these disturbing effects that led to Taylor's complicated expression for cutting speed, namely:

$$V = \frac{C \left(1 - \frac{8}{7(32r)^2}\right)}{F^{\left(\frac{2}{5} + \frac{212}{5 + 32r}\right)} \times \left(\frac{48}{32r} D\right)^{\left(\frac{1}{15} + .06 \sqrt{32r}\right)} + \frac{0.8(32r)}{6(32r) + 48D}}$$

From a practical point of view this expression is discouraging. Furthermore it may be pointed out here that

TABLE 1. COMPARISON OF TAYLOR'S RESULTS WITH CALCULATIONS FROM EQUATION $V = \frac{4.68}{F^{\frac{1}{2}} DF^{\frac{1}{2}}}$ FOR $\frac{1}{4}$ -IN. TOOL

Cut, Depth and Feed, Inches	$V = \frac{4.68}{F^{\frac{1}{2}} DF^{\frac{1}{2}}}$ Cutting Speed, Feet per Minute	Taylor Experimental, Cutting Speed, Feet per Minute	Taylor Calculated, Cutting Speed, Feet per Minute
$\frac{1}{16} \times 0.015$	176.6	174.5	175.9
$\frac{1}{16} \times 0.026$	122.0	119.0	122.0
$\frac{1}{16} \times 0.035$	98.3	98.0	100.1
$\frac{1}{16} \times 0.0458$	83.8	86.0	83.7
$\frac{1}{16} \times 0.0592$	70.7	70.0	70.6
$\frac{1}{16} \times 0.0244$	111.0	111.0	111.3
$\frac{1}{16} \times 0.0255$	108.0	115.0	108.0
$\frac{1}{16} \times 0.033$	91.0	99.0	91.0
$\frac{1}{16} \times 0.046$	73.0	73.0	73.0
$\frac{1}{16} \times 0.014$	141.0	141.0	142.1
$\frac{1}{16} \times 0.020$	111.0	111.0	112.1
$\frac{1}{16} \times 0.026$	91.0	95.0	94.2
$\frac{1}{16} \times 0.0318$	81.5	82.0	82.4
$\frac{1}{16} \times 0.0435$	66.0	65.0	66.9
$\frac{1}{16} \times 0.046$	63.6	60.0	64.4
$\frac{1}{16} \times 0.0265$	52.0	50.0	52.5

it has the anomalous property of giving, for a heavy depth of cut and light feed, a lower cutting speed for larger tool. Thus the calculated cutting speed for a cut of $\frac{1}{4}$ -in. depth by $\frac{1}{64}$ -in. feed is greater for a $\frac{5}{8}$ -in. tool than for a 1-in. tool.

It can be shown that for tools up to $\frac{7}{8}$ -in., or $\frac{9}{32}$ -in. radius of point, the much simpler expression $V =$

$\frac{K}{\sqrt[3]{D \times F^2}}$ gives values as close if not closer than Taylor's more complicated expression. For larger tools with larger nose radius the equation does not seem to hold.

From experimental data, given in Folder No. 18, "Art of Cutting Metals," for $\frac{1}{2}$ -in. and $\frac{7}{8}$ -in. tools, Tables 1 and 2 have been constructed. With one or two exceptions, the calculated values are remarkably close to those obtained by experiment.

TABLE 2. COMPARISON OF TAYLOR'S RESULTS WITH CALCULATIONS FROM EQUATION $V = \frac{K}{T^{.75} DF^{.25}}$ FOR $\frac{1}{2}$ -IN. TOOL.

Cut, Depth and Feed, Inches	$V = \frac{6.27}{T^{.75} DF^{.25}}$ Cutting Speed, Feet per Minute	Taylor Experimental, Cutting Speed, Feet per Minute	Taylor Calculated, Cutting Speed, Feet per Minute
$\frac{1}{16} \times \frac{1}{16}$	100.0	103.0	99.7
$\frac{1}{16} \times \frac{1}{8}$	63.5	65.5	68.1
$\frac{1}{16} \times \frac{1}{4}$	48.0	47.0	54.5
$\frac{1}{16} \times \frac{1}{2}$	39.0	42.0	45.3
$\frac{1}{8} \times \frac{1}{16}$	49.0	72.0	73.6
$\frac{1}{8} \times \frac{1}{8}$	38.0	48.8	50.3
$\frac{1}{8} \times \frac{1}{4}$	28.8	40.0	41.2
$\frac{1}{8} \times \frac{1}{2}$	20.0	30.0	31.9
$\frac{1}{4} \times \frac{1}{16}$	43.0	45.0	42.0
$\frac{1}{4} \times \frac{1}{8}$	34.0	35.0	33.7
$\frac{1}{4} \times \frac{1}{4}$	26.5	26.6	25.8
$\frac{1}{4} \times \frac{1}{2}$	20.0	20.0	19.4
$\frac{1}{2} \times \frac{1}{16}$	30.4	30.8	29.8
$\frac{1}{2} \times \frac{1}{8}$	23.0	23.0	22.4
$\frac{1}{2} \times \frac{1}{4}$	17.0	17.0	16.4
$\frac{1}{2} \times \frac{1}{2}$	13.0	13.0	12.4

It appears then that the law that cutting speed varies inversely as the cube root of the feed squared and inversely as the cube root of the depth of cut is fairly well established.

The effect on output due to an increase of feed alone has been considered. If the area of cut be increased by increasing the depth of cut, the gain is relatively greater. For by doubling the feed, the cutting speed is reduced in the ratio of 158 to 100, while the output is increased in the proportion of 158 to 200. By doubling the depth of cut the speed is reduced as 126 to 100 while the output is increased as 126 to 200.

STANDARD LIFE OF TOOL AND CUTTING SPEED

The relation between the cutting speed and the life of the tool as determined by Taylor is $V = \frac{K}{T^{.75}}$. Here

K is a constant depending on the material, tool and other factors and T is the life of the tool in minutes.

From his experiments Ripper deduced that $V = \frac{K}{T^{.75}}$.

Since $T^{.75}$ is intermediate between these two values and lends itself so much more readily to computation, it is

proposed to write $V = \frac{K}{T^{.75}}$ as the average relation between cutting speed and life of tool.

This equation tells us what is already well known, that the higher the associated cutting speed the shorter the life of the tool. The standard life of a tool then means simply the length of the time we can afford to run it between grindings or replacement.

It is Taylor's life for the most economical cutting speed. It would not be mentioned here but for the conviction that it furnishes the only logical basis for the comparison of the output of tools—not for test conditions, but for everyday shop conditions wherever the quantity of work of a kind is sufficient to justify the collection of the necessary data to make use of it.

It is a complex quantity depending on the original cost of the tool, proportion of this cost used up for each grinding, cost of grinding, time of changing tools, machine operators' rate and on overhead or machine rate.

Taylor's method was to convert all cost attending the grinding of a tool to an equivalent time of the machine operator. He failed, however, to take into account the

machine rate which is also an important factor in the cost of production.

Calling this time equivalent of cost per grinding t , and T the working life of the tool, its efficiency may

be represented by $\frac{T}{T+t}$ and this times the cutting speed

gives the rate at which the tool does work, or $r = V \left(\frac{T}{T+t} \right)$. But $V = \frac{K}{T^{.75}}$, therefore $r = \frac{K T^{.25}}{T+t}$. Differ-

entiating this $\frac{dr}{dT} = \frac{K[(T+t)^{.25} T^{-.75} - T^{.25}]}{T^2 + 2Tt + t^2}$.

Setting this equal to 0 and solving for T gives $T = 9t$. Hence the most economical or what has been called the standard life of a tool should be 9 times the time equivalent of the cost per grinding.

This time equivalent may be made up of a single item or a number of items, and care should be exercised in giving it a fairly correct value. An example or two will probably be agreeable.

A FEW ILLUSTRATIVE EXAMPLES

An operator on a turret lathe is paid 40c. per hour and the machine rate is 30c. He is using a solid reamer which does not permit of regrinding and hence when worn below the allowable limits of size must be replaced by a new one.

The reamer cost \$6, which is the equivalent of $\frac{600 \times 60}{40 + 30} = 514$ min. of the time of operator and machine rate.

The life of the reamer should then be $\frac{9 \times 514}{60} = 77$ hr.

Again suppose this reamer were an adjustable one and cost \$12. Further that it could be adjusted 6 times before being worn out, but it required 2 hr. of the time of a toolmaker at 50c. per hr. to effect the adjustment. With every adjustment \$2 worth of the reamer would be used up and the cost of adjustment \$1. Hence the

time equivalent $t = \frac{(200 + 100) 60}{40 + 30} = 259$ min. The

life between adjustments should therefore be $\frac{9 \times 259}{60} = 43$ hr.

The objection may be raised that this standard life of a tool is no standard at all, but a variable quantity, that a standard should not be made to depend on the operator's or machine rate. For test purposes any convenient standard may be adopted, but no one can tell what the maximum output of a tool is, or what it should be, without taking into account what its normal life should be and this depends on the conditions under which it is worked.

Numerous drill tests have been reported in the *American Machinist* in which drills have been made to penetrate metal at the rate of 10, 15 or 20 in. per min. While such tests have a certain value in showing that one drill may be better than another, they are absolutely worthless as showing the real output of the drill or what it will do under ordinary conditions of service. A drill may be made to penetrate metal at the rate of 20 in. per min., which is at the rate of 100 in. in 5 min., but no one would think of grinding a drill every minute or even every five minutes. Neither would it be fair to compare the output of a drill used in an old time flimsy drill press with the output in a modern rigid high-speed machine.

Furthermore, it is immaterial to A whether B is doing his drilling with a 20c. man or a 50c. man, or whether his machine rate is high or low; the important thing for A to know is whether or not his own drilling is as efficient as it should be and what effect on output will result from any changes he may make. Having determined the proper life of the tool this becomes *his own standard for his own conditions*.

With this as a basis and granting that he keeps track of the time between grindings, he is in position, with the aid of equations $V = \frac{K}{\sqrt[3]{DF^2}}$ and $V = \frac{K}{T_s^{.6}}$, to analyze

his drilling proposition with the utmost exactitude. The same is true of milling or screw-machine work.

It would seem desirable that in all shops where quantity production is the rule to (1) *keep a close record of the time between grindings* of the various tools and (2) *make a fairly accurate estimate of the cost per grinding*.

With these data there need be no guess work as to the effect on output with a change in kind of tool, tool steel, lubricant or material operated upon.

Yet another example of the general character of the analysis which can be made.

We are running screw machines on ordinary cold-drawn screw stock, with a cutting speed of 85 ft. per min., at which speed the tools last an average of 7½ hr. between grindings.

We wish to change and make the same product from chrome-vanadium steel. We guess that a speed of 65 ft. per min. will be about right for the chrome-vanadium and accordingly start with that. It is found that with this speed the tools require grinding every 2½ hr. What should be the speed to have the tools last the same as with the cold-drawn steel? What is the ratio of cutting speed of chrome-vanadium to the cold-drawn screw stock?

$V = \frac{K}{T_s^{.6}}$, therefore $K = VT_s^{.6}$, or $K = 85 \times 450^{.6} = 157$ and

$V_1 = \frac{K}{T_1^{.6}}$, therefore $K_1 = V_1 T_1^{.6}$, or $K_1 = 65 \times 150^{.6} = 107$.

Then the speed on the chrome-vanadium for the tool to last 7½ hr should be $V = \frac{107}{450^{.6}} = 59$ ft. per min.

The ratio of K_1 to K is here the ratio of cutting speed of chrome-vanadium to the ordinary stock or as 107 to 157.

In his consideration of cutting speeds Taylor proposed that all metals be divided into classes according to their cutting speeds and that the classes differ from each other by the common ratio of 1 to 1.1. The cutting speed of class B would be obtained by dividing that of class A by 1.1.

It is here proposed that the cutting speed of cold-drawn screw stock (or if reasons can be advanced, some other steel) be taken as a standard and the cutting speeds of other steels be rated in percentages of this.

The reasons for this is that the working of this steel is more or less familiar to every shop man, and it runs fairly uniform in quality. The unknown would be stated in terms of the known. If it could be said that a nickel steel had a cutting speed of 60 per cent. that of cold-drawn steel, an idea could at once be formed as to its machining qualities. It would also furnish a basis for adjusting speeds, setting rates and figuring costs.

In the previous example of the change from screw stock to chrome-vanadium steel, it was shown how the ratio of cutting speeds could be obtained. The same method can be used wherever a change of material is made, whether the operation be milling, drilling or lathe work. It implies, of course, that the same tools are used for both materials.

Observations of this kind would soon lead to the accumulation of valuable data.

It would be desirable to have some simple test whereby the cutting speed of a metal could be determined, but up to the present no such test has been devised.

From an examination of both Taylor's and Ripper's experimental results, it appears that $V = 600 \frac{\sqrt{E}}{T_s}$ furnishes a fairly reliable index to the cutting speed in terms of the tensile strength T_s in tons and E the percentage of elongation in 2 in. For the softer steels this gives values somewhat higher than is given by Ripper's equation $V = K(65 - T)$ and lower than Taylor's equation

$$V = \frac{105 \left(1 - \frac{215}{(15 + E)^2} \right)}{\sqrt{\frac{S}{10,000} - 3 - 0.9}}$$

The constant 600 in $V = \frac{600 \sqrt{E}}{T_s}$ makes the results comparable with Taylor's standard cut of ⅜-in. depth, ⅛-in. feed for ⅞-in. tool, and furthermore, if we take a rather soft screw stock of 65,000 lb. tensile strength and 30 per cent. elongation, the index of its cutting speed will be 100. Other steels can then be rated in percentages of this.

Table 3 has been prepared to show the comparison of results obtained experimentally with those calculated by the different equations.

TABLE 3. COMPARISON OF CUTTING SPEEDS DETERMINED BY EXPERIMENT AND DEDUCED BY VARIOUS EQUATIONS

Taylor Experiments Recorded In "Art of Cutting Metals" Page	Tensile Strength in Tons per Square Inch	Elongation per Cent. in 2 Inches	Determined Experimentally by Taylor	Cutting Speed		
				By Equation $V = \frac{600 \sqrt{E}}{T_s}$	By Ripper's Equation $V = 2.8 \frac{\sqrt{E}}{(65 - T)}$	By Taylor's Equation $V = \frac{105 \left(1 - \frac{215}{(15 + E)^2} \right)}{\sqrt{\frac{S}{10,000} - 3 - 0.9}}$
				T_s	$(65 - T)$	$\sqrt{\frac{S}{10,000} - 3 - 0.9}$
168.....	59.2	14.0	37.5	37.5	17	38
121.....	52.0	14.0	41.0	41.0	36	43
121.....	51.0	8.0	35.0	33.0	38	35
182.....	48.0	6.0	34.5	30.6	47	33
121.....	48.0	3.0	22.0	21.0	47	21
168.....	36.4	30.0	82.5	89.0	78	80
168.....	28.1	35.5	164.0	123.0	101	135
90.....	24.0	39.0	168.0	156.0	112	221
Experimentally by Ripper						
Ripper.....	27.2	28.4	108.0	118	106	141
Ripper.....	33.5	21.1	90.4	82	88	86
Ripper.....	50.5	12.0	39.0	41	40	42

No data are at hand to show whether the relation between tensile strength, elongation and cutting speed will hold for the alloy steels. The accompanying tabulation

Kind of Steel	Average Tensile Strength, Pounds per Square Inch	Average Elongation in per Cent.	Cutting Speed, Feet per Minute
Gun steel, low carbon.....	70,000	32.5	98
Best grade tool steel.....	100,000	17.5	50
Spring steel.....	105,000	6.5	29
Vanadium, Type D.....	97,500	22.5	58
Nickel barrel steel.....	92,500	22.5	61

shows a comparison of the steel used for making military rifles and serves as an indication, but the results should be verified by observation.

The laws that may be said to have been fairly well established at least for the most common range of work are:

$$(1) \quad V = \frac{K}{\sqrt[3]{DF^2}}$$

$$(2) \quad V = \frac{K}{T^{1/4}}$$

$$(3) \quad T = \frac{K\sqrt{E}}{T_s}$$

$$(4) \quad T = 9t$$

and combining (1) and (3),

$$(5) \quad V = \frac{K\sqrt{E}}{T_s \sqrt[3]{DF^2}}$$

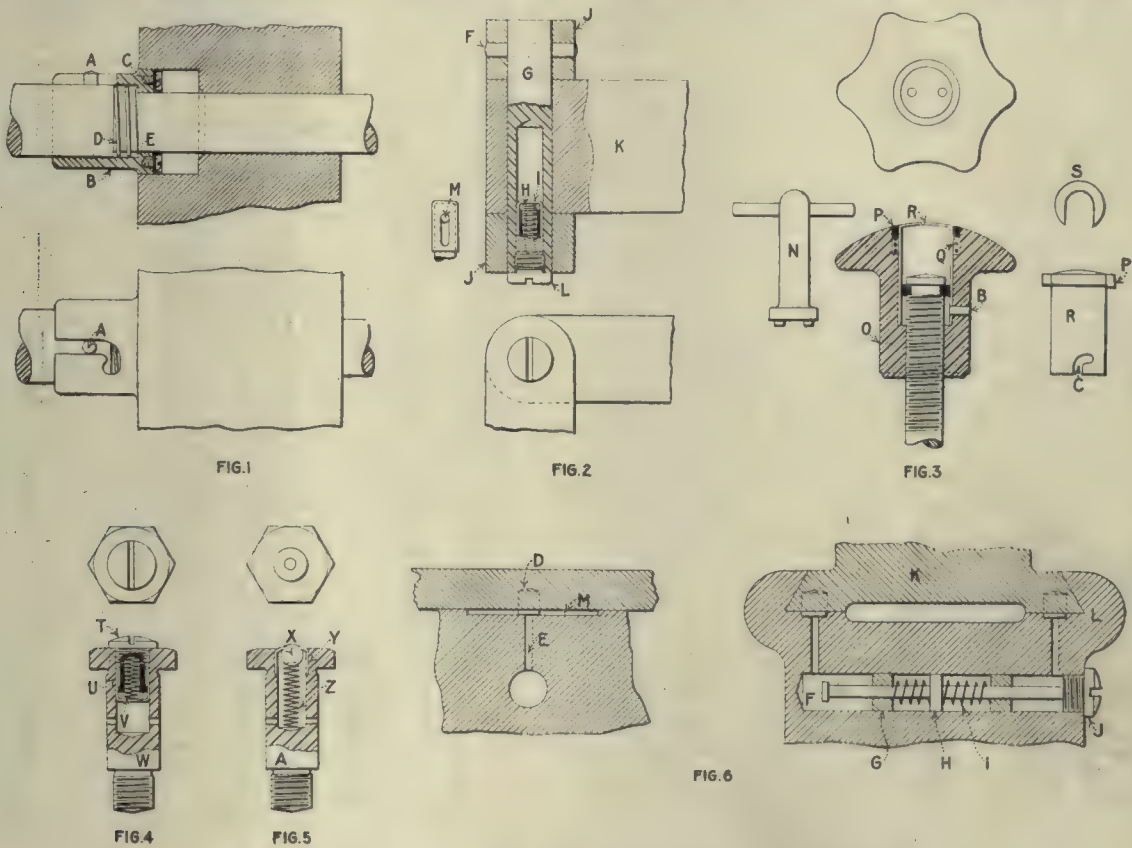
Regarding the constants in these equations, the conditions under which tools work are so varied that it is inadvisable to try and assign definite values. Moreover constants have never been established for drills, milling

Lubricating Devices for Jig and Fixture Parts

By W. BURR BENNETT

The lubrication of jigs and fixtures may seem a little far-fetched, and beyond the scope of the average shop, but when one stops to consider the cost of even the simplest jigs and how much their life may be prolonged by effectively lubricating their wearing parts, the situation becomes more interesting. First of all, in order to apply the following devices, we must assume that the jigs and fixtures are given intelligent care and that they are inspected, cleaned and adjusted daily. This, of course, will provide an opportunity to renew the lubricant. This operation is to be taken out of the hands of the machine men entirely. The lubricating devices shown have been arranged with the "fool-proof" idea uppermost in mind.

Grease is probably the best lubricant, because if correctly fed to the bearings it will force all grit and



LUBRICATING DEVICES FOR JIGS AND FIXTURE PARTS

cutters and many forms of box tools. The work of Taylor and Ripper supplies constants for lathe tools working under the ordinary conditions. Thus for Taylor's standard 1/2-in. tool, the general equation becomes $V =$

$\frac{46\sqrt{E}}{T_s \sqrt[3]{DF^2}}$ and for other sizes the constant can readily be determined.

However, the purpose here has been not to establish fixed constants, but to point out how these few comparatively simple laws may be used for the complete analysis of the output of a tool. As has been pointed out before, the constant for any given case can be determined by the simple expedient of keeping a record of the time between grindings.

foreign matter out and completely fill them. Also, it does not require the care in keeping joints tight that oil does. However, there are exceptional cases where it would seem advisable to use oil.

In Fig. 1 is shown an "accident-proof" grease cup for lubricating the bearing of a shaft where it was not practical to apply the lubricant in any other way. Concerning this application it might be said that the commercial type of grease cup could not be used. Such grease cups are usually unsuited to jig and fixture work, are too delicate, too easy to tamper with and are easily removed. The grease cup in Fig. 1 consists of a plunger ring B which is forced down on the grease in the cavity by means of the spring D. The plunger is provided with a leather cup washer E fastened on with screws C. The pin A

serves to carry the plunger with the shaft when it is rotated and fits in the "bayonet" slot so as to hold the plunger out while the cup is being filled with grease. In this application the shaft was fixed from moving endwise.

In Fig. 2 is shown one method of lubricating the pin in the jig and fixture leaf or hinge plate. The pin *G* is fastened in the body of the jig *J* by the pin *F* so that the bearing is in the plate *K*. The cavity for the grease is a hole drilled along the axis of the pin with a cross-hole drilled at right angles. Pressure is applied to the grease by the spring *H* working against the plunger cup *I*. This cup is carried on the capscrew *L*. The pin *M* that is driven in the side of the capscrew is to limit the motion of the cup *I*.

IMPORTANCE OF KNOB LUBRICATION

In Fig. 3 is shown how the knob or handnut may be lubricated. As every shopman knows, the knob is a part of jigs and fixtures that receives extreme wear, and there is no doubt that its life can be lengthened by good lubrication. In this design the knob *O* is prevented from running off the end of the screw by means of the C-washer *S* that is inserted in the slot or groove in the screw before the cup *R* is latched in place. This is easily done by running the end of the screw out beyond the end of the knob. After the grease cavity is filled the cup *R* is latched in place by means of the pin *B* working in the "bayonet" slot *C*. A collar *P* is soldered or otherwise fastened at the top of the cup *R* and serves as a shoulder for the spring *Q* to press against. The function of the spring is to keep the pin engaged in the slot in the cup. In order to make the lubrication of this knob "fool-proof," a special T-handle wrench *N* for removing the cup is provided. This wrench is only for the use of the man who is to attend to the lubrication. It is made with two short pins in the end which engage in two shallow holes in the top of the cup. By pressing downward and rotating the handle counter-clockwise the cup can be removed.

In Fig. 4 is illustrated the lubrication of a shoulder screw with grease. The grease cavity is a hole drilled along the axis of the screw *W* with a crosshole outlet. A plunger cup *U* is actuated by the spring *V*, working on capscrew *T*. The method of retaining the cup on the end of the capscrew is slightly different from that in Fig. 2. In this case it is simply spun over into a groove.

In Fig. 5 is shown another method of lubricating this same shoulder screw. In this case the lubricant is oil. It is introduced into the cavity with the spout of an oil can by depressing the ball *X*. The ball is held in place in the cup *Y* by the spring *Z*. The oil cavity in *A* is practically the same as in Fig. 4.

In Fig. 6 is shown the lubrication of a dovetail slide, rather difficult to provide for, especially with grease. This is shown at *K* and the base at *L*. Driven into the under-bearing pad on each side of the slide are the pins *D* which work in the slots *M* and distribute the grease as it is fed up through the small holes *E*. The grease is placed in the cavity *F* and the feed pressure is obtained by the springs *I* working against the plungers *G*. A double shoulder *H* is fastened on the extension of the capscrew *J*. This is a very effective method of lubricating slides and far superior to the old way of applying a few drops of oil. It is more convenient and the lubricant is always fresh and free from grit and dirt.

The Automatic Center Punch

By ERIC H. PETERSON

Although the automatic center punch has been on the market a long time, there are many who never saw the inside of one. The illustration shows three positions of the hammer and will make its action clear.

A pressure with the hand on the cap *C* compresses the helical spring *F*, Fig. 1, until the operating stud or slide *E*, on account of the counterbore in the body *D*, has slid to the center position, as shown in Fig. 2. This

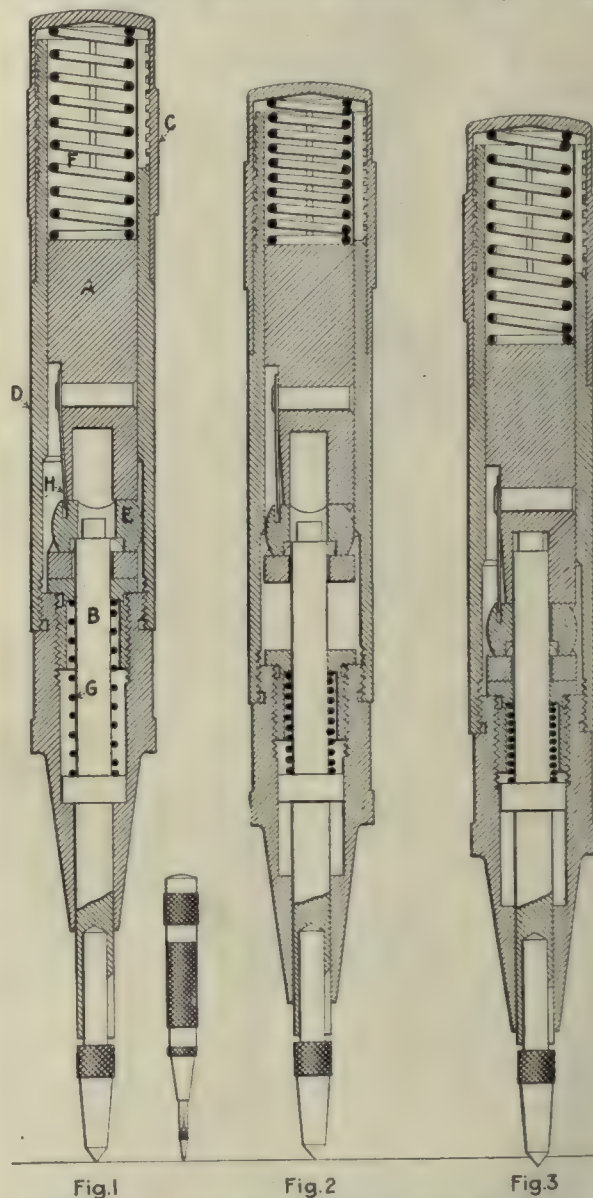


Fig.1 Fig.2 Fig.3
HOW THE AUTOMATIC CENTER PUNCH WORKS

releases the hammer block *A*, which by the power given to the helical spring *F* in compressing it is shot down and strikes the upper end of the punch shank *B*, as shown in Fig. 3.

Immediately after the blow the different parts of the punch have the positions shown in Fig. 3. By lifting the punch, the shank *B* is forced out of the body by the lower helical spring *G*. As soon as the shank is out, the operating stud or slide *E* is moved to the wall of the counterbore in the body *D* by the flat spring *H*, and then it locks, as is shown in Fig. 1, the shank again on its shoulder, whereby the punch is ready for its second blow.

Progressive Dies for a Pressed-Steel Automobile Hub

BY ERNEST A. WALTERS

SYNOPSIS—The production of a pressed-steel automobile hub necessitates drawing, annealing, pickling, forming, bulging, perforating, trimming, beveling and drilling spoke holes in the end. The drawing dies in six operations produce a hub $8\frac{1}{4}$ in. in diameter, $5\frac{3}{8}$ in. long, from a $13\frac{1}{8}$ -in. blank. The hub is bulged out at the small end in a bulging die, using lard oil for this operation. The perforating dies in one operation punch 24 spoke holes, 8 bolt holes and 1 large hole in the end, to let the axle pass through. The trimming and beveling is the last press operation, the hub being finished by having 24 spoke holes drilled in the bulged end, making 10 operations in all.

The pressed-steel automobile hub shown in Fig. 1 is drawn from a cold-rolled steel blank $13\frac{1}{8}$ in. in diameter and $\frac{1}{8}$ in. thick. It is finished in 10 operations. Several of the dies are of the tandem type, which increases production and decreases the number of presses used.

The tandem drawing dies are set upon double-crank presses. They can be operated by one operator, but two are required when the greatest possible output is desired.

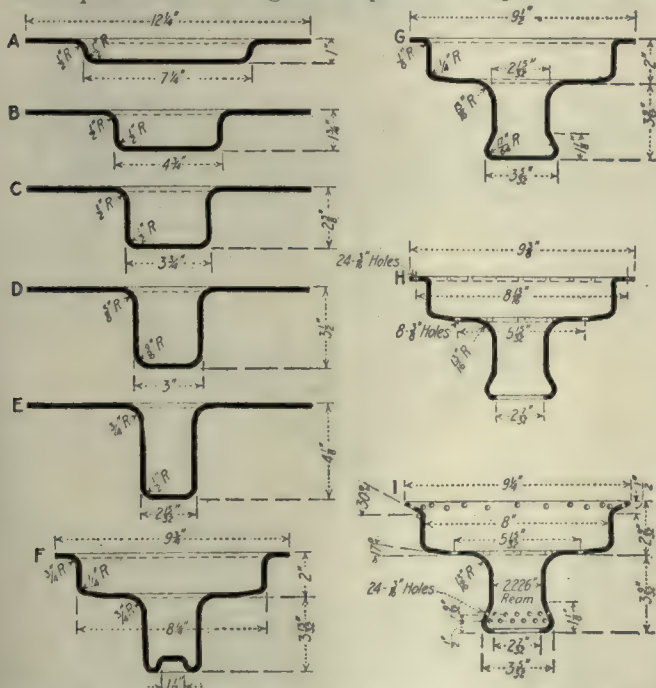


FIG. 1. SUCCESSIVE STEPS IN DRAWING A PRESSED-STEEL HUB

When two operators are engaged on one press, an electric device with four push-buttons is put in action, whereby both operators must touch the four buttons in unison before the press can be brought into action by a foot treadle controlled by one operator. This arrangement protects both operators from being injured in any way.

It is customary in most plants making pressed-steel articles to draw shells on dies that have only enough

clearance for the double thickness of stock between the punch and the die. This is not always practicable when heavy stock is used, a uniform wall thickness is not required and strength is more desirable.

The first four operations of this hub are drawn in dies that are $\frac{1}{2}$ in. large. The dies work easily and keep free from scratches. This saves much time usually required to polish the radius. The stampings release with less friction when made under these conditions, the stock does not have to withstand the high stresses and will go through more operations without annealing. The walls are apt to thicken up, which is desirable where strength is necessary; and the production from dies operated under these conditions is much greater.

The first two operations, shown at A and B, Fig. 1, are blanked and drawn on the dies seen in Fig. 2, operations 1 and 2. The stamping A, when blanked and drawn, is transferred from the first-operation to the second-operation die, which reduces its diameter to $4\frac{3}{4}$ in. and turns the stamping completely inside out. Whenever it is possible to use this method it should be adopted, as with it a greater reduction in diameter is effected.

The tandem dies in Fig. 2 are made of steel sections set in cast-iron plates A and B. To facilitate setting up the dies, the guide pins C are added and held in position by the setscrews D. The guide pins are made of hardened tool steel and are ground 0.002 smaller than the bronze bushings E. The bushings E have at F, recesses that are filled with a mixture of machine oil and white lead to lubricate the guide pins C. Referring to the first-operation dies, the blanking punch G is held in place by the screws K. The blanking die H is held in place by the screws R. Both punch and die are made of hardened tool steel. The punch G is hollow and allows the punch I to enter it when it descends. The blank from H and G is formed between I and G to the shape shown at A, Fig. 1. The punch I is held in place by the nut L. The pressure plate J is made of hardened tool steel. It prevents wrinkles in the stamping and at the same time acts as a knockout to raise the stamping out of the die and to a position where the operator can quickly transfer it to the second-operation die.

The pressure on J is controlled by the rubber bumper M. Adjustments of the pressure are made by tightening the nuts S against the plates O. Care must be exercised in adjusting this pressure pad, as too much pressure on the pad may strain the stamping on the radius and cause it to break when subjected to succeeding operations.

The gages X are of tool steel, hardened. The rear gage must be set to the edge of the die in order to allow the steel to part and open. This prevents the steel from holding to the punch, obviating the necessity for a stripper plate on the die.

The second-operation dies operate in the same manner as those for the first operation. C is the punch, held in place by a taper pin D. The die E is secured by the screws F. Both punch and die are made of tool steel, hardened. The stripper G also acts as a pressure

pad and is held by the screws *H*. It is given the proper pressure and ejecting action by the springs *I*. The knockout *J*, which discharges the stamping from the die, is made of tool steel, hardened. It is actuated by the pins *K* and plates *L* when the rubber bumper *M* is properly adjusted by the bolt and nut *N*. The shoe *A* has T-slots *Z* to fasten it to the ram of the press. The stampings *CDE*, Fig. 1, are reduced from $4\frac{3}{4}$ to $2\frac{1}{2}$ in. diameter in three operations. The work is drawn on tandem dies, shown in Fig. 3. This die is also operated in a double-crank press. The shoe or punch casting *A* is made of cast steel and the shoe *B* of cast iron set with steel dies and punches. These are guided by the pins *C*, held by set-screws *D*, and ride with the necessary freedom in the bronze bushing *E*. The punches *F* are made of tool steel, hardened; they are held in place by the taper pins *G*. The dies *H* are of tool steel hardened, and are held in place by the screws *I*. The stripper plate *J* has hardened bushings *K*, which act as pressure pads to flatten the flanges of stampings. The stripper is held by the bolts *L* and is so adjusted as to hold also the bolts *M*, which carry the lower plate *N*. This lower plate is so adjusted that it gives the shoulder knockout *O* the proper travel to expel the stampings *CDE*, Fig. 1, when the ram is on its upward stroke. The T-slots *P* are for securing the punch to the ram of the press. The stampings *E* are now annealed and pickled to remove all scale before they are put through the sixth-operation dies, shown in Fig. 4. Here they are formed into a hub $8\frac{1}{4}$ in. in diameter, and the bottom is indented. This indentation is necessary to shorten the hub to fit the succeeding die, as well as to supply the much needed stock that is necessary for bulging in a later operation. At *A*, Fig. 4, is the punch, which is made of tool steel, hardened. The stud *B* has a hole *X* through the shank to secure it to the ram. It is threaded on the opposite end to hold together the sections *BCD*. The shoe *E* is of cast iron and serves to hold the dies that are made in sections. The forming die *F* is secured by screws *G* and is made of tool steel, hardened. The bushing *H*, held in place by screws *I*, is also made of tool steel, hardened, and serves to guide the hub in its downward course to indent the bottom with the tool-steel hardened punch *J*. A tool-steel hardened ring *K* acts as a knockout, should the hub stay in the die. The stripper *L* also serves to flatten the flange of the hub. This stripper is made of machine steel and has a tool-steel hardened ring *M*, held in place by screws *N*.

The stripper *L*, which is free to slide on the punch *A*, must be held to the ram by bolts and given the proper sliding adjustment. The tapped holes *O* are provided for securing it to the press ram. The rods *P* are screwed to the stripper pad *L* and carry the knockout plate *R* underneath the die.

The knockout ring *K* is fastened to the plate *R* by the bolts *S* and when properly adjusted works as a unit in connection with the stud *J* to release the hub on its upward course. The holes *T* in the die serve to bolt it to the press, being simply fastenings in function.

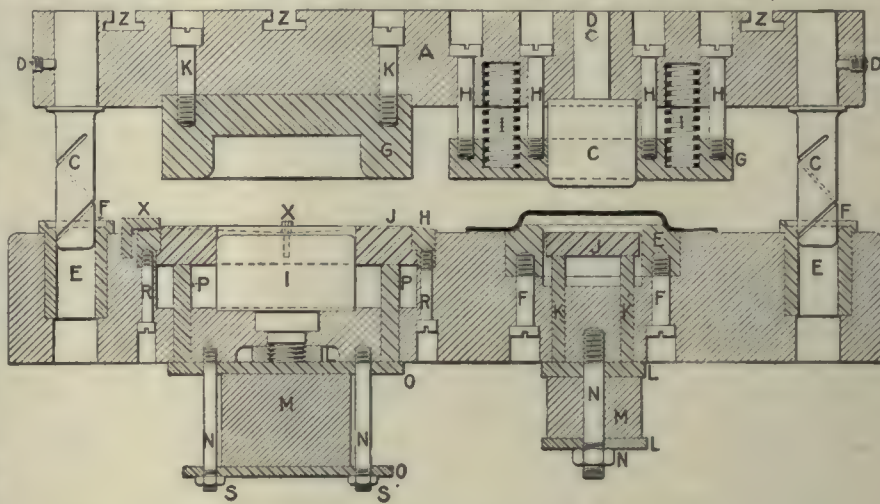


FIG. 2. FIRST AND SECOND OPERATIONS

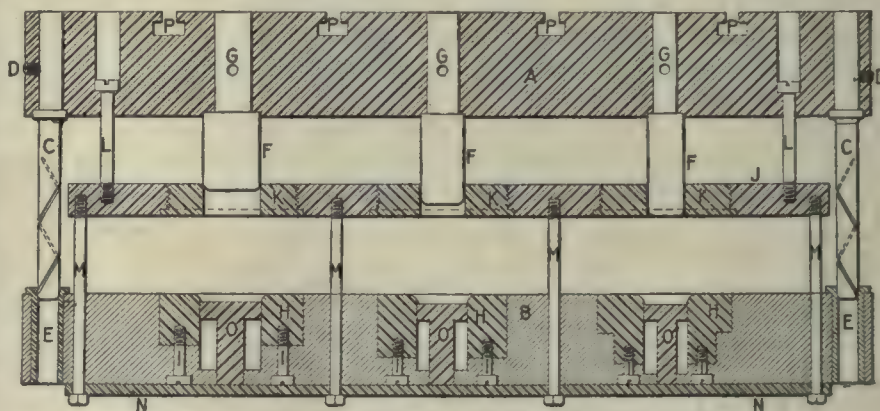


FIG. 3. THIRD, FOURTH AND FIFTH OPERATIONS

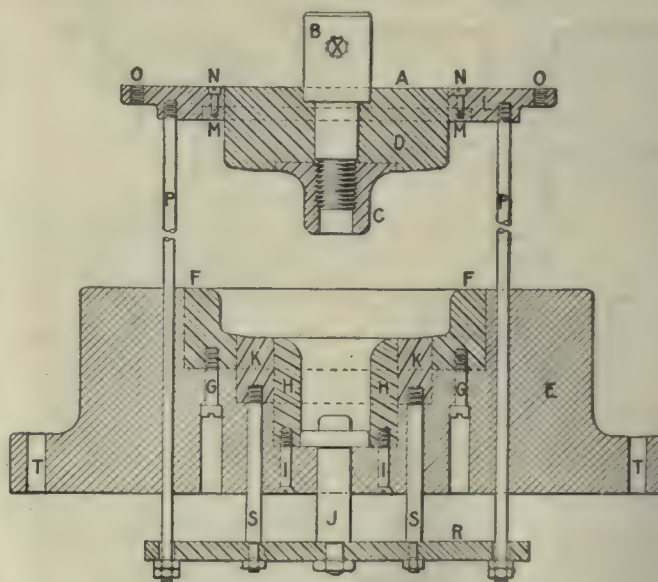


FIG. 4. SIXTH-OPERATION DIES

The hub *F*, Fig. 1, is now put through the oil bulging dies. This is the seventh operation and is shown in Fig. 5. The end is bulged out until it fills the cavity

Z in the die, forming the necessary end. The flanges are also squared in this operation. The hub should be 0.010 in. small at O in the dies, so that the punch X when entering the hub will expand it to size. There

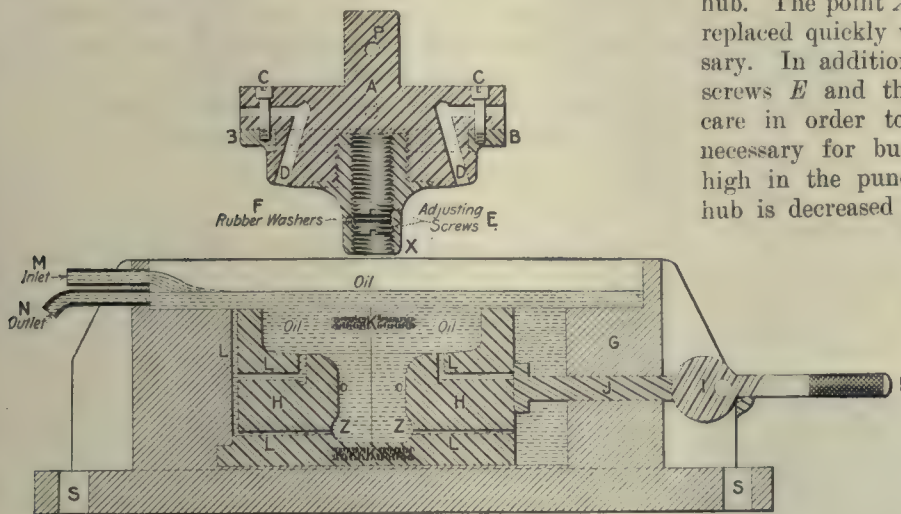


FIG. 5. SEVENTH OPERATION

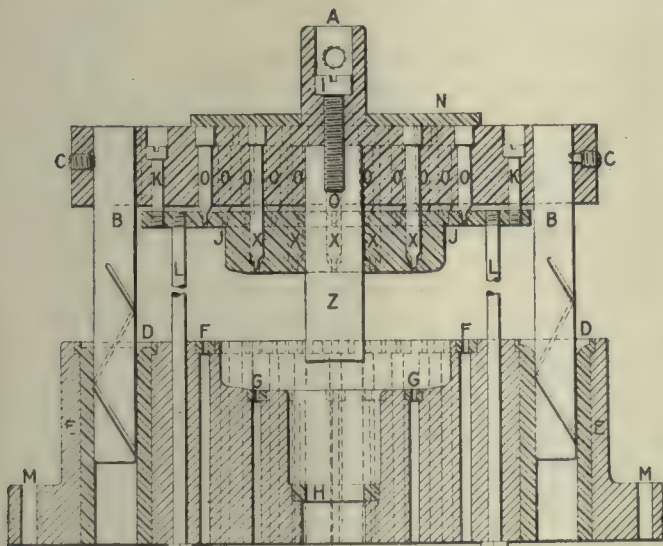


FIG. 6. EIGHTH OPERATION

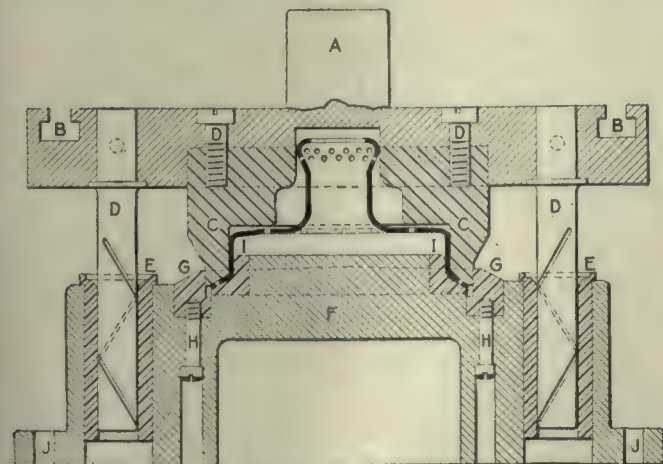


FIG. 7. NINTH OPERATION

being no escape for the oil because of the tight fit of the punch in the work, the hub will be bulged out until it hugs the cavity Z in the die. The punch A is made

of machine steel with a hardened plate B held by the screws C. This plate serves to flatten the flanges of the hub. The holes D are drilled in the punch and serve to discharge the oil from the upper part of the hub. The point X is made of high-speed steel and can be replaced quickly when through wear this becomes necessary. In addition to the ram adjustment the adjusting screws E and the rubber washer F must be set with care in order to regulate the amount of oil that is necessary for bulging. If the setscrews EE are too high in the punch, the pressure in the bottom of the hub is decreased to such an extent that it will not fill

the cavity Z; and if the screws are too low in the punch, there is too much pressure, which might result in damage to either the press or the die or to both. The die shoe G is made of cast iron and serves as a die holder and oil reservoir. The die H is made in halves and is opened by the cam I and square sliding pin J, assisted by the springs K. Oil channels large enough to discharge the surplus oil are

provided at L in the die as well as at D in the punch. The inlet and outlet pipes M and N must be so placed as to give at all times the proper depth of oil in the reservoir. These pipes are supplied with lard oil through properly adjusted automatic pumps. The punch is secured by a pin through the hole P in the shank. The holes S in the die serve to secure the die to the press.

The hub G, Fig. 1, having been finished on the bulging die, is now ready to be perforated in the eighth-operation die, shown in Fig. 6. The punch A is made of cast steel, has twenty-four 1/8-in. punches O, eight 3/4-in. punches X and one 2 3/2-in. punch Z.

The small punches OX are made of tool steel, hardened. They are driven into place and have shoulders backed by the hard plate N. The punch A has guide pins B secured by setscrews C. The guide pins work in bronze bushings D seated in the cast-iron die plate E. The die plate E has 33 dies pressed into place. These correspond to the punches. The dies F and G are made of tool steel and hardened.

The large bushing H is made of tool steel, hardened, slightly tapered and pressed into place. The small and large punches are staggered so as to use as little power and be as easy on the dies as possible. The large punch Z is made of tool steel, hardened, and is held in place by the screw I. The stripper J is made of machine steel and is held by the screws K that slide in the punch with enough freedom to allow the stripper to disengage the hub from the punches. The stripper bolts L must be adjusted to suit the stroke of the ram. The holes M are for bolts to secure the die to the press bed.

The hub H, Fig. 1, having been perforated, is now trimmed on the flange and beveled, which concludes the presswork. This operation is performed on the ninth-operation die and punch shown in Fig. 7.

The punch holder A is made of cast iron and has a stud and two T-slots B to secure it to the press ram. The holder A is counterbored to seat the hardened tool-steel, hollow, trimming and beveling punch C which is held in position by the screws D. The guide pins D,

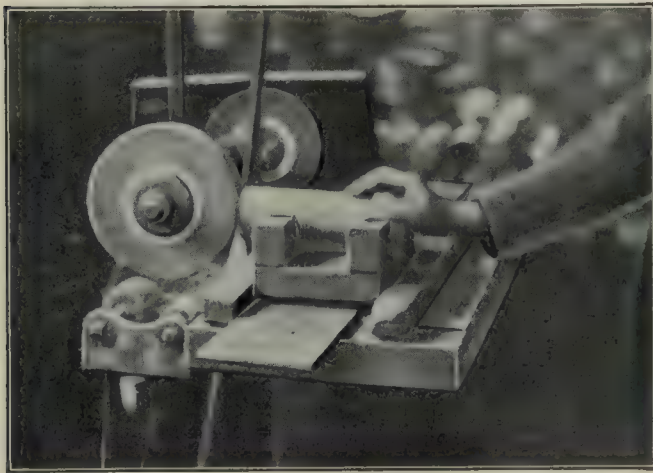
made of tool steel, hardened and ground, slide in the bronze bushings *E*. The die plate *F* is of cast iron and seats the tool-steel trimming die *G*, which is held in place by the screws *H*.

The ring *I* is made of tool steel, hardened, and is pressed on *F*. It acts as the beveling die. The last operation consists of drilling the small spoke holes in the bulged end of the hub and is done in the drill press with the assistance of a jig.

❧

Snagging Small Shells

A simple form of cradle for holding 3-in. shells while snagging the end of the center plug is here shown. It is in service in the shop of the Dayton Pipe Coupling Co.,



SHELL-SNAGGING CRADLE

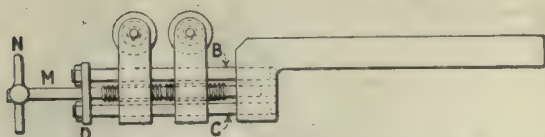
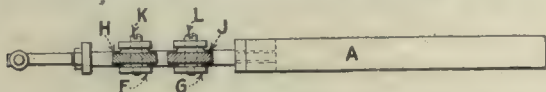
Dayton, Ohio. By using something like this it is far easier to keep the wheel true, and it is not so tiring on the men. In handling these rough forgings the workmen wear heavy mittens and will grind about 200 shells per hour.

❧

Adjustable and Self-Centering Knurling Tool

BY JAN SPAANDER

The knurling tool shown in the illustration consists of a steel handle *A*, in which two drill rods *B* and *C* are screwed. These are connected at *D* by a 1/8-in. steel



A KNURLING TOOL THAT HAS PROVED ITS WORTH

plate. This plate is screwed tightly against the shoulders of the 1/4-in. drill rods, which thus form a very rigid guide for the blocks *F* and *G*. These blocks are slotted for the 5/8-in. diameter hardened-steel knurls *H* and *J*. The knurls run on spindles *K* and *L*, threaded and should-

ered on one side only to give the knurls ample bearing. The blocks *F* and *G* are connected by means of a 3/2-in. right- and left-handed screw, 32 threads to the inch, made out of drill rod. By turning the handle *N* of screw *M*, the knurls can be adjusted to suit the work in hand. The ends of the screw can pass freely through the holes in the plate *D* and the handle *A*. This allows the blocks to slide one-quarter inch either side along the guides, making the tool self-centering and assuring neat work.

❧

Miscellaneous Steel Production

The American Iron and Steel Association has issued Bulletin No. 4, which gives some statistics as to the production of various articles of finished iron and steel that were not included in the previous bulletins.

The production of tin and terne plates in 1915 was: Tin plates, 982,958 gross tons; terne plates, 72,978; total, 1,055,936 tons, an increase of 124,695 tons over 1914. Adding imports and deducting exports—which reached the high figure of 154,642 tons—the consumption of tin and terne plates in 1915 was 903,644 tons. There were 34 active works in 1915. Of the tin plates made 43,172,676 lb. were charcoal plates.

The production of galvanized sheets in 1915 was: Iron, 33,729,945 lb.; steel, 1,660,107,051; total, 1,693,836,996 lb. This is a decrease of 245,433,742 lb. from 1914. There was a large increase in the make of sheets in 1915, and the decrease given was due entirely to the high price of zinc, which caused the use of black or painted sheets in place of galvanized.

The production of rail joints and fastenings in 1915 was: Iron, 46,931 gross tons; steel, 423,793; total, 470,724 tons, an increase over 1914 of 98,182 tons.

The production of pipes and tubes in 1915 was, in gross tons: Black, standard 823,767; galvanized, 280,944; oil-country goods, 602,920; O.D. and miscellaneous, 115,113; boiler tubes, 96,930; total, 1,919,874; whereof 206,713 tons were made of iron and 1,713,161 tons of steel. Compared with 1914, there was an increase of 181,970 tons. The total of seamless steel tubes made in 1915 was 139,668 gross tons, whereof 63,488 tons were hot-finished and 76,180 tons cold-drawn. The total increase over 1914 was 49,073 tons.

The make of cast-iron pipe in 1915 was, including fittings, 1,214,870 gross tons, an increase of 54,090 tons over the previous year.

The production and consumption of nails of all kinds are reported as follows, in kegs of 100 lb. each:

	1913	1914	1915
Wire nails	13,559,727	13,132,814	14,583,026
Cut nails	842,038	769,665	775,327
Total production	14,401,765	13,902,479	15,358,353
Exports	1,062,362	885,843	2,146,353
Consumption	13,339,403	13,016,636	13,212,000

Wire nails were made in 1915 by 49 works and cut nails by seven.

The production of forgings in 1915 was, in gross tons: Iron, 2,814; steel, 520,909; total, 523,723 tons, an increase of 182,302 tons over 1914. The production of hammered charcoal-iron blooms and billets in 1915 was 43,121 tons, whereof 42,219 tons were for the maker's own use and 902 tons for sale. As compared with 1914 there was an increase of 1,696 tons.

Control of Expense Materials*

BY W. ROCKWOOD CONOVER†

SYNOPSIS—A detailed discussion of the purchase, storage, issuing and use of many supplies in the shop. In several cases reasonable unit costs per employee of such materials are given. The principles laid down purpose to control the consumption of these expense articles.

Expense materials constitute a very appreciable fraction of the factory expenditures. The subject is of sufficient importance to warrant a somewhat detailed discussion. We are apt oftentimes to give more careful attention to productive materials and to consider this item of manufacturing expenses as of minor importance. An analysis will convince the manager in any line of business that the total yearly consumption of this class of materials deserves his serious consideration.

In general, the main stock of expense materials should be kept in a central stock building, from which they can be drawn by the shop department foreman or separate departmental storerooms for redistribution to the workmen on the machine floors and benches. This method permits a more systematic handling of stocks that are purchased in large quantities for the purpose of securing advantageous prices or for other manufacturing reasons. Where these materials are stored in individual shops, valuable floor space that is needed for manufacturing purposes is often taken up. Better results are also obtained where the control of consumption is centralized under the general storekeeper of the plant.

Among the more important items of expense materials commonly used in the factory may be enumerated the following: Coal; fuel oil; fuel gas; lubricating oils; cutting oils and compounds; naphtha or gasoline; acids and chemicals; cleaning compounds, soaps, etc.; cotton waste; compressed air; small expense tools; emery cloth and paper; shop boxes, barrels, bags and refuse cans; brooms and brushes; rope and steel slings, cables, chains, etc.; incandescent lamps; printed forms; office supplies and stationery.

Some of the materials will not be discussed here. Among these are coal, fuel gas, fuel oil, lubricating oils and cutting compounds and small expense tools.

Naphtha, a common article of consumption in factories, is frequently employed for cleaning castings and small metal parts made on the automatics and turret lathes. This practice is expensive, and the total amount of naphtha consumed in shops producing large numbers of small machined parts is generally large. A good substitute for this method of cleaning oil from metal is found in the use of potash or caustic soda. A kettle of convenient size, into which steam can be introduced for keeping the solution hot, should be located in the department or within easy access, where the product of the automatics may be conveyed and dipped as it comes from the machines or before it is delivered to the stockroom or assembly floors. It is also a quite common practice for workmen in the shops to use both naphtha and kerosene

for general cleaning purposes. Unless some restrictions are placed upon the delivery of these materials the consumption is apt to be large. The matter is one that requires a system of regulation so that these products cannot be obtained except upon the authority of the foreman of the department.

In frequent instances where the conditions of manufacture require the employment of naphtha it will be found that equally good results may be obtained with a grade having a viscosity of approximately 55 deg., as with some of the grades of greater viscosity and higher cost.

ACIDS, CHEMICALS, CLEANING COMPOUNDS

In nearly all the big industries the purchases of acids, chemicals and cleaning compounds usually include a more or less extended and varied list. Except in cases where a regular chemist is employed, the technical information possessed concerning them is generally of a more or less vague and unsatisfactory character. In consequence the manufacturer is sometimes buying more expensive solutions than he requires for his work and not infrequently employing different chemicals in various parts of his factory where the processes and requirements are somewhat similar and where the practice is capable of some degree of simplification. This condition may be due in part to the matter being left to the judgment and experience of the department foremen or to individuals who have not given the subject the careful study that it deserves. Acids for dipping and cleaning processes, soldering acids and a variety of chemicals used in the preparation of metal paints, varnishes and various kinds of insulations and finishes all come under this head.

Much valuable work can often be accomplished by having a skilled chemist conduct investigations and analyses from time to time in order to make substitutions that will effect a reduction in cost and also reduce the number of these items on the purchasing list. Some preparations or solutions that the manufacturer has been led, from a lack of technical knowledge, to consider it necessary to purchase from recognized dealers or producers, often at a high cost, can either be duplicated or compounded with more or less modification in the shop and give equally good results.

It is advisable to provide the storekeeper with a list of the names of foremen authorized to draw any of these materials, so that orders from other sources may be questioned before filling and the consumption confined strictly to the classes of production requiring such articles.

Cleaning compounds, soaps, etc., although not usually expensive in initial cost, are generally used in an extravagant and wasteful manner and should receive attention. Liquid soaps are less expensive than those manufactured in the form of bars or cakes and besides effecting an economy in consumption are without doubt more sanitary and satisfactory for general shop purposes as well as in the office.

The amount of cotton waste required for cleaning machines, tools, etc., depends largely on the nature of the product manufactured and the accumulation of oil, metal dust or other substances to be removed. There is us-

*Prepared for the author's forthcoming book on "Industrial Economics." Copyright, 1916, Hill Publishing Co.

†Factory economist, General Electric Co.

ually, however, in most shops a lack of proper control in the use of cotton waste, and in consequence the consumption is generally far greater than conditions warrant. The maintenance of machine tools in good working order is most important, but this can be accomplished without loss and extravagance if proper methods of control are established in each department.

A schedule showing the number of ounces per man required weekly in each department should be placed in the hands of the stock keeper for the purpose of checking the orders given by the foremen of the several shops. Each foreman should supply himself once a week with the amount required to keep the tools in his department in cleanly condition. The order placed on the stock keeper should call for the number of pounds required and should show the number of productive hands in the department. The total amount called for should be based on the number of productive employees multiplied by the schedule of ounces per man per week allotted to the department. In this manner the consumption will fluctuate according to productive conditions.

This plan forms, on the average, a very satisfactory method of control, as any increase or decrease in the productive operatives of the shop naturally affects the amount of waste consumed. In the automatic department or other sections of the machine shop where more than one tool is operated by an individual employee the workman should be supplied weekly with the schedule allotment in ounces per man for each machine, in order to provide for the extra amount of cleaning to be done.

CONTROL OF SUPPLIES OF WASTE

The foregoing schedule is for controlling the supply drawn weekly by the foreman from the stockroom. The distribution of this supply to the workmen on the shop floor will obviously be governed by the class of work that each employee is performing. The bench hand, having to do only with clean materials, may require little or no waste, while the operator on a large planer or boring mill or on a group of automatics must have a liberal supply for his needs. A schedule of four to five ounces per productive employee per week will be found sufficient to take care of automatic screw-machine departments, machine shops, etc., where there is a large accumulation of oil and metal dust constantly deposited on the tools. In departments devoted chiefly to bench and assembly work, where there is practically little machining of detail parts and the processes are essentially free from oils or foreign matters, the schedule of consumption may average from one-half to one ounce per productive employee per week. In shops where the work is of a mixed character two to three ounces per man weekly will be found ample.

This system provides for the regular cleaning of all machine tools, shop cranes, hoists, etc. When new tools are installed or machines are taken down for repairs or special emergencies arise, the stock keeper should be in a position to supply the extra amount of cleaning material required.

The use of colored waste for cleaning purposes is not economical in practice. Although the colored waste is lower in initial cost, the consumption will generally be found to be much greater than that of the white. There is a tendency among workmen to discard the darker material as soon as it becomes oily or partly dirty and

before its cleaning value has been fully utilized. With the white, under proper restrictions, a portion of the weekly supply is kept by the employee for wiping his hands, while there is always a quantity of soiled or partly worn waste for cleaning the more oily and dirty parts of the machine; and the operator soon learns not to discard this soiled waste until it is fully consumed.

An inspection of the tool cabinets and bench drawers of the machine shop often reveals a large accumulation of unused waste, which the workmen have been allowed to draw from the stockroom without restriction or a proper system of regulation. Much of this finds its way to the refuse cans before it is little more than partially consumed, and this fact explains why some manufacturers find it profitable to reclaim their waste by machines for that purpose. With a proper system of control and distribution the waste will be almost entirely used up by the workman, and the small residue consigned to the scrap can will not possess sufficient value to make the reclaiming process an economic one.

ECONOMIC USE OF COMPRESSED AIR

The cost of high-pressure air and the necessity for economy in its consumption are not generally appreciated in the shop. It is of such common use in large machine-building plants in connection with pneumatic hammers and drills and for other purposes that the workman rarely stops to consider the large expense incurred annually in providing the supply. On account of the number of applications there is usually a leakage somewhere, which fails to receive attention until the loss involved is considerable. So long as there is sufficient pressure for the work being done, the hissing of leaky connections or pipes often goes on indefinitely. In some cases the operator will be observed cleaning the floor about his bench or machine with the high-pressure air hose.

The foreman of the department should give the matter his personal attention. Smaller-sized cocks and openings can often be placed on the hose and pipings and effect a saving in the amount consumed. All leaks in pipes and connections should be repaired at once when discovered, and not neglected until the volume of air escaped has caused a serious loss. Air should not be left at full pressure in the hose when the tools are not in use. The foreman should insist upon the workman's closing the stop valve back of the hose whenever he leaves his tool to engage in other work. This practice will prevent loss through any small defects or leaky spots that may not have been discovered.

EMERY CLOTH AND EMERY PAPER

Abrasive materials are frequently discarded by the workman before they are fully used up and a new supply obtained from the stock keeper. This course results in a greater consumption than the conditions of production normally warrant. Much of this waste can be prevented by requiring the workman to bring the partly worn sheets to the foreman or toolroom keeper for inspection before his order for a fresh supply is approved.

The trimmings or corners of emery sheets from which disks for the grinders have been cut may be used in the painting department on the finishing of iron castings. The coarser grades are not suitable for this purpose, but all the scrap from the finer grades is of value and can be used in this way to good advantage.

The equipment of boxes and other receptacles for storing and conveying materials in and about the shop represents a large item of expense. The old practice of piling materials in heaps on the machine and assembly floors, to be scattered and gathered together again and rehandled many times at great expense, is no longer in vogue in the modern well-managed shop. Nearly all materials, with the exception of large heavy castings, should be placed in boxes or on trays or platforms and conveyed with up-to-date electric or elevating trucks from one point to another about the factory.

It is advisable to have the equipment of boxes, whether of wood or metal, so constructed that several sizes may be shunted together and stacked in a limited space when not in use. Unless this is done, the floor will frequently be cluttered with empty boxes, and much valuable space needed for other purposes will be occupied. Boxes constructed in this way also occupy much less space on cars and trucks in the return transit to departments from which they were originally sent containing materials.

Metal boxes are stronger and more durable than wood and are more economical in the long run. The wooden boxes are easily splintered and broken in handling when heavily loaded, and once in this condition they rapidly find their way to the scrap heap or destructor plant. The supply, because of this fact, requires constant renewal. Where special sizes are made for an individual shop, they should be marked with the building or department number in order that they may be readily identified and returned.

Boxes in which incoming raw materials have been received should not be destroyed, as is a quite common practice in many shops. If in good condition these boxes are always valuable for storing odd lots of materials or for transferring articles from one point of the factory to another. The same is true of barrels. The heavy barrels in which oils or chemicals have been received are good receptacles for chips and turnings in the small shop or in the machine sections of the larger factory, where the accumulation is not sufficient to require steel boxes specially made for handling this scrap with the shop crane. The lighter barrels serve a good purpose in shipping scrap wire, miscellaneous metals and other materials of little weight. Metal oil barrels are excellent scrap retainers and last a long period with slight repairs.

There is scarcely anything in the shape of barrel or box coming into the factory that cannot be put into service, if in reasonably good condition on receipt and its usefulness is not destroyed in the process of unpacking.

Bags, if in good condition, can often be returned to the shipper and credit therefor obtained, or they can be put to some valuable purpose in the shop.

Refuse cans should always be made of good strong metal, which increases the life of the can sufficiently to make up for the little additional cost. If made of No. 16 gage material with a $\frac{1}{8}$ -in. steel band around the top, a receptacle giving very durable service is insured. It is poor economy to purchase receptacles made of the thinner sheet metals, which are usually corrugated to make up the strength lost by use of these materials. They will not stand the rough usage of the shop and wear out rapidly.

There is always an opportunity to effect some saving in the consumption of brooms and brushes. The work-

men discard both articles before their full value has been utilized, unless some method of control is established. The worn-out utensil should be returned to the stock keeper when the workman presents his order for a new one. After a little experience he will learn that a new broom or brush cannot be obtained until the old one has become unfit for further efficient service.

The most practical style and quality of broom will depend on the work to be done. Nearly every factory has use for at least three styles—the coarse-fiber push broom, the hair broom and the common corn broom. All are useful in one section or another of the shop.

Paint brushes that have become too much worn for the finer grades of work are still serviceable for rough painting, either on castings or on the various repair jobs about the shop departments and buildings of the plant. All brushes should be returned to the store keeper when unfit for further use on a given class of work, to be sorted, inspected and again given out where they will be of service. Dust and file brushes should be controlled in the same manner as other expense tools and the worn-out brush always returned to the store keeper before a new one is given out.

An inspection of the list of brushes purchased will often reveal the fact that the foremen or workmen are calling for brushes of a better grade than the class of work to be done demands. The list should be checked over from time to time and the practice as to grades authorized for various jobs in the shop definitely established.

SLINGS, HOISTING CABLES, CHAINS

Rope slings, chains and hoisting cables constitute a large item of expense in all manufacturing plants of any considerable proportions. The class of help usually employed in handling these materials renders it impossible entirely to avoid cuts and breakages, and notwithstanding the care exercised on the part of the foreman in directing the use of pads or other means of protection the consumption is necessarily large. The careless crane operator who starts and stops too quickly, lifts loads sideways or runs cables up too high on the drum is sure to work disastrous results, while the crane follower who puts his hook through chain links or neglects thoroughly to protect his slings from sharp edges will add his share to the sum total of expense and loss.

New rope slings that have been cut can frequently be made into shorter lengths and save a portion of the loss. Steel cables that have been taken from elevators or cranes can, after proper tests have been applied, be converted into slings. They make an excellent and durable substitute for rope, will last from eight to ten times as long and unquestionably result in practical economy wherever used. They are also cheaper in cost than chains, and on certain kinds of work give better service. Where chains are employed to any great extent, the labor of frequent welding and annealing involves a large expenditure annually. The manufacturer who makes a practice of discarding partly worn steel crane or elevator cables and sending them to the scrap heap will find it to his advantage to have the greater percentage of them retested and converted into slings. As in the case of rope, all loads will necessarily be handled with a margin of safety, and the fact that the cables have previously been in use is an element of little importance, if they are

properly tested. The economy of purchasing new steel cable for this purpose can also hardly be questioned. Iron cable will be found impracticable as a substitute for rope slings for evident reasons.

It is an excellent plan, where the number of elevators and cranes is sufficiently large, to draw all the supply of steel slings from this source, as far as possible, as this insures frequent renewal on the elevators and cranes and thus provides the maximum of strength and safety at all times. A section that is becoming slightly worn or cut on an elevator cable can be removed, leaving the remainder practically as good as new for slings.

CARE AND USE OF INCANDESCENT LAMPS

The care and use of incandescent lamps should receive the foreman's attention. The careless workman repeatedly breaks his lamp when working about large castings where it is necessary that the interior spaces be illuminated or by leaving it lying unprotected on the bench or machine. All lamps attached to leads should be protected by wire guards of a pattern that will protect the bulb from breakage under severe conditions. Most of the destruction of lamps due to carelessness can be prevented by compelling the workman to return the broken stub to the stockroom with an order approved by the head foreman of the department, before being given a new lamp.

Even the most thoughtless workman does not like to have his slackness of habit in his work brought to the attention of the executive head. It is not sufficient to have these orders approved by subforemen or bosses. These under overseers are often not good disciplinarians and frequently pass orders for replacements of tools and materials destroyed through carelessness or incompetency on the part of the employee, on which some action should be taken. If the workman is compelled to go personally to the head of the department and exhibit the results of his destructive habits, he soon begins to mend his ways and use his tools and materials with greater care.

In electrical establishments the filaments of lamps are often broken by overloads when running tests, and the long hours in factories operating continuously overtime or with night shifts tend to increase the consumption. It is safe to assume, however, that fully 25 per cent. of the lamps purchased in most factories are broken from one unnecessary cause or another. Practically all this waste can be eliminated by the adoption of some method of protection and control.

PRINTED FORMS, OFFICE SUPPLIES AND STATIONERY

No subject involving the minor expenditures of the factory is more worthy of attention than the item of supplies and stationery for office consumption. Waste and extravagance in the use of these materials are common to nearly every office, whether state, municipal or industrial. In large industries the yearly cost for these articles often reaches a bigger sum than many of the expense materials consumed directly within the shop. One reason for this is found in the employment of modern systems of record and accounting, requiring a multiplicity of printed forms and blanks of various kinds. Another reason, and a vital one, is lack of proper control in the distribution and use of such supplies.

Correspondence paper with official printed headings is often taken for ordinary office-routine correspondence between departments, and more often than otherwise the

full-sized official letter sheet is used for brief notes where a half-letter size of plain pad paper would answer the purpose equally well. Thoughtless clerks will be found doing on printed blanks the pencil figuring for which plain pads are provided. Expensive bindings are ordered on accounting and office records, which are generally closed with the current year and stored in the vaults. In many cases less expensive and durable bindings could be substituted to good advantage. New forms, also, are often devised for various sections of the office or factory departments, but possess little or no value and merely tend to increase the expenditures. In this manner there is set up an extravagant and expensive routine that it requires much patient labor eventually to break down.

It is good practice to have some competent person go over all printed forms periodically and eliminate those that are essentially alike in most details and serve similar purposes in different sections of the office or shop. It is a hobby with some persons to suggest new forms, for which they easily secure approval. The process of elimination needs to be a continuous one.

Remailing envelopes are in use in many industries at the present time. They serve a good purpose where the volume of correspondence between two or more departments is considerable, and they effect an economy in the consumption.

The control of office supplies and stationery requires a well-established system. Numerous special so-called time-saving articles and devices creep into the list of purchases. Most of them serve no practical purpose, their employment being due chiefly to individual opinion as to their value.

LIST OF STANDARD OFFICE SUPPLIES

It is well to provide each office with a printed list of such supplies as are considered necessary, with instructions that the items standardized must be employed in regular practice. This method eliminates many purchases of unnecessary items. In addition, a printed form or blueprint giving a list of the various principal office supplies in common use and having a column for the months of the year, together with spaces under each caption in which to enter the number of any given item withdrawn during the month, should be placed in each office. The employee's name should be entered in the upper right corner of the sheet and a sufficient number of sheets provided to cover all the clerks of the department. It is well to place the forms in a substantial binder, as this record will be in frequent use throughout the year and should be inspected from time to time by the executive head of the department. When an employee draws any of the items of supplies, the person in charge of the stock in the department makes an entry (a simple dot being all that is necessary) in the proper column opposite the month in which the article was withdrawn. At the end of the month each sheet shows the number or amount of each kind of supply used by the employee whose name it bears.

The clerical labor necessary to maintain the record is negligible, while much value lies in the moral effect of its publicity. The wasteful clerk soon learns from his foreman that he is using a far greater amount of supplies monthly than his fellow-workmen on the same or similar classes of work. His knowledge that the record is constantly being inspected by his chief acts automatically

as a restraint upon his wastefulness. A noticeable reduction in the total consumption of these materials in the department immediately begins, which in the final analysis will usually not be less than 25 per cent. of the original purchases.

The cost of office supplies and stationery per employee should be compiled monthly or for longer periods. This record will serve a valuable purpose in checking waste. In commercial, accounting and production offices the cost per employee per month (excluding printed forms) should not exceed \$1.50 under average normal conditions; and in general, it should be lower than this figure. In shop department offices supplies are needed by the foreman and his assistants in addition to those regularly doing clerical work. In these offices the average cost may reach 65c. per employee per month. In frequent instances it will not exceed 40 to 50c. per employee, depending to some degree on the conditions of manufacture and the amount of clerical routine that has been built up.

The main stocks of office supplies should be kept in a central stockroom, only small stocks being kept in individual offices or departments. This is true, also, in reference to printed forms in general use in the shop. If these forms are kept in any quantity in individual offices, large accumulations will usually be found on hand when the forms are changed and the present stocks are set aside. There is always a tendency to order larger quantities of both printed forms and supplies than are required for present needs, and it is therefore advisable to concentrate the stocks in one stockroom under one controlling head.

TELEGRAM, TELEPHONE AND EXPRESS CHARGES

Unless proper check and censorship are kept on the telegram, telephone and express charges, the expenditures mount up to a large sum during the year. There is always a tendency on the part of customers to demand answers by wire or phone to communications regarding requisitions which in many instances are relatively unimportant and where an answer by letter would reach the customer within a few hours. Often these telegrams come to the local factory during the middle or latter part of the day and involve some little time to look up the necessary data for reply. It usually follows in these cases that the message to the customer is not sent out until toward the close of office hours and therefore is not delivered at his place of business until the following day. Within reasonable limits of distance a reply by letter, promptly mailed, would reach its destination and be placed in his hands at about the same time.

The answering of these communications by telegraph or telephone should not be left to the discretion of clerks, but should be referred to the executive head of the department for approval. This practice will eliminate a considerable percentage of the expense.

In like manner the ordering of raw materials from outside producers by telegraph and telephone and requests to hurry materials, as well as requests to ship by express, should be censored by some person competent to judge of the urgency of each individual case. It will very frequently be found that the necessity for these expenditures lies in the fact that the orders for raw materials have not been promptly placed, due to one cause or another. The responsibility for delay may lie

in the engineering, commercial or production offices, but it frequently develops that the reason for the delay is without valid excuse.

It is good practice to have regular monthly reports of these charges prepared and submitted to the proper executive heads for their investigation. This form of publicity will, in general, have a salutary effect in reducing the total amount expended.

MONTHLY REPORTS OF EXPENSE MATERIALS

Regular monthly reports of the various expense materials delivered to the several shop departments should be issued by the central storekeeper. These reports should be forwarded to the department of economy or in the case of small factories to the superintendent for investigation and criticism. Each foreman should be furnished with copies of the record of materials drawn for consumption in his shop. This keeps him posted each month on the amount of these materials his men are using.

An investigation into the quantity of any given expense material, such as cotton waste, lubricating oils, etc., consumed in one department as compared with another will reveal the fact that the amount consumed per employee on similar classes of work or under similar conditions is far greater in one instance than in the other. Statements issued at frequent intervals showing the comparative rate of consumption in the various departments will invariably result in more economic practices in those departments which show high. When a proper basis of distribution is established, the foreman will draw from the general storehouse or the departmental stockroom a supply commensurate with and governed by the manufacturing conditions and the number of productive employees under his charge. His organization record, which in addition to expense employees also shows the total number of productive employees from month to month, furnishes him with a ready reference in placing orders with the stock keeper for the stock of certain kinds of supplies for his department.

The value of publicity in all matters of economy cannot be too strongly emphasized. As soon as a foreman learns that the operating expenses of his shop are being regularly scrutinized and compared with those of other shops doing similar classes of productive work, he is instigated to take a personal interest in the economic conduct of his department. He will begin to study into matters more deeply than he has previously been accustomed to do. In the same way, with careful teaching and explanation, he can extend this influence among all his employees, thus giving them an intelligent understanding of the importance of practicing economy in the regular performance of their tasks. The result will be a higher degree of efficiency throughout the factory as a whole.

Complete lists of all expense materials purchased should be prepared at least once a year. An analysis of quantity, cost and purpose to which each class of material is devoted will be found of great advantage. Such analyses often develop the fact that substitutions can in many instances be made or materials of lower cost be more generally adopted, while the use of some that have been considered by the foreman as necessary in his work may be discontinued.

Gages and Other Details of Fuse Work

Every factory engaged on fuse work or making a similar product is deeply interested in the question of gages. This matter is so closely tied up with the acceptance of the output that it becomes doubly important, not only to have the work fit the gages used, but to be sure that these gages correspond with the gages by which the articles will be finally inspected. The master-gage situation is not all that can be desired in some instances.

Plug and ring gages soon wear when they are being used on thousands of pieces, even of such materials as bronze and aluminum. Plug gages can be made of extra

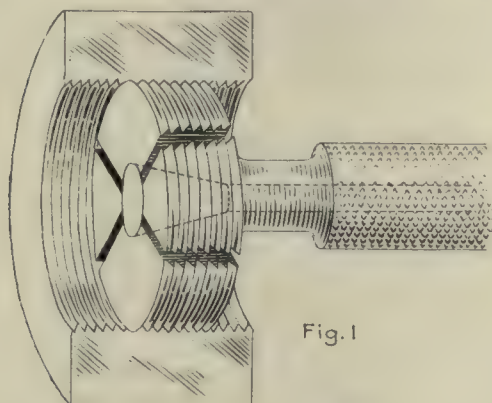


Fig. 1

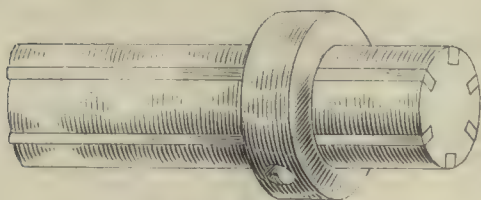


Fig. 2

RING AND PLUG GAGES

length and the end cut off as it wears down. With the ring gage, the wear takes place at the outer end and in the case of the solid gage destroys its usefulness. An adjustable ring thread gage is sometimes restored to usefulness by making a short bronze lap, as shown in Fig. 1, and lapping the central portion of the gage to the same size as the end, closing the whole gage to the proper size.

For gaging internal threads the form of fluted gage seen in Fig. 2 has been found useful in many cases. It is made with a long threaded portion, so that the end may be cut off as it wears, the same as in the regular plug gage. The flutes, however, enable the stop collar to be accurately located for depth, serving the double purpose of gaging the diameter and the length of the threaded portion, or the distance between the inner and the outer shoulders.

Objections may be made to the possible warping of the long gage in hardening; but when we remember that only a short portion of it is being used for gaging purposes, it will be seen that this becomes negligible, just as in the case of a short plug.

Many shops seem to have found carbon drills best for all work below $\frac{1}{8}$ in. In other words, the carbon drills will stand any speed that can be given them up to $\frac{1}{8}$ in. in diameter. As most of the fuse work is

bronze or aluminum, there has been no difficulty in securing excellent results from the small carbon drills. One of the difficult pieces is the long hole in the graze pellet. This is only 0.05 in. in diameter and about $1\frac{1}{8}$ in. long. After trying elaborate fixtures, these holes are now being drilled in a simple jig that starts the drill central with the stem and allows the pellet to be held principally in the fingers during the drilling.

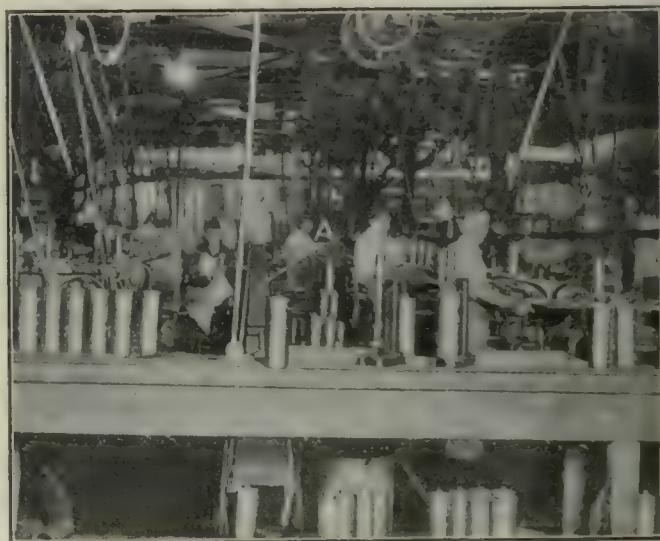
This method enables the operator to revolve the pellet during the drilling operation and to feel any tendency to catch. In this way it removes the likelihood of drill breakage and also insures high production. The length of the hole being so long in comparison with the drill diameter makes it necessary to clear the chips by removing the drill frequently, sometimes 15 to 20 times during the drilling of one hole. In spite of this an expert operator will drill from 60 to 100 of these holes per hour.

In most cases the use of wholly automatic screw machines has been found inadvisable, owing to the extremely close shoulder limits of the fuse bodies. They are in most cases being roughed out on the automatics and finished on hand screw machines. Extreme care in tooling makes it possible to do this work on the automatics, but it is not usually considered advisable to do so.

One of the great drawbacks in some instances is the unfortunate fact that machines built during the last year have often been so much out of line that they could not be depended on for accurate work until the spindle bearing had been properly scraped in and lined up. This failing has been all too common and has caused much delay in beginning to make suitable deliveries on fuses.

A Shell Conveyor

In the plant of the Dayton Pipe Coupling Co., Dayton, Ohio, a long sloping trough is placed between the rows of lathes as shown at A. When an operator completes



SHELL TROUGH CONVEYOR

his work on a 3-in. shell he places it in the trough from where it rolls down opposite the machine where the next operation is to be done. The last operator lets it roll on down to the inspector's bench shown in the foreground.

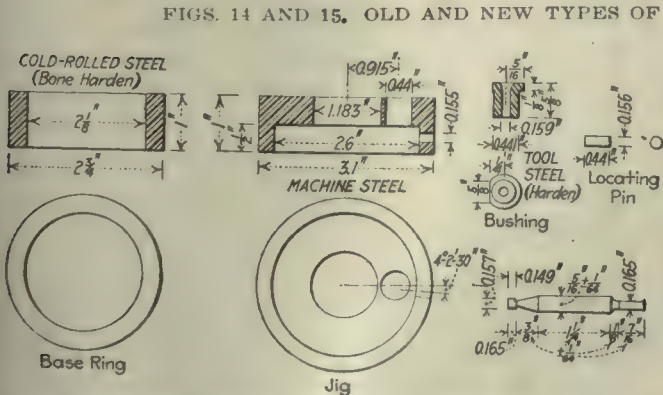
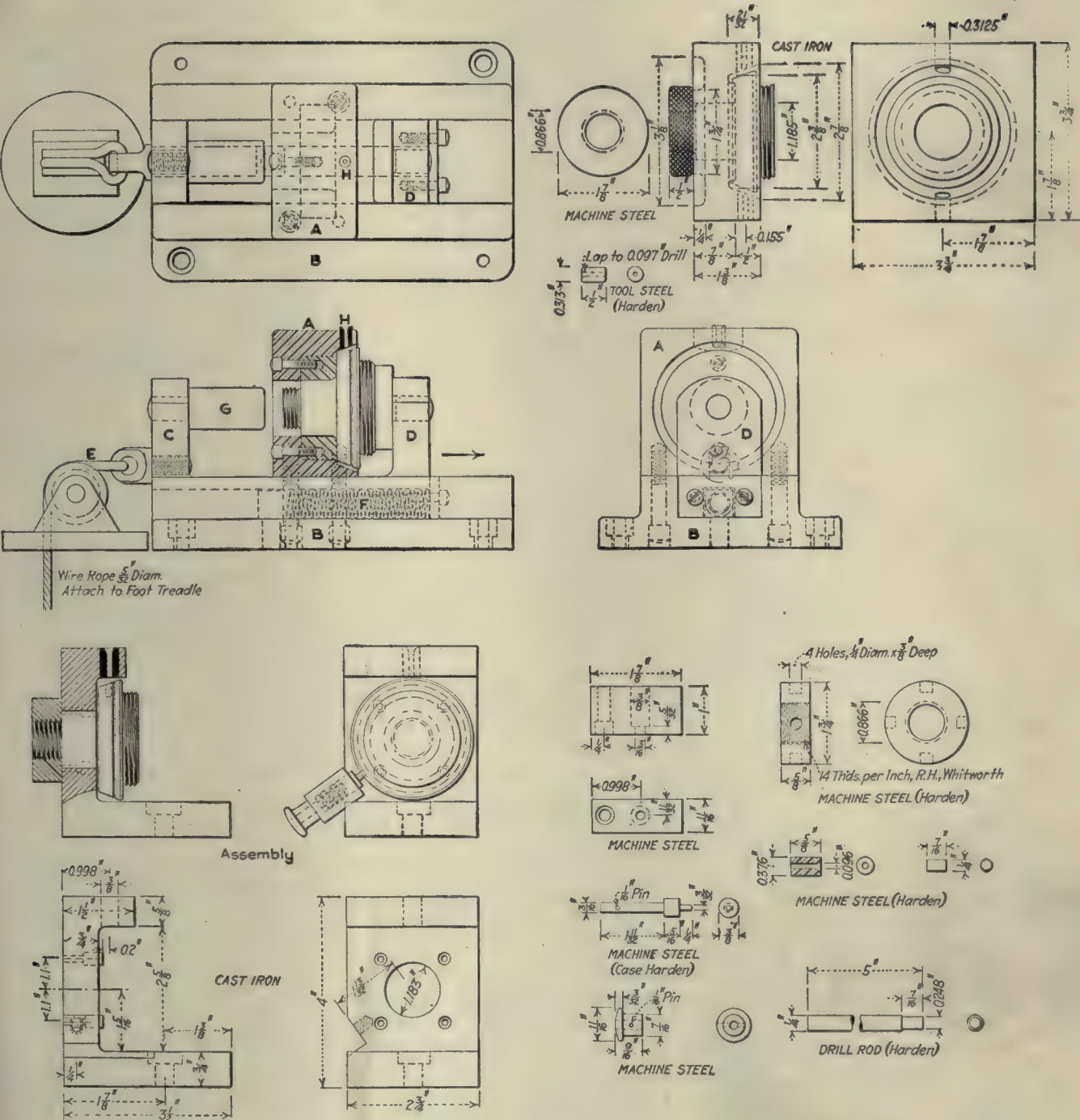


FIG. 20. FIXTURE AND GAGES FOR DRILLING PLATFORM HOLES. PRODUCTION, 100 PER HR.

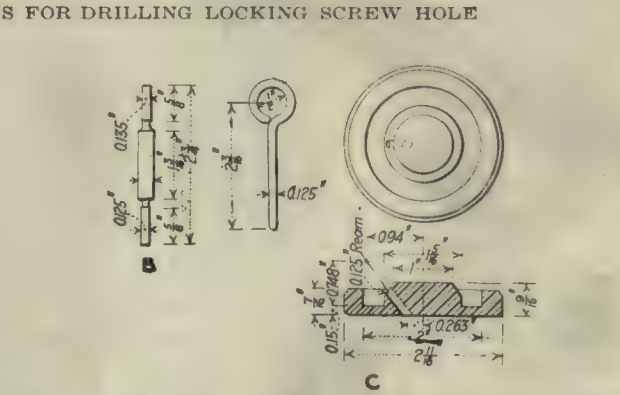


FIG. 21. JIGS AND GAGES FOR DRILLING MAGAZINE HOLES. PRODUCTION, 100 PER HR.

the center of the key slot. The gages are also shown in the same figure.

Drilling the hole through from the side of the platform hole to the magazine is done in operation 19 and in the fixture shown in Fig. 21. Originally, a spring control sliding fixture similar to that shown in Fig. 14 was

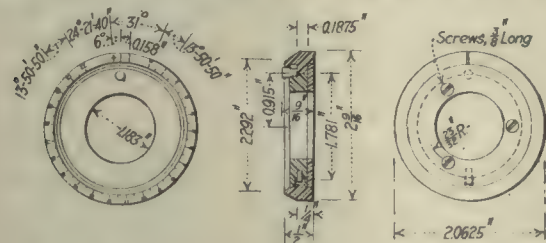


FIG. 23. GAGES FOR GRADUATION OF RING

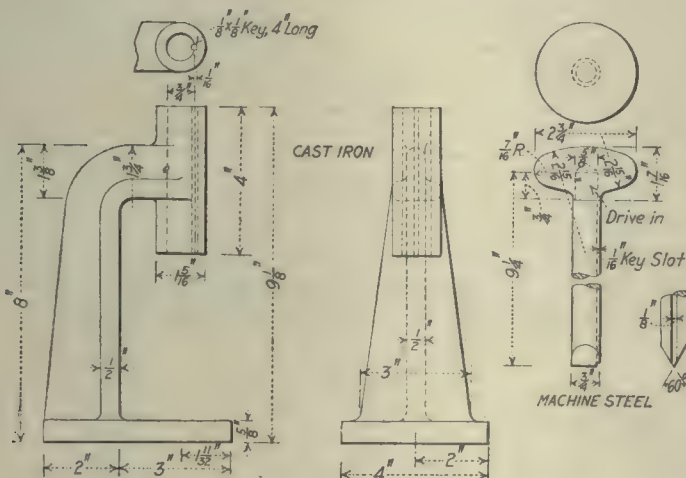


FIG. 25. PUNCH AND GAGE FOR BASE LINE

designed for this work. In common with the other, however, it was found that the simpler form of jig here shown was best adapted for the machines and the operators by which this work was performed. The gages are also shown in the same figure.

The flash hole, which is drilled through the stem of the body into the recess shown in Fig. 16, constitutes operation 19. The fixture and gages for this are shown in Fig. 22, these being very similar to those for the magazine hole. It will be noted in several of these fixtures that four small hardened and ground pins are used for locating the fuse body endwise. These come in contact with the serrations on the upper side of the platform and inside the raised ring on the outer diameter.

Next comes the graduating of the ring on a rolling machine built by Noble & Westbrook. This is divided into two suboperations—the first rolling in the graduations and the second rolling the numerals in their proper position. In both of these suboperations the key slot previously referred to serves to locate the graduations in their proper position on the ring. The gage is shown in Fig. 23.

Operation 22 consists of necking behind the thread on the end of the stem. For this purpose the form of scissors tool, as it is called, shown in Fig. 24 is used, together with the gages shown in the same group.

The final operation on the body consists of marking the base line. This is done by the punch shown in Fig. 25 and is inspected by the gage shown in the same figure.

Work Holder for Burring Disks

BY EARL F. BIRDSALL

In the course of a season's work I have a large number of notched disks to file and finish with emery cloth. I

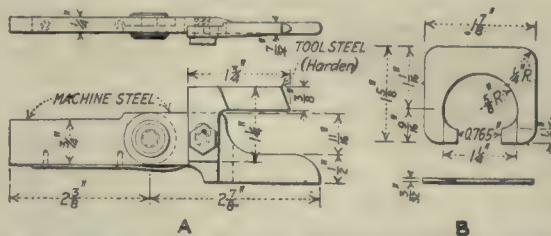


FIG. 24. TOOLS AND GAGES FOR NECKING THE STEM
A, necking tool for stem; B, diameter of recess behind thread
on stem

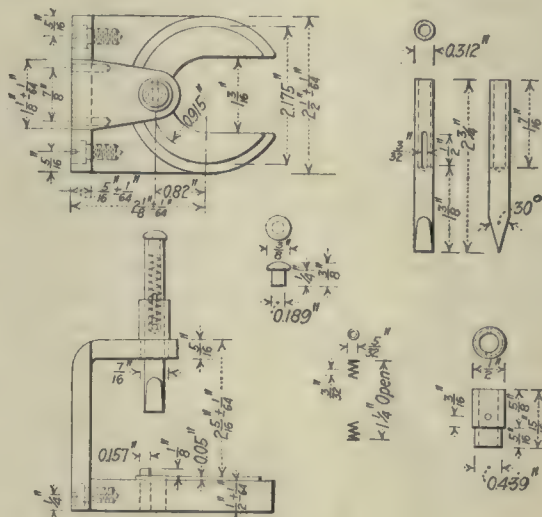
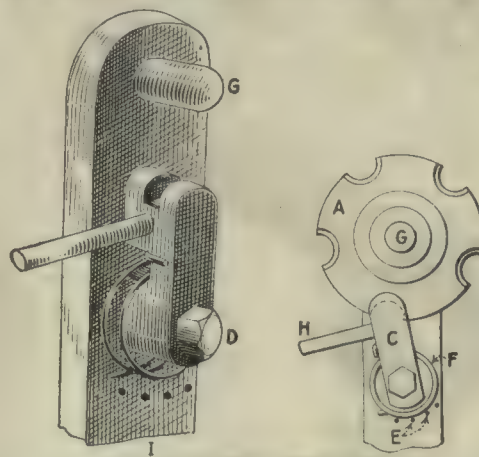


FIG. 25. PUNCH AND GAGE FOR BASE LINE

was at a loss for a suitable holder until I hit upon the device illustrated.

The shank *I* is held in the vise. A disk *A* is placed on the plug *G*. The pawl *C* enters a notch and holds the work by pressure of the spring *F*. The pawl fulcrums on the capscrew *D* and has a handle *H* to swing it easily. When one section is finished, the work is moved in the



THE HOLDING FIXTURE

direction shown by the arrow. This lifts the pawl, and it snaps into the next notch. A modification of this device would be satisfactory for burring gears or pinions. The tension of the spring can be changed by entering the end in the different holes *B*.

Indicator for Irregular Planer Work

BY T. J. CONNINGTON

Having a number of pieces of various shapes and radii to plane, I constructed an indicator as shown. I have never seen, nor read of, one like it, but I found it practical and accurate.

The sheet-zinc templet *A* is filed to suit the work required and clamped to the crossrail of the planer. The bar *B* is of steel $1\frac{3}{4} \times 1\frac{1}{4}$ in. by 12 in. long, bent at right angles $4\frac{1}{2}$ in. from the end (measurement from crossrail to the face of the tool block). The piece of sheet steel *C* is $\frac{3}{2}$ in. thick, with $\frac{1}{4} \times \frac{1}{16}$ -in. slot, and has a $\frac{3}{16}$ -in. hole for a stud. The part *D* is of sheet steel $\frac{3}{2}$ in. thick, bent at right angles to fasten on the button *E*, filed at the other end to pass freely through the slot in *C* and pivoted on the $\frac{3}{16}$ -in. stud *D1*. The button *E* is of tool steel, $\frac{3}{8}$ in. in diameter, $\frac{3}{4}$ in. long and is fastened with screws to *D*.

The part *F* is made of sheet steel $\frac{1}{8}$ in. thick, riveted on *B* with a slot cut to hold the adjustable zero mark *F1*. The part *G* is an extension bolted to *B* with a $\frac{1}{2}$ -in. bolt, which makes the indicator easy to adjust.

The indicator is fastened under the bolt on the tool block and adjusted so that the button *E* is on the center of the templet *A*, which will be shown when the pointer

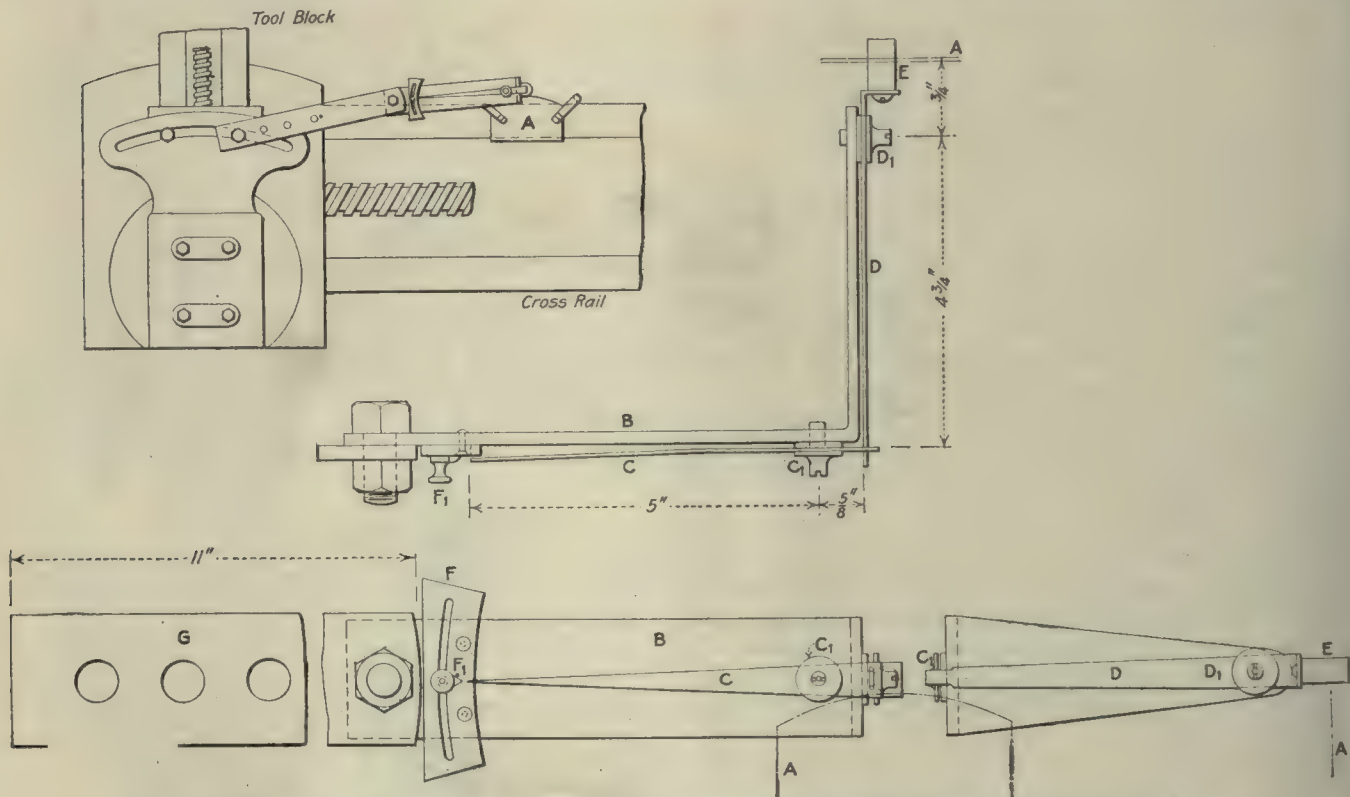
giving time for the operator to raise or lower the tool the proper distance to bring the pointer *D* back to zero.

The button moving on the curved templet multiplies 50 times at *F1* and shows clearly how much the tool should be raised or lowered to make it cut the same as the templet.

The button should be made long enough so that the pointer *C* will be sufficiently heavy to keep it in light contact with the templet. The part *D* is filed to a knife-edge at the slot.

32

The Effect of Manganese on the corrosion of steel has recently been investigated by Sir Robert Hadfield and J. Newton Friend, and the results were reported in a paper read at the recent meeting of the Iron and Steel Institute. A number of previous investigators reached the conclusion that it is the manganese in steel, introduced in the process of manufacture, that is largely responsible for the rapid rate of corrosion of much of the present-day steel. The most notable statement to this effect was the paper published by Cushman in 1905, when he was connected with the Department of Agriculture. The series of tests carried on by Hadfield and Friend included also the effect of increasing percentages of carbon on the rate of corrosion. It was found that the addition of carbon from 0.03 to 1.63% to pure iron containing less than 0.2% of manganese produced a steadily increasing rate of corrosion as the carbon increased. These tests were made with specimens immersed both in fresh water and in sea water. When the metal was immersed in dilute sulphuric acid, there was a rapid increase in the rate of corrosion as the quantity of carbon increased until a maximum was reached at 0.8% carbon. Tests were then made on similar steels containing 0.7% of manganese.



DETAILS OF INDICATOR ESPECIALLY DESIGNED FOR IRREGULAR PLANER WORK

at *F1* is at the highest point. The planer tool should have the same radius as the button *E* and be adjusted in the tool block to the same relative position on the job as the button is on the templet.

The head is then moved to the edge of the job and the cut started in the usual way. The indicator is tapped up or down in order to bring the pointer at *F1* to zero. The planer is made to feed at the start of the return stroke,

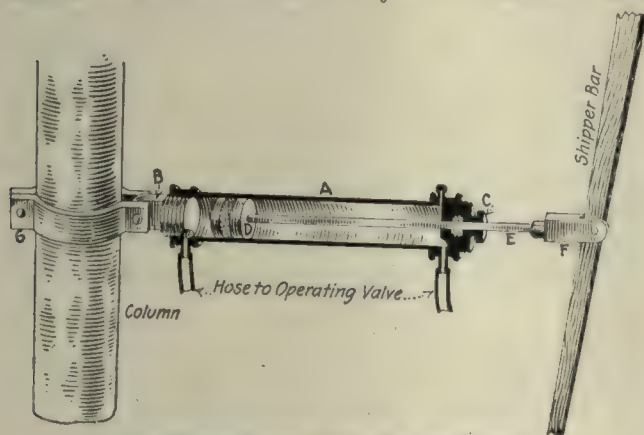
The result was a very slightly increased corrosion when the metal was immersed in both fresh and salt water, until the carbon content reached 0.4 to 0.5%. From this point upward the manganese affords a slight protection. When the steel was immersed in dilute sulphuric acid, however, the specimens containing the high percentage of manganese showed an enormously increased corrosion. Steels were then tested in which the manganese content had been increased to 2% and upward. These specimens showed greatly decreased corrodibility in neutral solution, but the corrosion in dilute sulphuric acid was greatly enhanced.

Letters from Practical Men

Air-Operated Clutch Shipper

The illustration shows an air cylinder for operating the clutch shipper on a 4.5-in. shell-band turning lathe. These lathes will machine the copper band in less than 45 sec., so that unless some power arrangement is used to start and stop the lathe, the operator soon becomes tired out pulling the shipper bar back and forth, which reduces the output considerably. It takes about 20 hp. to drive these machines and the pull required to move the shipper is correspondingly great.

The cylinder *A* is made of 2-in. brass pipe having a union threaded on each end. A joint *B* is screwed in at



AIR-OPERATED CLUTCH SHIPPER

the column end, and a stuffing-box *C* at the other end of the pipe.

The piston *D* is a piece of round steel turned an easy fit for the pipe and having a groove for the packing. The piston rod *E* is a piece of $\frac{3}{4}$ -in. cold-rolled steel screwed into the piston and fitted at the other end with a yoke *F* to take the shipper bar.

The joint *B* swivels on a pin in the clamp *G* on the column. This column is fitted with flanges top and bottom to bolt securely to the floor of the shop and the beams above.

The two pieces of hose are run to an air-operating valve which is made by the Manufacturers Equipment Co. and is of the kind supplied to operate double-action air chucks. This valve by a movement of the lever admits air to either end of the cylinder as desired, at the same time opening the opposite end of the cylinder to exhaust.

The operating valve can be fastened anywhere on the lathe convenient to the operator, and by having the chuck operated by an air cylinder too, the time occupied in putting a shell into the machine, chucking it and starting the lathe is reduced to an absolute minimum and the operator saved considerable muscular exertion.

The machine on which we are using this equipment is driven by a 20-in. expanding clutch of our own make, running on the lineshaft with a pulley 30 in. in diameter by 10 in., the face keyed to the clutch. The lathe spindle has a 15-in. pulley and we use a 9-in. belt, running the machine at 220 r.p.m.

We can turn a shell band in 45 sec. from floor to floor, but it appears to be physically impossible for a man to keep up this rate for long. We can get 325 shells per shift, which is about as many as the average man can handle per day and keep his tools, etc., in condition.

We find that with 90 lb. air pressure the air shipper is too quick, and have fitted a valve in the air-supply line to throttle down the pressure.

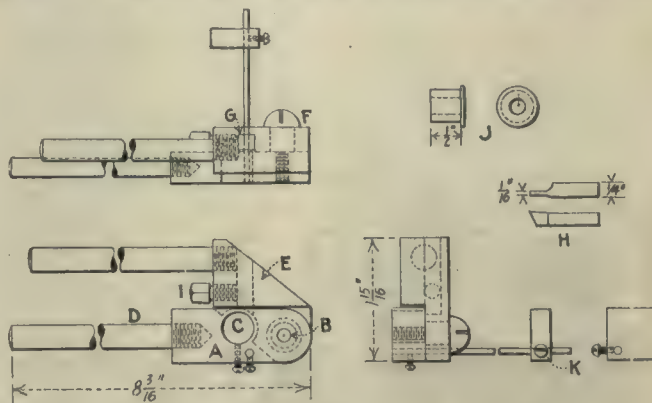
Nova Scotia, Canada.

JOHN S. WATTS.

Convenient Cutting-Off Tool

Having to cut off a great many short lengths of small rod and tubing in both iron and brass ranging from $\frac{1}{8}$ to $\frac{1}{2}$ in. in diameter and from $\frac{1}{8}$ to 5 in. in length, I deemed it inadvisable to tie up the lathe with such seemingly insignificant duty. Consequently, I made the attachment here described and found it highly satisfactory and convenient.

By using the hollow-spindle speed lathe I could mount an entire mill length of the stock, allowing several feet to project at each chucking; or by first sawing off lengths



A CONVENIENT CUTTING-OFF TOOL

that would just clear the floor I could use the drill press. I have also made an ordinary fan motor serve by mounting a small drill chuck in place of the fan blades.

The tool consists of a piece of $\frac{1}{2}$ x1-in. machine steel *A* tapped $\frac{1}{4}$ -20 threads at *B*. A $\frac{1}{2}$ -in. hole is drilled at *C*, and a piece of $\frac{3}{8}$ -in. round iron about 6 in. long is screwed in at *D* for a handle.

A piece of $\frac{3}{4}$ x1-in. steel *E* is cut out to fit over *A* as shown, with a body screw *F* forming a hinge. A square hole *G* carries a short piece of $\frac{1}{4}$ -in. square tool steel *H*, ground for a cutter with the cutting edge slightly oblique. This is held in position by the $\frac{1}{4}$ -in. setscrew *I*, which permits adjustment of the cutter in or out according to the diameter of the stock. A piece of $\frac{3}{8}$ -in. round iron is also inserted in *E* for a handle. Hardened-steel bushings like *J*, bored to fit the various diameters of the stock, were used in the $\frac{1}{2}$ -in. hole *A* and held by a small setscrew.

In operation the revolving stock was passed through the bushing until it brought up against the adjustable

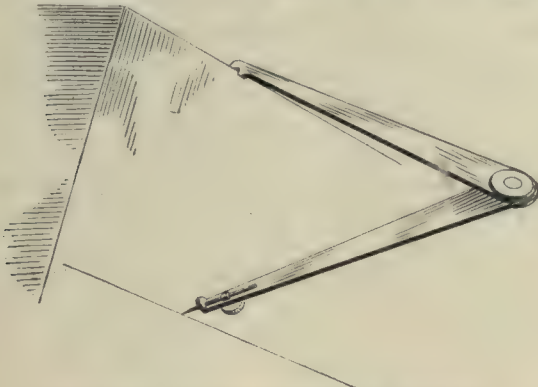
stop *K*. The handles were then squeezed together, bringing the cutter against the work. The pressure required on the handles is slight, and the time for the operation a matter of a few seconds only, the projecting point of the cutter cleanly removing the piece without leaving any burr. A slight side pressure toward the remaining stock faces off the burr that has a tendency to remain there.

Newark, N. J.

WALKER S. QUIMBY.

Improved Hermaphrodite Caliper

The hermaphrodite shown in the sketch is an improvement over that most commonly used, owing to the extra bearing point the function of which can be plainly seen. When laying off a line with a hermaphrodite not possessing this extra point, the scriber point of the tool will mark



IMPROVED HERMAPHRODITE CALIPER

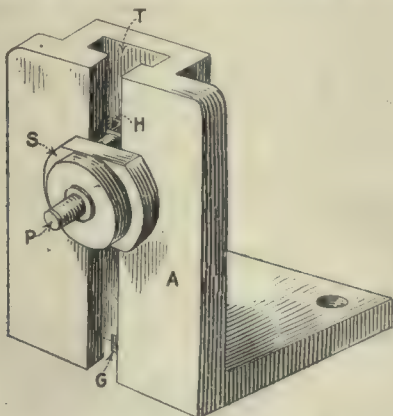
off a line varying in distance from the edge of the piece, in accordance with the varying of the contact point in relation to the top of the piece. In using the improved hermaphrodite the extra contact bearing upon the top of the piece keeps the other contact point always the same distance from the top edge of the work. Therefore the line is more apt to be parallel to the edge of the piece.

Newark, N. J.

GUSTAVE A. REMACLE.

Surface-Grinder Angle Plate

It is generally conceded that disk grinding, wherever practicable, saves a considerable amount of time and labor. Herewith is described a simple and inexpensive



ANGLE PLATE FOR SURFACE GRINDER

attachment for second-operation work, used for facing pieces in which a hole has previously been reamed. The body of the fixture is an angle plate *A*, which is

bolted to the regular work table and located by the tongue *G*, fitting the regular slot. The vertical T-slot *T* extends the full length of the face and carries the square nut *H*, of steel, which is threaded to fit the shank of the supporting flange *S*. This flange is turned, with the pin *P*, from round steel stock, having two flats for tightening in place, and casehardened. The work is slipped over the pin *P*, which is slightly undersize and $\frac{1}{16}$ shorter than the overall of the piece, and fed against the wheel. As most surface grinders are provided with micrometer stop, it is possible to work to fairly close limits.

The flanges may be made with pin diameters from $\frac{1}{4}$ in. up, in as many diameters as necessary. It will be noticed that there is a slight boss back of the pin to square the work; the pin also has a dirt groove, which is essential for accurate duplication of work.

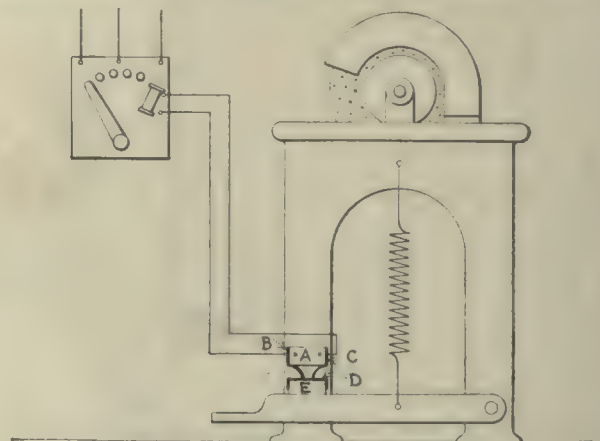
In my experience this attachment has not only saved much time, but has done away with a great deal of expense for counterbores, facers and pilots.

Charles City, Iowa.

H. B. McCray.

Automatic Grinder Shut-Off

Nearly every machine-shop foreman knows that the ordinary shop grinder is one of the most troublesome machines about his plant. A new wheel will be used only a short time before it requires dressing; and if this is not done promptly and periodically, the wheel will soon be sufficiently out of balance to cause it to vibrate badly, making it difficult to perform a neat job with it. Bear-



AUTOMATIC GRINDER SHUT-OFF

ings are also a source of trouble, as they run at high speed, and grit and dirt will get into them in spite of all precautions that may be taken.

When these grinders serve for the usual run of odd jobs in the average machine shop, the tool is working under a handicap, as it is used by everybody and no one is responsible for its condition. The result is frequent stops for repairs.

An analysis of conditions where this sort of trouble existed developed that the grinder was needed many times a day by the various workers, but for only a few minutes at each operation. The total time of actual use of the machine did not exceed two hours out of ten. It therefore seemed advisable to have the grinder stopped and started for each particular job.

As this grinder was driven by an individual motor, controlled by an ordinary starter, this plan was easy of accomplishment. An insulated block *A*, shown in the

sketch, was attached to the frame of the machine. To this block were attached two strips of metal *B* and *C*. Wires were run from each of these strips to the release magnet on the starter and secured under the screw heads on the starter front.

A foot pedal was arranged with a spring, so that when in its normal position a strip of metal *D* mounted on an insulated block *E* and affixed to it would be held in contact with the other two contacts. To start the grinder, the operator first steps on the foot pedal, which relieves the short-circuit on the release magnet, then starts the motor in the usual manner.

When he is through with the machine, removing his foot from the pedal causes the latter to assume its normal position, short-circuiting the release-magnet circuit, which causes the starter arm to return to the "Off" position, thus stopping the motor.

This arrangement has been in use four years, and the machine has been repaired only three times during this period, whereas before this equipment was installed the machine needed overhauling about once a month.

Madison, Wis.

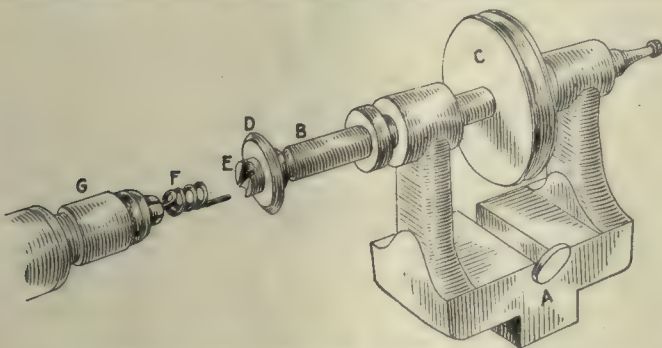
F. S. CULVER.

Grinding Small Holes on the Bench Lathe

Grinding very small holes with the bench-lathe grinder and diamond-charged laps is, to say the least, a monotonous job. The following scheme was worked out to relieve the monotony. Being successful, it allows time to work on something more interesting.

The drawing shows a simple and effective method of causing a grinder spindle, of the type shown, to move back and forth on short holes; that is, where the travel does not go beyond about $\frac{1}{2}$ in.

Referring to the drawing, *A* is the grinder frame, *B* the spindle, and *C* the belt pulley. At *D* is a loose washer



AUTOMATIC FEED FOR BENCH-LATHE GRINDING ATTACHMENT

of hard rubber, which is held in the fingers ordinarily and used to push the spindle back and forth, while *E* is a screw for holding it in place. A small coil spring *F* is bent as shown and held in a drill chuck in the lathe tailstock.

In operation the device works as follows: The screw head *E* has had notches ground in it on the emery wheel somewhat in the shape indicated. Then, by adjusting either the pulley on the grinder spindle or the pulley on the countershaft, the pull of the belt has been arranged so that the spindle when in motion will have a tendency to just throw back against the spring which is held in the drill chuck. Revolving as it does at a rapid rate of speed, about 25,000 r.p.m., the notches in the

screw striking on the end of the spring cause it to kick the spindle in such a manner as will make it move back and forth.

This motion is about what one would give it by hand, not as might be expected a bounding back and forth in rapid succession; that is, it will be if the belt pull is balanced properly. This of course can soon be determined by experiment.

For grinding longer holes than those mentioned, one could make up an arrangement similar to the bobbin-winding device that is seen on some styles of sewing machines, notably the Singer. This consists of a worm and worm gear of simple construction and a heart-shaped cam that operates a lever back and forth. While this device has not been tried by me, I have seen it in use by toolmakers in the Howard and Waltham watch-factory toolrooms and know it to be a success.

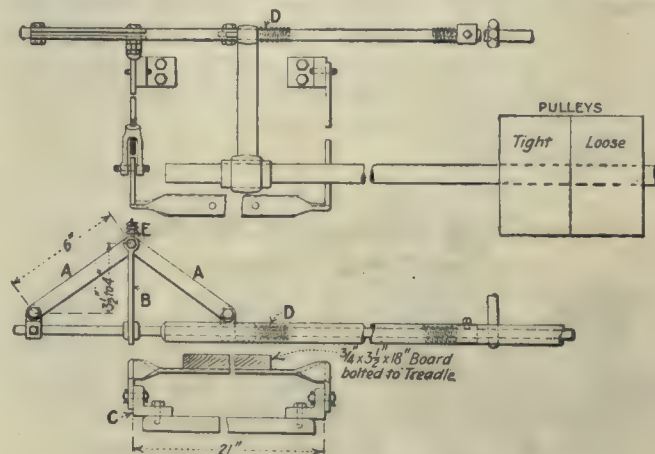
Jersey City, N. J.

DONALD BAKER.

Automatic Shutoff for Tool Grinders

A practice among workmen who have to do their own grinding of tools and drills is to walk away from the emery wheel, leaving it running. In a short time the bearings of the wheel are worn out.

The accompanying illustration shows a good device for overcoming this habit, and it is not expensive to install.



AUTOMATIC BELT SHIFTER FOR TOOL GRINDER

The toggle links *A* are fastened in the center with the connecting-rod *B*, which is connected to the treadle *C*. A spring *D* draws the shifter rod back, and a spring *E* helps lift the weight of the treadle.

For grinding, the operator must place his foot on the treadle and hold it there until the grinding is completed. Immediately upon his departure from the emery wheel it automatically shuts off. This device is simple to make, and it can be applied to small shops as well as to large ones.

CHARLES E. HENDRICKS.

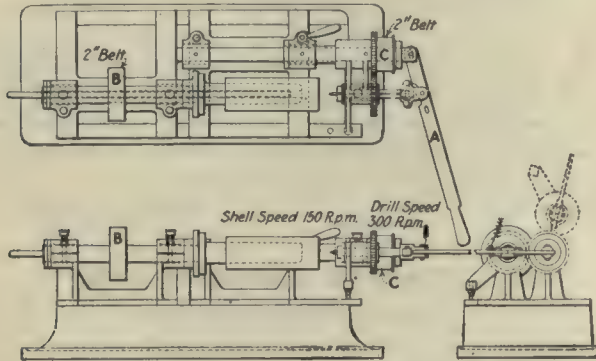
Flint, Mich.

Centering Machine for Shell Blanks

The illustration shows a machine for testing and centering shell blanks. It has a capacity of 100 shells per hour. The operator soon becomes proficient enough to detect at a glance any shell that will not clean up on the outside and thus returns it to the forgers.

The machine is driven from a countershaft. The 8-in. pulley *B* on the main spindle should run 150 and the 5-in. pulley *C* 300, both in the same direction. The gearing causes the drill spindle to rotate in the opposite direction to the work, insuring a center true with the hole in the work.

The drill spindle is splined to a sleeve running in a brass bush. The spur gear is keyed to the sleeve and is driven by a similar gear integral with the pulley *C*.



SHELL-TESTING AND CENTERING MACHINE

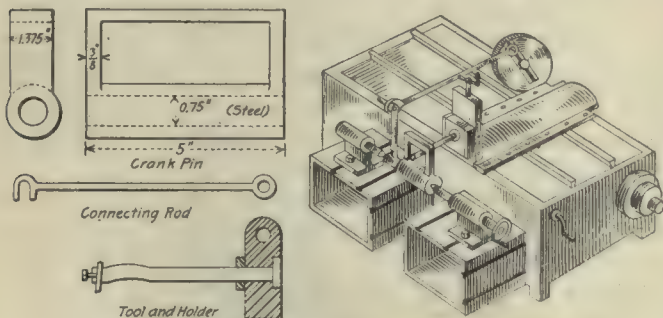
The inner spindle and tapered mandrel are both hollow, to admit the knock-out rod. The lever *A* is thrown up out of the way when replacing shells, the lever being counterbalanced by a spring, from above to keep it up.

The casting carrying the main spindle and the one carrying the lever spindle are similar. So far as I know, this is the most rapid and satisfactory method of testing and centering shell blanks.

H. P. HOAG.
Brantford, Canada.

Turning Integral Wristpins on a Shaper

To finish on the lathe a crankpin that is solid with the crosshead, of the type shown, is tedious and tiresome and requires two men. I therefore decided to do the job on an old crank shaper. Two centers were set crosswise and



TURNING INTEGRAL WRISTPINS ON A SHAPER

square to the shaper head. Then the connecting-rod that drives the head was removed, and the gibs were tightened. The work, on an arbor that has a lever on one end, was inserted between the centers. The lever is connected to the gear wheel by the connecting-rod shown. The amount of travel is regulated by setting the shaper crankpin toward or from the center of the wheel. The crossfeed is used to move the tool. The part is finished with the index heads in line with the ram.

I cut the time in half by this method, and I believe this idea could be used on lots of work that has only part of a circle to be finished.

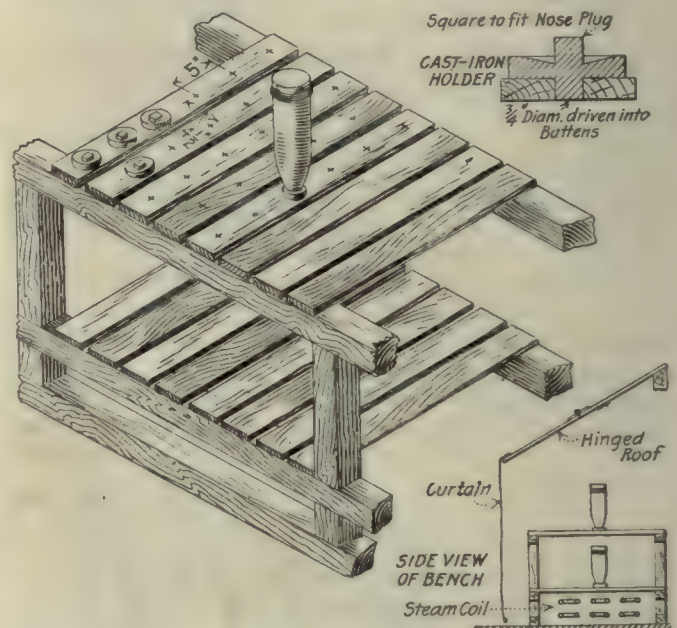
KARL FENNELL.

Davenport, Iowa.

[We have done this work years ago by using two lathes set parallel. A pin in the faceplate of one lathe acts as a crankpin. A connecting-rod from this to a pin on the large faceplate of the lathe used for the actual turning gives the spindle of this lathe an oscillating motion. The stroke, or amount of oscillation, is changed by adjusting the pins.—Editor.]

Paint-Drying Bench for Shells

The illustration shows a bench for holding shells while the paint is drying. The only parts of the shell not painted are the copper band and the nose plug. It is therefore necessary to stand the shell on its nose, where it is "in a condition of unstable equilibrium," as the textbooks put it. This condition can be overcome by having castings made to fit the nose plug, a square projection fit-



PAINT-DRYING BENCH FOR SHELLS ARRANGED TO HASTEN THE DRYING PROCESS

ting the square hole in the plug. These castings have on their underside a cylindrical projection that is driven into a hole in the bench, as shown in the detail in the illustration.

The bench itself is made of $3\frac{1}{2} \times \frac{3}{4}$ -in. hardwood pieces fastened at $4\frac{1}{2}$ -in. centers, thus leaving a 1-in. space between to allow for the circulation of air around the shells.

Underneath the bench a steam coil is run to heat the air and so hasten the drying, as the quicker the paint is dried the smaller and consequently more easily loaded will be the bench required for a given output.

To further speed up the drying a light roof is built over the bench, the front half of which is hinged to facilitate the putting in and taking out of the shells. Fastened to the front of this roof is a curtain of light canvas that can be let down when the bench is filled and so keep the heat in and the dust out.

JOHN S. WATTS.

Nova Scotia, Canada.

Discussion of Previous Question

Same Hours for Office, Drawing Room and Shop

The editorial in the issue of July 20, suggesting the same hours for office, drawing room and shop, is interesting and brings up for consideration many points that were evidently overlooked. From a purely theoretical viewpoint there seems to be no just reason for compelling a machinist or a tool maker to labor longer per day than the office clerk or the draftsman. What are we to do about it? Will the shopman's hours of labor be reduced, or will the office force be compelled to hit the time clock at 7 a.m.? Eight hours per day is the generally accepted standard for office and drafting-room employees, and it has also been the dream of the producer for many years.

Suppose we ask our office and drafting-room employees to work the same hours as the productive force. Well, to make a long story short, they would not take kindly to the innovation. The more skillful would seek employment where conditions were more favorable. To compel office employees to work longer hours than those they have been accustomed to would be such a decidedly new departure from the present order of things that it is hard to predict what the ultimate result would be.

I have never been an office employee, therefore I cannot state from experience the conditions governing such labor; but from my experience as a designing draftsman I wish to state most emphatically that those who have never worked at the board do not realize the amount of daily mental effort that this work demands. Designs originate in one's brain; to place them in black and white so as to enable another to understand them calls for close mental concentration, which is very fatiguing, to say the least. Again, for a moment consider the long hours the draftsman spends in working out complicated mathematical problems, of which the average shopman is as ignorant as a babe unborn, and then ask yourself if you think it just to compel him to work longer hours than he does at present.

F. B. JACOBS.

Indianapolis, Ind.

Force Fits and Allowances

I have recently had occasion to look into the subject of forced fits, and of the many articles written the best I have found was that of Professor Jenkins, in the *American Machinist*, Vol. 42, page 377, where he develops a theoretical formula showing how the force varies with the different materials and dimensions of the hub and then checks the theoretical work with shop records of different fits. Because of the excellence of this article I would like to add a few constructive comments that would be of assistance to anyone applying the formulas to different classes of work.

Take the three pieces, a pulley and flywheels, shown in section in Fig. 1. Give each the same size of hub and allowance to press on shafts. It is evident that each would require a different force to press on. The elemen-

tary friction formula is that the force to press in the shaft equals a coefficient of friction multiplied by the total pressure exerted in the contact between the hub and the shaft surfaces. From our knowledge of friction one cannot expect much of a change in the value of the friction coefficient for the three pieces, so there must be a large change in the total pressure between the hub and the shaft surfaces. In Fig. 1-A the hub changes diameter in pressing on and, neglecting the small rim, the hub only exerts a pressure on the shaft. In Fig. 1-B the hub arms

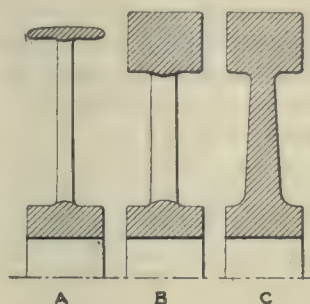


Fig. 1.

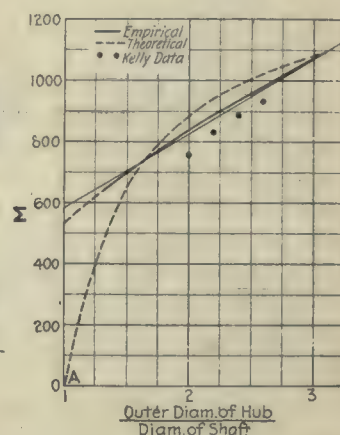


Fig. 2.

FORCE FITS AND ALLOWANCES

Fig. 1—Sections of a pulley and two flywheels. Fig. 2—Force-fit curves

and rim are all distorted by the change of hub diameter and exert a pressure on the shaft. In Fig. 1-C, due to the disk, a still greater squeezing pressure acts on the shaft. Professor Jenkins' formula accounts for the pressure exerted by the hub only and should give correct results for such cases as crank disks and Fig. 1-A. But for Figs. 1-B and 1-C the formula should be multiplied by some factor to take account of the additional force exerted by the rim. Average of a number of records of flywheels, as in Fig. 1-B, shows this factor to vary from 1.8 to 2.5, the higher values being for the heavier rims, the same factor applying to both cast-iron and cast-steel wheels. For the disk flywheels of Fig. 1-C the factor varied from two to three times Professor Jenkins' formula.

In analyzing the MacGill data Professor Jenkins finds that it requires about twice the force of that obtained from crank disks. Could not this be explained by the MacGill records being from machine parts in which more than the hub should be considered as squeezing on the shaft? Since both cases used the same lubricant of linseed oil and white lead, one could not expect a great change in the coefficient of friction, but would look for a change in the total pressure between the hub and the shaft.

Could not a peculiarity of the miscellaneous character of the work recorded by MacGill (*A. S. M. E.*, Vol. 39, page 941) have led him to recommend a constant allowance for all diameters?

The point is that of the law of friction that the force to press on equals the coefficient of friction multiplied by the total pressure between shaft and hub; and in any analysis the relative importance or "weight" should be given to the coefficient and the pressure; that we cannot expect much change in the coefficient, so the pressure is of greatest importance; that the influence of parts other than the hub must be carefully considered either by calculations or by a multiplying factor for the hub based on judgment and experience to account for the added stiffness of the other parts; and in theoretical calculations or shop records only one type of machine part should be analyzed at a time, and the resulting formula would apply to no other type.

In Professor Jenkins' article there is developed from an accepted theory a theoretical formula for a cast-iron hub on a steel shaft. The variable quantity M is expressed theoretically from a part of equation 18 and plotted in a curve (dashed line) for the coefficient of friction $W = 0.085$. An empirical formula, equation 31, is then given for M as drawn from the records of forced fits on crank-pins, crankshafts and piston rods, and shown in heavy-line curve. Why does not the actual curve agree with the theoretical? The actual curve has to drop down and pass through the point $M = 0$ when there is no thickness to the hub, and the heavy line shown will not pass through the point marked A . Could this be due to a mixture of data for crankshafts and pistons when from their shape they should have been treated separately? From an empirical curve with the working range given, why should not a straight line answer the purpose and simplify the formula?

T. C. Kelly, in Vol. 22, page 660, gives four curves from fit records of the same company. Four values of M can be calculated from these curves, and the points are shown by small circles in Fig. 2. They appear to lie on a theoretical curve with a value of friction coefficient of $W = 0.075$ instead of 0.085.

I mention these points as they occur to me in the hope that they may be of value to those working on this problem.

S. H. WEAVER,

Supvr. of Drafting Calculation, General Electric Co.
Schenectady, N. Y.

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Where Are the Good Mechanics?

The article by J. P. Brophy on page 236 presents a situation that confronts thousands of manufacturers at the present day. There may be scores of reasons for the lack of good mechanics, but let the writer who was once an all-around machinist—and still proud of the fact—explain the situation as seen by one who has risen from the ranks. To begin with, the trade seems to have lost much of its dignity of late years. Twenty-five years ago it was considered of some consequence to be an all-around man. It meant high wages—for that time at least—and the skilled mechanic was looked upon as a sober, industrious citizen and a valuable asset to society. If a boy started to learn the machinists' trade, it was with the intention of making it his lifework. He was proud of his chosen calling and his whole heart was in it. And if he was mechanically inclined he became a skilled workman.

Times have changed, however, and the steady march of progress has altered the conditions that existed a quar-

ter of a century ago. In place of the all-around man we have the operator, one who is skilled at a particular branch of the trade. He may be a lathe hand, grinder hand, planer hand, tool- or diemaker, but in the strictest sense of the word he is not an all-around machinist. As an illustration, a tool- or diemaker would be too slow and painstaking to operate any of the present-day manufacturing automatics—as we term the complicated screw machines that have taken the place of the lathe of yesterday—and, on the other hand, a competent operator of our modern automatics would be out of place in the tool-room; a bull in a china shop would not have anything on him.

In looking for suitable reasons for the lack of good mechanics we must view the case impartially, abandon theory as much as possible and consider the actual facts as they exist. To begin with, we have no apprenticeship system. We do not try to teach the young mechanic the machinists' trade as it existed in my younger days. We hire boys and put them to work on routine operations, affording them no chance to become skilled at the several branches of the trade. To be sure, some of these young men become skilled at all-around work by traveling and working in different localities, and in nine cases out of ten they eventually become toolmakers. Anyone will admit this to be a fact, as there is no lack of competent toolmakers in our large manufacturing centers. How many of them, however, ever served their time at tool-making? They just drifted into it because their experience as tramp machinists developed the initiative and courage to tackle the unknown. From the toolroom many of them drift into the drafting-room, as expert toolmakers make excellent tool designers because of their practical knowledge of tools and shop practice.

Other skilled machinists often become traveling salesmen. While working nine or ten hours between four walls they often have opportunities to observe the salesman as he strolls through the shop looking for the superintendent or foreman. The machinist notices the well-fitting clothes, clean linen and occasionally catches a whiff of a two-for-a-quarter cigar which naturally causes him to think: "Why in h— can't I be a salesman; what's the use of staying cooped up in here?" Result—another good mechanic takes to the road.

In passing I will state that this is no idle dream, for in my own experience as a traveling salesman I have met hundreds of ex-machinists selling steel, grinding wheels, small tools, machine tools and other shop accessories too numerous to mention. Thus it is seen that the machinists' trade is a stepping stone to other things—a constant factor toward thinning the ranks. I do not wish to appear egotistical, but I will state most assuredly that it takes a fair amount of gray matter and close application to become a skilled mechanic, and it is these very factors that cause the machinist to seek more congenial employment. The ambitious workman sees others rise in the business world and he strives to emulate them. This is all very well, as ambition and progress are twins, so to speak. But it does not answer the present question.

Another point that we must not overlook is the question of compensation. It is not my intention to state that machinists are underpaid, as their wages are regulated by the law of supply and demand. Yet they do not receive as high wages as many other skilled trades; and even if one does have to toil for his daily bread we

certainly cannot deny him the right to choose a trade that pays high wages. Other skilled workers—carpenters, masons, tile setters, plumbers, steam fitters, printers, engravers, locomotive and marine engineers, boot and shoe workers and a score of others—receive higher wages and in many cases work shorter hours than the machinist, and these trades, therefore, experience no trouble in finding apprentices.

While considering the machinist's case let us indulge in a few simple figures. Suppose he receives 40 cents per hour and works nine hours per day. If he could accomplish the almost impossible feat of getting in full time for one year he would have earned \$1,123.20. It is no more than fair that he should take at least two weeks' vacation during the summer, which brings his total down to \$1,080. Statisticians inform us that the average worker loses ten days out of every year through sickness. In this case the total shrinks to \$1,043.90. As every worker is bound to lose some time in the course of the year through tardiness in reporting for work we will take ten hours as a conservative average. This amounts to \$4, which leaves \$1,039.90. Many machinists are affiliated with their union, the dues of which are \$12 annually, not counting occasional assessments, so we must subtract this amount, which leaves \$1,027.90. The number of holidays in different states varies, but seven per year is a fair estimate. As the machinist has to lose this time it means \$25.20 to him. Subtract this amount and we have a net total of \$1,002.70. In considering these figures we must not overlook the fact that all machinists do not get 40 cents per hour. Indeed, in some localities 30 cents per hour is considered good wages.

Let me relate an incident that came to my notice a few months ago, which bears on the question of the wages paid in different trades. I was interviewing the purchasing agent of a steel foundry in the Middle West, and as his office was on the ground floor we had occasion to observe several negro hod carriers who were working on an adjoining building. "Those fellows certainly work hard, don't they?" I said. "Yes," he replied, "but they are well paid. They get \$3.50 per day."

It begins to look rather queer, doesn't it? We pay unskilled labor the same wages we expect the expert machinist to work for, notwithstanding the fact that it takes several years of study and application to become a skilled workman, to say nothing of having to purchase an expensive kit of tools.

In conclusion, can we really blame the man for quitting his trade if an opportunity offers, and can we blame the young man for choosing a trade that pays better wages?

Indianapolis, Ind.

F. B. JACOBS.

In the *American Machinist* on page 236 J. P. Brophy asked the question just why there are not as many good mechanics as there were years ago. He says it is difficult to find a man nowadays who can work with equal skill on all standard machines. In my opinion the reason for this is that the apprentices do not learn to run more than one machine.

In the old days a boy wanting to learn the trade would usually do so in a small or medium-size shop and would consider himself fortunate to get in at all, although his wages were generally less than boys are in the habit of receiving today. The boss was in those days able to get a better price for his products, wages for mechanics were

lower, and competition was not quite so keen as nowadays. Small wonder, then, that the boss was able and willing to give his apprentices a chance to try their hands at different jobs and thus work on different machines, at the same time telling some of his best men to look after the boys.

Time was not quite so important a factor then as it is today. Let a boy start in one of these shops now, and they will pay him a better wage than ten years ago; but the boss usually decides what machine the boy is to be taught to run. They show him how to do a certain kind of work on a certain kind of machine, and they will keep him there as long as the boy is satisfied to stay. Should one of the workmen step over to tell the boy more about his job, how it could be done on another machine, etc., he would most likely be told to dispense with his hot air and not waste his and the boy's valuable time.

I remember that, when I was learning the trade, the boss bought several pounds of large nails and after showing me how to make a good flat drill told me to go ahead and make drills of all the nails. I forged and filed them, and the boss himself looked over each of these drills, pointing out their defects. Then he showed me how to harden them, as if they were steel. I also drew the temper, and these fake drills were criticized again. Then I was given a few lengths of drill rod, and I had to make real drills. This, I believe, was a good way to learn that particular thing. Are there many employers who would consent to have their boys' time taken up in this manner?

Large shops are nowadays specializing to such an extent that one man, for example, is turning up crankshafts every day in the year. Another may be draw-filing the same piece all the year around, so where can the resourcefulness of the all-around mechanic develop?

The apprentice schools maintained by some large shops are good, but the schools themselves cannot turn out all-around machinists unless they also have a variety of jobs to do in the shop. Let us take, for example, the case cited by Mr. Brophy. Give one of the machinists turned out by one such big concern that $\frac{3}{8}$ -in. by 3-ft. rod and tell him to reduce it to $\frac{1}{4}$ in. in diameter. He will know how to center it, and he may even think of the steadyrest, but the chances are that he will not spot the rod before applying the steadyrest. He has of course done one such job at the school, but he forgot all about it because in the shop they kept him on the drilling machine or the miller.

You cannot make a good machinist of anyone by letting him do a job once. He has to do it repeatedly. The large shops keep the boys doing the same thing to make them earn their wages and help support the schools.

Many a man hiring out as a first-class lathe hand does so, believing himself to be just that, because he perhaps has stayed too long in one place or has done the same kind of work all the time; but when he starts in a new shop, he finds himself at a disadvantage and will soon be known as a faker. This is the fault of the system, not of the man.

JOSEPH LIMBRUNNER.

Shelton, Conn.

I have read with interest Mr. Brophy's article on page 236. I shall endeavor to explain the whereabouts of our good mechanics.

You hire a planer hand or a lathe hand or a miller hand and find that he is inefficient. Such men now pose as first-class all-round expert machinists. Where are the machinists? Oh, they are now first-class, expert tool, die and gage makers. They wear a white apron in place of overalls, have a new and more fancy tool box, a lot of gumption, and they get away with it—after a fashion. Where are the real tool makers? They are smothered among the new crop that has sprung up. The real tool maker is now at a loss to find enough adjectives of sufficient power properly to express his superiority over the new class—when applying for a job.

Conditions are such that many more thousands of mechanics are required than are available. While the plants are now wondering where the good mechanics are, the good mechanics may—when the rush is over—wonder where they can find someone who is willing to pay the price for a good mechanic. GUSTAVE A. REMACLE.

Newark, N. J.



Fitting Flywheel Keys

Why are tapered keys avoided as much as possible in machine-tool work? Is it not because of the difficulty in fitting and the inspection occasioned by their use? Does not the fit depend entirely upon the man who does the final fitting, for what inspector is going to draw keys to see if the fit on all four sides is what it should be?

Mr. Haas' article (Vol. 44, page 1087) seems to dwell more on the fitting of engine-flywheel keys. But do not numerous machines have flywheels that are subject to much greater stresses and sudden shocks than are most engine flywheels? Take for instance a punch press or a nail-making machine. These machines depend on the inertia of the flywheel to carry them over what would otherwise be a great overload, and the load is suddenly applied too. In the case of the punch, it is the practice of one firm at least building these and kindred machines to make the flywheel a wringing fit on the shaft, and drive a straight key in tight on the sides and $\frac{1}{64}$ in. loose top and bottom. The manufacturing problems involved are the holding of the shaft and hole diameters correctly, and keeping the keyways central in both shaft and hole.

A tightness of 0.002 to 0.006 in. may be allowed on the sides of keys, provided there is room for the metal to flow in the other direction and that the key is stiff enough to stand flogging without bending over.

The slot miller mentioned by Mr. Haas has the objection of slowness to overcome in large work. The Newton system of a disk cutter to mill the length of the keyway and an end mill to clean out the ends is much more practicable for medium-sized work.

When taper keys are specified—and they must be used if any hopes of interchangeability are to be entertained—the gaging system must be most comprehensive in order to take care of: (1) The diameter of the hole; (2) the width of the keyway; (3) the taper of the keyway with the center line of the hole; (4) the depth of the keyway, and (5) the coincidence of the center line of the keyway with a radial line drawn through the center of the hole.

The first point is a question of reamers in a manufacturing proposition, while the rest of the points may be taken care of by broaching in a machine fitted up with

good fixtures and subjected to inspection fairly often. Where no broaching machine is available the problem is such that it seems best to resort to the straight key as, to insure real accuracy, it would be necessary to gage a far greater proportion of the total number than if the broaching equipment were available.

In jobbing work very little trouble is experienced if the wheel and shaft are assembled, the depth of keyway calipered at each end, the length noted and these dimensions laid off on cold-rolled steel and the excess metal taken off in the shaper.

A shaper will prove to be of great utility on the erecting floor and is more useful than a surface grinder. Probably the best combination would be a shaper and a disk grinder, as the shaper could be used to "hog off" the metal and the disk grinder for the final finishing.

So far as broaching the keyways to size after assembly is concerned, there are two objections—in larger work, awkwardness and difficulty in handling; in small work, broach breakage.

With the shaper and the disk grinder even a large keyway may rapidly be finished, and the machines are also suitable for a good deal of the work beyond the limited range of a surface grinder.

Finally, when taper keys are used, the tendency is to sacrifice the extremely tight side fit when fitting for a good bearing on top and bottom. Should the wheel move on the shaft, the fit is in nine cases out of ten a loose one, and it is only a matter of time before the key will come out. With a straight key, however, the fit is on the sides and is tight enough, or should be, to hold the wheel from moving along the shaft. A setscrew over the key might reassure some of the more timid or doubtful, a drilled and tapped hole taking very little time to make and setscrews being cheap.

Ironton, Ohio.

ROLAND V. HUTCHINSON.



A Keg-Moving Scheme

Some time ago, you published a description of a novel method of moving milling cutters in the shop, using a broom as a means of conveyance.

I recently saw the following method used for moving kegs of base plates for 18-lb. H. E. shells. The kegs weighed about 300 lb. and had suffered the discomforts of a long railroad journey. If they were rolled across the floor the jolting would burst the heads and spill the contents.

The kegs were standing on their ends and were tilted enough to allow a shovel to be slid under them. It was then an easy job for a helper to pull the novel skid and its load to the lathe. Of course the keg had to be steadied on the shovel while in transit; but it arrived in good time and all in one piece.

A. F. MENZIES.

New Westminster, B. C.



Compressed Air, the air which is compressed in front of a projectile in flight, is an important factor to be reckoned with in the designing of anti-aircraft guns and in the study of their action and efficiencies. A single instance of the complications encountered is seen in the study of falling bodies. Gravity, of course, if not interfered with, produces a constantly accelerated drop, but this is opposed and may be entirely negated by the gradually increasing resistance of the air. When this resistance equals the force of gravity, no matter what the height may be, there can be no more acceleration and, in fact, on account of the increasing density of the air there must be some actual retardation.—"Compressed Air Magazine."

Editorials

How Far Can Supervision Replace Skill?

There is a shop in New England that produces a large quantity of intricate drop forgings, which necessitates the operation of an extensive toolroom in which all the dies for this work are made. This department is well equipped with up-to-date machine tools; its work benches are arranged in such manner as to obtain good light upon the work; in fact, it resembles in appearance many other well-arranged, modern die-sinking departments in other parts of the country.

Operating the machines and working at the benches are employees who resemble very closely those found in any other like department. They appear to be capable men and go about their work as if they understood it. And this work is not simple by any means.

The strange feature about all this is something that is not evident on the surface. It is claimed by the management of this shop that not one of the sixty-odd men employed in this department is an experienced die maker or has had previous training in this work. As a matter of fact, those skilled die makers who had been previously employed in this shop left the locality for the more profitable fields that developed from the demand for munition making, which carried away not only skilled die makers, but the semiskilled as well.

One of the men employed was pointed out as an ex-chauffeur who had been in the shop for two months. If it had not been for the known veracity of the informant, this statement would have been received with considerable doubt, as the class of work that this man was engaged upon was considerably above the average.

As a matter of fact, a decrease in the available supply of skill must be overcome by an increase in the grade of supervision. In this particular plant, although skilled men have been replaced with those not skilled, dies are still made, forgings are still made, costs have not been materially increased nor quality reduced. Examples of this kind bring up the question as to the extent to which intelligent supervision can replace skill.

High Cost of Shipbuilding in Navy Yards

The criticism from certain quarters of the policy of ship construction in Government navy yards may perhaps be well founded; but if so, it is not because the workmen in the navy yards are inferior to those in privately owned yards. This is a point which should clearly be understood, in order that the responsibility for the slowness and the high cost of work in Government establishments in general may properly be placed.

Shipyard workmen drift about from shipyard to navy yard and from navy yard to shipyard. There is not a shipyard that does not employ workmen who have worked in navy yards, nor a navy yard that does not employ workmen who have worked in shipyards. Men who were

born and brought up in English and Scotch shipyards are found in both Government owned and privately owned yards over here, many of them holding responsible jobs.

Draftsmen, foremen and other supervisory men shift about between navy yards and shipyards, too, so that there is a constant interchange of men, ideas, methods and practices. This is even true of piece-work prices; each yard has good information of the other yards' prices.

Workmen have ways of working, dependent usually upon the men from whom they first learned their trades and upon their early environment. A man's methods and speed of working are practically independent of his location, unless in one place he has better facilities than in another. In this respect, if there is a difference, the navy yards have a bit of an advantage.

The real difference is found in the high places. The *American Machinist* has consistently pointed out that reform in industrial management must begin at the top of the organization, and here is an excellent illustration. Navy yards are not well organized; it might almost be said they are not organized at all. Each consists of two or more departments with separate heads, each department with its own "organization," discipline, system, etc., and each considering itself and its interests to be paramount. Just a little active coördination, as has appeared at times in spots, makes such a big improvement as to be markedly noticeable and prove the general idea.

Privately owned shipyards are much better in this respect. They are not so well run, perhaps, as the average machine tool plant, but still they do hang together at the top; requirements for material are actively looked after; political interference is little, if any; department heads work together; there is one system of operation; there is a balance sheet by which to judge results.

People in general ought to know that the high cost of work in Government-owned activities is not the fault of the workman, but of the administration; and the cure is to be applied to the executive departments in Washington.

Training That Will Not Be Forgotten

Day by day little influences build upon the human mind various impressions which may not be noted at the time, but which culminate in lifelong habits of thought and action. The fact that this is done unconsciously in many cases is not evidence of any lack of permanency of the effect.

During the last two years the machine shops of this country and the machinists who work in them have been undergoing an unconscious evolution. What important bearing this will have on work in the future it is hard to predict, but only the most thoughtless will deny that the effect will be considerable.

One of the most important influences is likely to be that relating to the use of precision gages. Practically

all munition work calls for accurate gaging, and this has been accompanied by the invariable use of limit gages for indicating the proper amount of tolerance on each piece. Thousands of men who never before saw or handled a limit gage are now familiar with its use and think no more of working to close limits than they would have done formerly of taking a roughing cut. In reality it is much easier to turn out work with the aid of some simple device such as a limit gage than it is to guess at the size without it. Yet in many shops, previous to the war, the term "limit gage" involved a mental impression of something quite formidable.

While the employees have learned this lesson in the use of accurate measuring devices, the employers have also come to realize how necessary these tools are in order to produce goods at a minimum cost. They have learned that working to these fine gages, instead of increasing cost, as might be imagined, has reduced it and has brought about the somewhat paradoxical situation in which it is cheaper to produce work to close limits than to make it without any limits at all. The result is very likely to be a permanent demand for clearly specified limits on all work that runs into fair quantities.

In the matter of quantity production there have also been certain unconscious lessons that will have their effect. The relation between tool expense and cost has been strongly emphasized, and a great many manufacturers have got over the idea of expecting cheap tool equipment to produce low-cost work. Munition making, with its enormous quantities of pieces, has called for the best that could be had in the tool line, and the gain from using this best has been so evident that there is no longer any question as to the advantage of this policy.

Another lesson which has been learned is that of the economy of simplified operations. Many a discarded old lathe reposing in the scrap heap has come back into its own and done nobly on some simple operation on which no automatic could do better. The influence has been toward simplicity, which may have a beneficial effect on design. Let us hope so, at any rate.

■

Accident-Hazard Rulings

In a recent number of the monthly bulletin issued by the Pennsylvania Department of Labor and Industry several interesting rulings on accident hazard are recorded. These relate to setscrews and metal belt lacings, and are based on the fact that a number of injuries have been reported recently from industrial plants due to projecting setscrews, and further because the restrictions in that state on metal belt lacings have proved to be somewhat poorly understood. While these causes of accidents are obviously rather small in importance, they are both productive of injury and are typical of the precautions that are being taken in certain states in the campaign against preventable accidents.

A customary objection by a shop proprietor concerning setscrews used with overhead shafting, for example, is set forth in this bulletin under the statement: "It isn't necessary to remove that setscrew; no one ever goes up there." The bulletin answers this typical objection by citing an actual case in which an inspector requested the removal of a projecting setscrew in a shaft some 12 ft. above the floor. The shop proprietor criticized the order as well as the inspector's ability by sending

a letter to the central office, stating that no one ever worked around this shaft. A week later an oiler was caught on this identical setscrew and whirled to death by the rapidly moving shafting.

The effort to prevent similar occurrences is made clear in a circular letter addressed to all state inspectors from the chief of the bureau of inspection, an abstract of which, as follows, covers this point:

Recently there has come to my attention the report of several accidents caused by protruding setscrews. Irrespective of location, all protruding setscrews in moving parts of machinery, when exposed to contact, shall be removed and replaced by flush setscrews. This is a very simple but important request, and I trust you will in future give this matter the careful attention it deserves.

A quotation from a similar letter on the part of the chief of the bureau of inspection in the same state covers the interpretation of the rulings concerning metal belt lacings, as follows:

The section which reads "Hereafter no change belts shall be laced with metal" should be construed with the following interpretation of the industrial board, which reads: "It is the intent in drafting this particular regulation to prohibit the lacing with metal of any belt which it is possible to shift by hand. It is understood that any mechanical shifting apparatus which prevents the human hand coming in contact with the belt at all times would be permissible if laced with metal." Therefore it will be seen that belts which are not shifted by hand will be permitted to have metal lacings.

These quotations from letters of interpretation are interesting side lights on the work of a large bureau of inspection, in the one case emphasizing the original order and in the other placing a more liberal interpretation on a former rule. There is probably no field of legislative inspection and enforcement where more care is required than in that of such a bureau connected with a department of labor and industry. Occasional cases must surely arise now and then where an inspector may prove to be unreasonable, but similar cases are almost equally sure to exist where shop proprietors in their turn do not show that spirit of coöperation which the conditions warrant. A fair degree of ability to see through each other's eyes is required both of inspectors and proprietors, and with a central office that is able and willing to place correct and yet liberal interpretations on existing rules, this spirit of coöperation will avoid or at least materially reduce many of the troubles involved in this class of work.

■

So long as the American public implicitly holds to the belief that the business of higher education is to impart specialized information on every subject under the sun, from computing bridge stresses by the latest short cut to training a hen to lay 200 eggs a year, or writing advertisements for liver pills—so long will the higher education prove a huge disappointment to many of those who invest time and money in it. This does not mean that there is not room and place for the vocational school, but that the first aim of higher education should be to fit the student for whatever occupation he may have to follow in life, and not for the one particular niche that he may never be able to fit.—*Engineering News*.

■

Men give me credit for some genius. All the genius I have lies in this: When I have a subject in hand, I study it profoundly. Day and night it is before me. I explore it in all its bearings. My mind becomes pervaded with it. Then the effort which I have made is what people are pleased to call the fruit of genius. It is the fruit of labor and thought.—*Alexander Hamilton*

Shop Equipment News

Internal-Thread Millers

The internal threader shown in Fig. 1 was designed for milling the internal threads on the nose or base of shell bodies. The shell is held in a hollow spindle, the

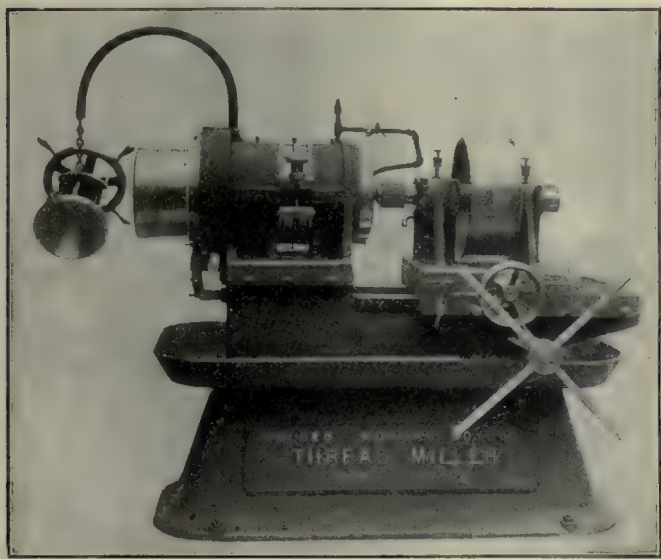


FIG. 1. INTERNAL THREAD MILLER
Capacity, 7- to 12-in. shells

detail construction of which is shown in the cross-section, Fig. 2.

The working parts of the machine consist mainly of the hollow spindle or shell holder *A*, which is ground and fitted to the head *B* and is held in fixed position by the

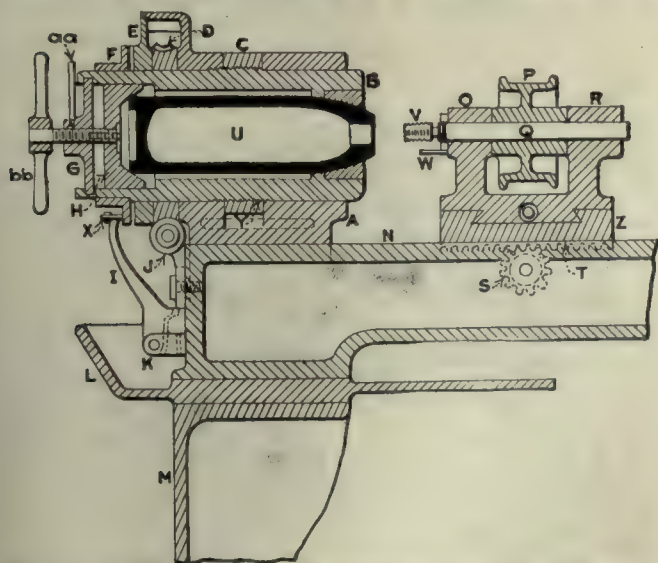


FIG. 2. CROSS-SECTION OF INTERNAL THREAD MILLER

bronze half-nuts *C* and *Y*. The shell holder and half-nuts are threaded to the pitch of the thread required in the piece to be threaded. The shell holder is driven by means of the bronze wormwheel *D*, which is engaged by the worm *J*. On the rear of the shell holder is the

angle ring *F*, which operates the trip trigger. The trigger *I* holds the wormshaft engaged and at one revolution of the shell holder is automatically tripped by the angle ring. The rear nut or cone *H* turns on the screw that is held in the nut *G*. This comprises the shell-clamping device shown in detail in Fig. 3. The cutter-spindle head is traveled longitudinally by means of the

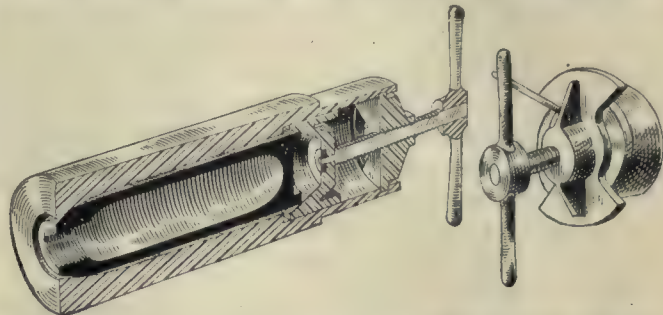


FIG. 3. DETAILS OF SHELL HOLDING AND CLAMPING DEVICES

rack *T* and the pinion *S*, and transversely by means of a screw feed.

The shell is placed in the shell holder and is held on the conical surfaces formed by the nose of the shell and the rear clamp, as shown in Fig. 3. This holds the shell accurate with the center axes of the holder, thus insuring the thread being milled true with the axes of the shell.

When the shell is put in the machine, the rear clamp is placed in position. This is designed similarly to a



FIG. 4. INTERNAL THREAD MILLER
Capacity, 3- to 6-in. shells

gun-breech locking device, and by giving it a quarter turn by the handle *aa* (Fig. 2) the operator has the clamp securely locked. Then the handle *bb* is used to tighten

the shell in the holder. At this point the shell is ready to have the hob adjusted. This is quickly done by turning the handwheel on the side of the machine, which rotates the pinion *H* and brings the carriage forward until the stop *W* comes in contact with the end of the shell; then the carriage is locked in position, and the cutter is moved transversely to its proper depth in the shell; then the cross-slide is locked in position.

The worm, which is in rotation continually, is lifted by means of a handle formed by the wormshaft projecting beyond the worm and toward the operator. This shaft pivots on a bracket on the rear of the machine; and by lifting the front end up, the wormshaft becomes engaged with the wormwheel and the trigger snaps under the wormshaft bracket, holding it in place until the shell has made a little more than one revolution and is tripped off by the angle ring, which has moved the trigger out one pitch, causing the worm to trip out of gear. By means of the adjustment at *X* the machine can be made to trip at any desired point. When the worm drops out of gear, the hob is backed away from the work. The shell holder is turned one revolution forward and is held in position by means of a pawl dropping into a notch in the angle ring. Then the clamp is removed, the shell withdrawn, and the operation is complete.

The machine shown in Fig. 4 is of a lighter type, with leg-base construction. The design and operation are similar to the heavier style seen in Fig. 1.

Both machines are recent additions to the line of shell-threading equipment made by the Holden-Morgan Co., Toronto, Canada.

✽

Horizontal Tapper

In the tapper shown the forward drive and reverse are accomplished by friction, applied on the cone principle. The friction is leather to cast iron and is dry, arranged so that no oil can work its way to the leather under normal conditions. The leather face is cushioned and gives an easy, sensitive and at the same time powerful grip under slight longitudinal pressure.

The spindle is of tool steel and of small diameter, while the cone spider on the spindle is of aluminum and is of lightened design. In this manner the flywheel effect is kept to a minimum and the spindle comes to a stop when the friction is released; therefore tapping to a fixed distance or to a bottom may be positively effected.

The forward friction is thrown into action by a slight pressure on the end of the tap, applied by pushing up the tap drill hole in the work against it. When the work is tapped deep enough and the work spindle in the tailstock comes against the stop, the cone friction is automatically released by the action of the tap drawing into the work. Then the tap is reversed and backed out by a slight pressure of the operator's hand in a direction to pull the work from the tap.

The pressure required to cause the friction to grip and drive is very slight, and the cushioning and angle of the friction have been so developed that the change from driving to releasing and vice versa is accomplished instantly and smoothly.

Work-holding fixtures fitted to a taper shank are inserted in the tail spindle. This insures tapping the holes in alignment and in the correct location, as the

fixtures have the taper shank so attached to be in line with the hole to be tapped.

The set-up on this machine consists of removing one fixture by knocking out its taper shank from the tail spindle by means of the hole through the spindle and



HORIZONTAL TAPPER
Capacity, $\frac{1}{4}$ to $\frac{1}{2}$ in. in diameter

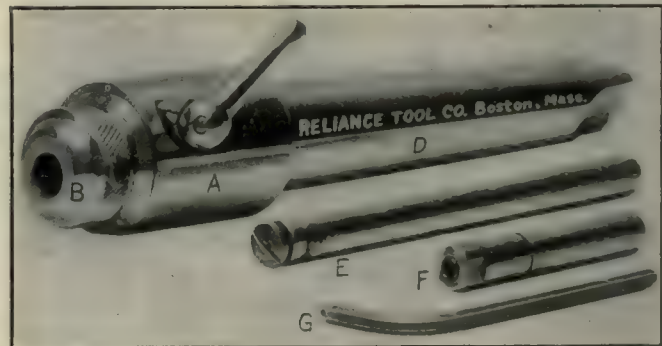
then inserting another fixture and setting the tailstock and adjusting the stop for proper depth.

This form of machine is made in several sizes, in both bench and pedestal types, by the H. E. Harris Engineering Co., Bridgeport, Conn.

✽

Offset Boring Head

The offset boring head shown consists mainly of two parts *A* and *B*, a simplified form of two eccentric bushings one within the other. The hole in the outer bushing is



OFFSET BORING HEAD

bored 0.050 in. off center; similarly the hole in the inner bushing supporting the cutter bar is off center.

The illustration shows the holder with a solid shank *D*; the two parts *A* and *D* may be made in one piece. The lever *C* is used for locking the bushing *B* in place when boring and is shown in a position of release. The

beveled flange on *B* is divided into 100 equal divisions, of which each tenth one is marked.

From this it may be seen that by turning the inner bushing or *B* around either to the right or to the left, for a right- or a left-hand cutter, the cutter-bar hole in *B* is thrown off-center, continuing so up to one-half turn of *B*, or point 50 on the dial, which is the highest point of the eccentric. At this point the cutter-bar hole in *B* is 0.100 in. off the true center.

When the zero points on *A* and *B* coincide, the cutter-bar hole in *B* runs perfectly central and true and is generally used as the starting point in boring holes. During the course of boring, when it is desired to change the adjustment for another cut, releasing the lever *C*, turning the bushing *B* the number of graduations required and tightening the lever *C* is all that is necessary.

When boring large holes, the cutter in the end of the cutter bar is usually adjusted by means of the screw in the end of the bar, as shown, until the hole diameter is within the graduated limits of the boring tool.

For boring holes of a small diameter a cutter bar with a small split chuck, holding $\frac{3}{8}$ -in. round drill-rod stock, cutters for which can be made and shaped to meet the requirements of the hole to be bored, is furnished.

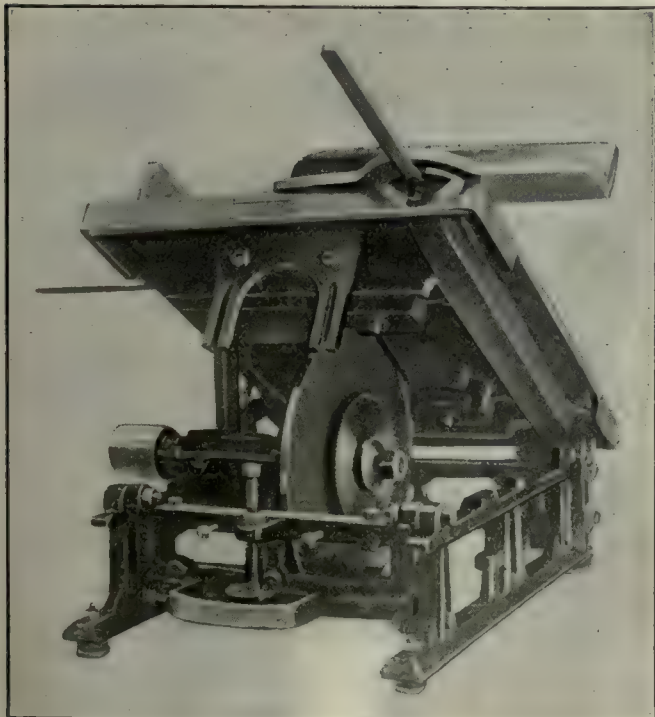
The boring tools are furnished complete with two cutter bars, one for boring holes of a large diameter *E*, and a smaller one for holes of very small diameter *F*. Shanks of any size and taper can be furnished.

The tool is a recent product of the Reliance Tool Co., 134 Eliot St., Boston, Mass.



Combination Disk Grinder and Saw Table

The illustration shows a combination tool for use in the shop. The arbor is arranged to take abrasive wheels, a disk with abrasive cloth or paper or a circular saw.



COMBINATION DISK GRINDER AND SAW TABLE
Table, 18x15 $\frac{1}{4}$ in.; steel-shaft diameter, $\frac{3}{4}$ in.; bearing, 7 in. long; weight, 70 lb.

The mounting of thin abrasive wheels is provided for so that high-speed and tempered steels can be cut. The table tilts to any angle or can be raised or lowered at the back. It is provided with two adjustable angle rests which can be set and locked in any position by thumb-screws provided for the purpose.



Clutch-Milling Fixture

By E. V. ALLEN

The device shown in Fig. 2 is used in the shops of the Henderson Motorcycle Co., Detroit, Mich., for milling the teeth on the jaws of small starting clutches. As the two parts are not alike, except for the teeth, one part is

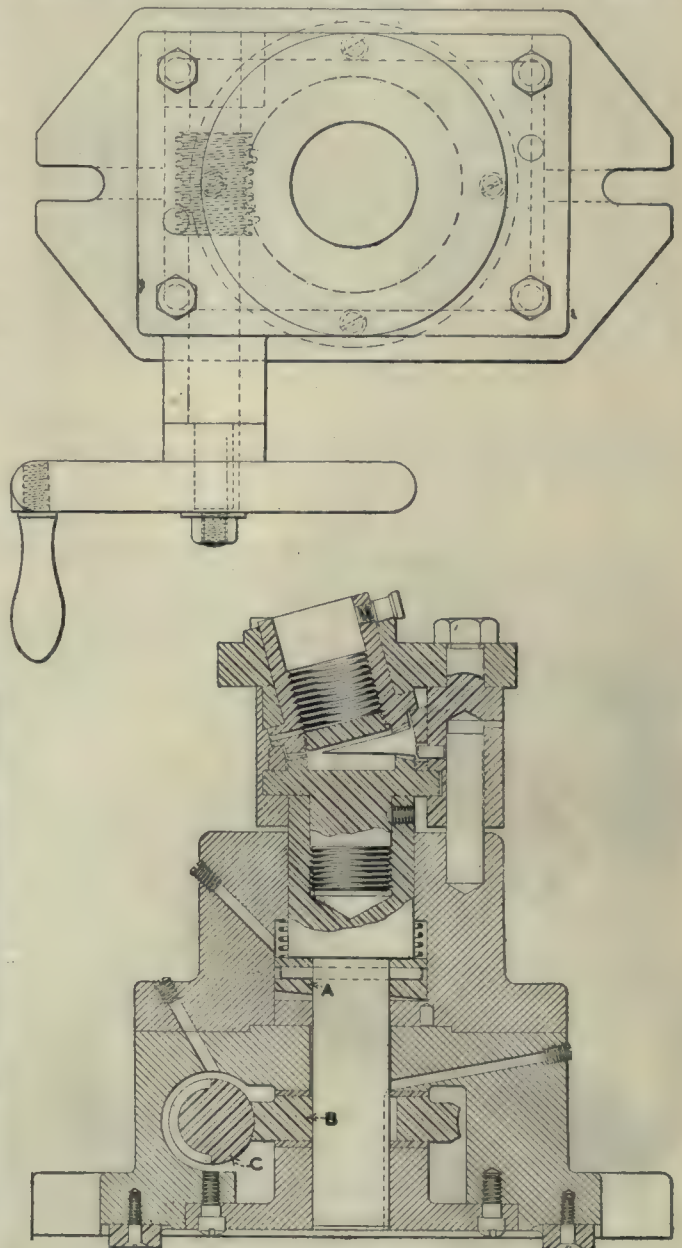


FIG. 1. DETAILS OF MECHANISM

held as shown at *A*, while the holder for the other is seen at *B*. The cutter used is shown at *C*. Once set, the milling is continuous on a clutch, the operator simply turning the handwheel *D*.

Details of the fixture are given in Fig. 1. Here it will be seen that a cam at *A*, cut with rises to correspond

to the clutch teeth, gives the necessary vertical movement as the clutch is rotated by means of the wormwheel *B* operated by the handwheel that turns the worm *C*. Springs

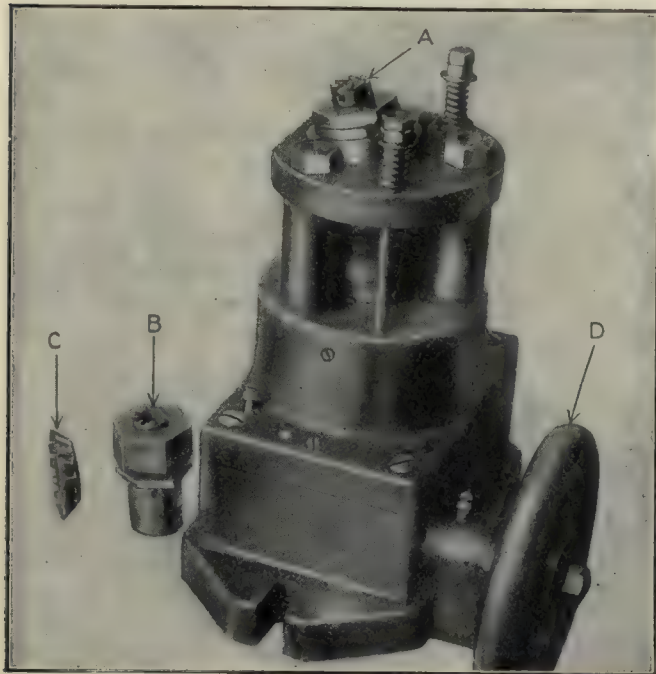


FIG. 2. CLUTCH-MILLING FIXTURE

keep the cam parts in close contact at all times. The angle at which the work holder is set is taken care of by a pair of fine-tooth bevel gears.

Cutting Steel with the Grain

By C. P. MAISEL

Some time ago I tried an experiment on cold-rolled steel, which I think will be of interest. We had been making up a set of friction wheels by cutting off and

turning a V-groove in the edge of the wheel. These wheels were about $\frac{1}{8}$ in. thick and a little over $1\frac{1}{2}$ in. in diameter.

We had been having considerable trouble in cutting the V-groove, spoiling about 50 per cent. of the work in the process. In some cases the grooves would be smooth and in others very rough. I was given the job of finding the trouble.

I started in cutting the grooves and got three perfect ones, two bad ones and another perfect one in the order named. This seemed very peculiar, as I had not changed the tool or even its setting.

I happened to think of the influence that grain has in cutting wood. I therefore took one of the smooth wheels and turned it in the opposite direction, taking a very light cut. The metal immediately began to burr up at the point of the tool. Instead of cutting, the tool would, with the aid of the burr on the point, shear the metal, leaving an irregular cut on each side of the V-groove. I reversed all three of the smooth wheels with identically the same result. I then tried one of the rough ones. The metal did not burr up, and the groove was finished perfectly smooth.

After that whenever the cut became rough and started to burr up at the point of the tool, I reversed the wheel and turned it in the opposite direction. In this way we have practically eliminated the item of spoiled material on these wheels.

The fact that the change in the direction of the cut on cold-rolled steel will change the character of the surface of the cut would indicate that in the rolling process the steel is subjected to longitudinal and torsional strains which impart to the steel a definite grain that resists the action of cutting. I have not found anybody who could either refute or sustain this theory, but it seems to me to be tenable after the results I obtained.

I would like to see this article in print, because I think many machinists would be interested in trying this experiment for themselves.

Business Items

Metalwood Manufacturing Co., Detroit, Mich., is remodeling its present building and adding a three-story annex. H. M. Austin, Jr., factory manager, states that they are in the market for heavy tools and cranes.

Crocker Wheeler Co., Ampere, N. J., announces a removal of its San Francisco district office from the Crossly Building to 87 New Montgomery St. The office will be continued in charge of W. K. Brown, district manager.

The name of **Prentiss Tool & Supply Co.**, New York, Boston, Buffalo, Rochester, Scranton and Syracuse, has been changed to Henry Prentiss & Co., Inc. With the exception of the name, however, there is no change, the officers, directors, stockholders and business policies remaining the same.

Trade Catalogs

Taps and Dies. The Standard Tool Co., Cleveland, Ohio., Catalog; Pp. 32, $4\frac{1}{2} \times 7$ in.; illustrated.

Duplex Surface Grinder. The Stenotype Co., Indianapolis, Ind., Leaflet; Pp. 4, $5 \times 7\frac{1}{4}$ in.; illustrated.

Tempered and Polished Strip Steel. Edgar T. Ward's Sons, 44-54 Farnsworth St., Boston, Mass. Price list; pp. 16, 4×9 in.

Circulating Oil Pumps. C. F. Roper & Co., Hopedale, Mass. Circular illustrating and describing Type 2 circulating pump.

Engine Lathes. Lodge & Shipley Machine Tool Co., Cincinnati, Ohio. Catalog, loose leaf. Illustrations and descriptive matter explain the operation of the company's lathes and the wide variety of work to which they are adapted.

Engine Lathes. Hendey Machine Co., Torrington, Conn. Catalog, Pp. 67, 9×12 in.; illustrated. In addition to specifications and illustrations of the complete line of engine lathes built by this company the catalog contains material of much mechanical interest in connection with materials of construction and lathe operating attachments. Thread cutting hints and useful tables are also included.

Welding and Cutting. Imperial Brass Mfg. Co., Chicago, Ill. Handbook; Pp. 56, 6×9 in.; illustrated. While the illustrations used in this book cover the welding and cutting products of the manufacturers distributing it, the information contained in it, of which there is considerable covering modern practice, is of general nature. A special effort has been made to reduce the whole treatment to the simplest possible form. The handbook has been prepared for free distribution to all purchasers of Imperial equipment, while it is sold to all others. Bound in silk cloth and gold embossed cover at \$1 each.

Forthcoming Meetings

American Foundrymen's Association and American Institute of Metals. Annual meeting, Sept. 11-16, Cleveland, Ohio. A. O. Backert, secretary, American Foundrymen's Association, Cleveland, Ohio.

National Machine Tool Builders' Association. Annual convention, Oct. 24-25, Hotel Astor, New York City. Charles E. Hildreth, general manager, Worcester, Mass.

American Society of Mechanical Engineers. Monthly meeting, first Tuesday. Calvin W. Rice, secretary, 29 West 39th St., New York City.

Boston Branch National Metal Trades Association. Monthly meeting on first Wednesday of each month, Young's Hotel. W. W. Poole, secretary, 40 Central St., Boston, Mass.

Providence Association of Mechanical Engineers. Monthly meeting, fourth Wednesday of each month. J. A. Brooks, secretary, Brown University, Providence, R. I.

New England Foundrymen's Association. Regular meeting, second Wednesday of each month. Exchange Club, Boston, Mass. Fred F. Stockwell, 205 Broadway, Cambridgeport, Mass.

Engineers' Society of Western Pennsylvania. Monthly meeting, third Tuesday; section meeting, first Tuesday. Elmer K. Hiles, secretary, Oliver Building, Pittsburgh, Penn.

Rochester Society of Technical Draftsmen. Monthly meeting, last Thursday. O. L. Angevine, Jr., secretary, 857 Genesee St., Rochester, N. Y.

Superintendents' and Foremen's Club of Cleveland. Monthly meeting, third Saturday. Philip Frankel, secretary, 310 New England Building, Cleveland, Ohio.

Western Society of Engineers, Chicago, Ill. Regular meeting, first Wednesday evening of each month, excepting July and August. J. H. Warner, secretary, 1785 Monadnock Block, Chicago, Ill.

Philadelphia Foundrymen's Association. Meetings first Wednesday of each month. Manufacturers' Club, Philadelphia, Penn. Howard Evans, secretary, Pier 45 North, Philadelphia, Penn.

Technical League of America. Regular meeting, second Friday of each month. Oscar S. Teale, secretary, 35 Broadway, New York, N. Y.

Manufacturing Sharpening Stones

EDITORIAL CORRESPONDENCE

SYNOPSIS—In this article are shown the various operations and machines used when making sharpening stones. Those described include natural stones like Arkansas and Washita, and artificial stones like India and Crystolon. The machines used are of a distinctly special nature. In the case of natural stone, after it is quarried it is placed in beds of plaster of paris and sawed into slabs. These slabs are again embedded in plaster, and a second sawing that gives another dimension takes place. The resulting slabs are then ground on the faces and ends to the desired dimensions. Natural-stone wheels are made with a special type of cutter, which is illustrated.

Sharpening stones have been known and used for untold ages. The first cutting stones of primitive man were made by chipping flint or other hard stones into the desired shape. It is quite certain, however, that the art of grinding was slowly developing during the latter part of the stone age. From those primitive methods, with the equally crude stones produced, to the stones

manufactured by the Pike Manufacturing Co., Pike, N. H., is quite a development of research and experiment.

The beginning of the Pike Manufacturing Co. is one of interest. About 1821 Person Noyes, a farmer living in northern New Hampshire, while chopping trees in the woods picked up a piece of stone and started to whet his ax.

This stone gave such good results that he took a few rough pieces from a nearby ledge and broke them into rough scythestone shape, but made no attempt to grind them smooth.

The product was only sold locally and no endeavor was made to develop any industry. Later Noyes died and his widow married Isaac Pike and through him the business was established in 1823. The first quarry was located on the shores of Indian Pond and the product became known as Indian Pond Scythestone, a name now familiar the world over. Since that time the Pike Manufacturing Co. has expanded into other fields for making sharpening stones such as Arkansas, Washita and also artificial stones.

In Fig. 1 is shown a view of the quarries at Pike, N. H., where the stone is obtained for making the scythe-



FIG. 1. SCYTHESTONE QUARRY AT PIKE, N. H.

stones. The raw material is a mica schist, a finely grained thinly laminated sandstone. Between the layers of stone are thin layers of mica flakes. The stone is loosened by blasting.

The Arkansas and Washita stone is found in Arkansas and is quarried in summer. All pieces weighing over 5 lb. are saved and shipped to the Pike oilstone factory at Littleton, N. H. A quantity of the Arkansas rock as received at the factory is shown in Fig. 2. In this illustration may be seen the condition of the quarried stone accepted for manufacturing oilstones. In Fig. 3 is shown a quantity of another kind of rock known by its color as chocolate rock. This stone comes from Lisbon, N. H. This stone is much softer and can be quarried in larger sizes than the Arkansas. After the stone has been received, pieces are placed in the wooden frame, illustrated in Fig. 4, and plaster of paris poured around the stones as shown. This is then allowed to solidify. The bed of stone and plaster is

wide, and for Arkansas $\frac{1}{10}$ in. thick by 2 in. wide. The cutting element is a stream of sand and water forced over the stone being sawed. The sand grains supplied being much coarser than the grain of the stone they gradually scratch the stone away. The sawing operation is very slow, being approximately the following: For Arkansas, on a bed $6\frac{1}{2}$ ft. long by 4 ft. wide, with the saws operat-



FIG. 2. QUANTITY OF ROUGH ARKANSAS STONE



FIG. 3. QUANTITY OF CHOCOLATE ROCK

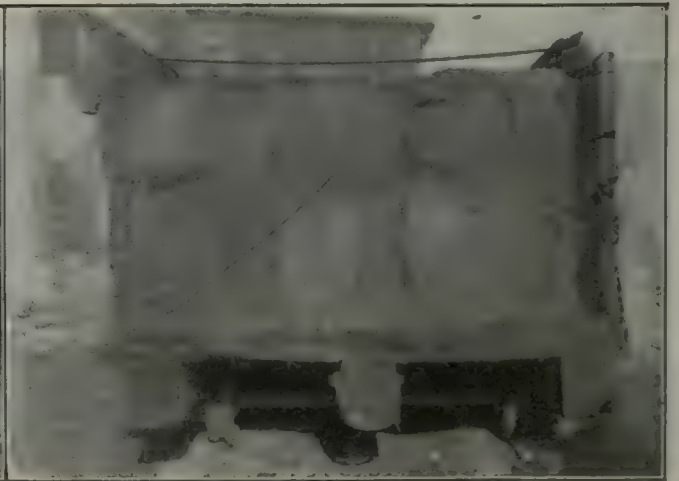


FIG. 4. HOLDING THE ROCK IN A CAST

then conveyed into the shop and placed under the sawing machine shown in Fig. 5. Two types of feeding mechanism are used on these machines. On some, for sawing the harder stones like Arkansas and Washita, the feed is by gravity. On the machines used for sawing the softer stone, such as chocolate and scythestone, a positive feed is provided, operated by a screw. The saws used are plain bands of steel without teeth, and for Washita are $\frac{1}{8}$ in. thick by 3 in.

ing at 30 strokes per minute in 12 hr., the bed would be cut about 1 in. deep. For Washita, on a bed 8 ft. long by 5 ft. wide, with the saws operating at the same speed, the depth cut in 12 hr. is 5 in. For chocolate rock, on a bed the same size as the Washita and with the saws operated at 60 r.p.m., in 12 hr. a depth of 20 in. would be cut.

After the bed of stones has been cut through, the slabs are relaid in beds of plaster of paris and a second cutting

as shown in Fig. 6 is made. This operation produces the desired width of stone. After this operation, the largest sizes are taken to the chipping room while the smaller and irregular pieces are again cut, to be used for making the smaller sizes and odd-shaped stones.

In Fig. 7 is shown the operation of chipping Arkansas stones. This operation is a very simple one, the operator

desired length. The stone is placed on the anvil as shown and the trip with the cutter attached is fed down with the cam and cuts the slab as desired.

The machine shown in Fig. 9 is used in the finishing or surfacing of Arkansas or Washita stones. The cast-iron disk *A* is 8 ft. in diameter and revolves at 80 r.p.m. The surface of the disk is kept true with the cast-iron

block *B*. Water and sand are used on the surface of the revolving disk and form the cutting medium. The stone to be ground or surfaced is held by the operator on the disk as shown until the desired shape and finish are obtained. When facing the ends of the stones a number are placed together, as shown in Fig. 10, and plaster of paris is poured over them. This flows between the crevices and holds the stones together. The bed is then taken to the same machine as shown in Fig. 9, and the ends are faced in a manner similar to that described for facing the sides. When grinding scythestones, the machine shown in Fig. 11 is used. The grinding wheel is made of wood into which steel wedges are driven, practically making a steel surface. Sand and water are supplied to the revolving wheel, the grains of silica in the sand enabling the grinding operation to be performed quickly. In the illustration may be seen a number of the stones held in a cage *A* so that the operator may hold the stone conveniently during the grinding operation. The construction of the wooden wheel with the steel inserted wedges may be noted. In Fig. 12 may be seen two of the operators grinding scythestones, and the manner in which the stones are held may be observed. After the stones have been ground on the four sides, about fifty are clamped into a wooden frame and set on end on wheels reserved for this work. The ends are then ground automatically with the revolving wheel. In Fig. 13 one of these machines is shown with a frame loaded and others in position on the wheel with the stones being ground. Quite a number of wheels are made from the harder stones in various diameters. The method in which these are produced is shown in Fig. 14. The stone is placed in position and the cutter, which revolves at about 200 r.p.m., is fed down into the stone, cutting out the wheel. Water and sand again constitute the cutting

medium. A number of wheels of various sizes are shown in the illustration. It will be observed that the feed to the cutter is obtained by gravity through the weight *A*.

In Fig. 15 may be seen one of the tools used when cutting out the wheels. It will be noted that the cutting part is almost a knife edge and does not extend all the

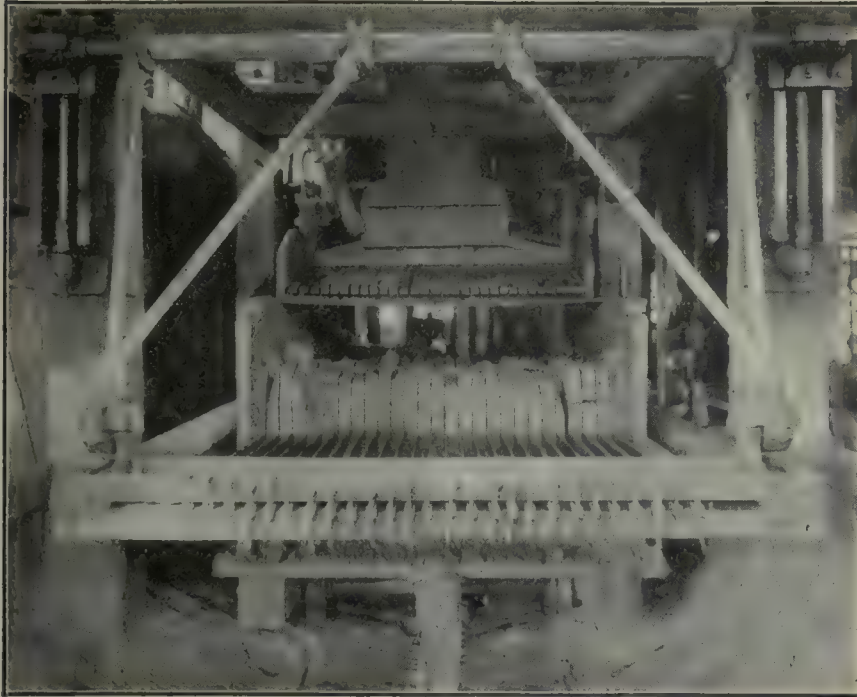


FIG. 5. FIRST CUTTING OPERATION

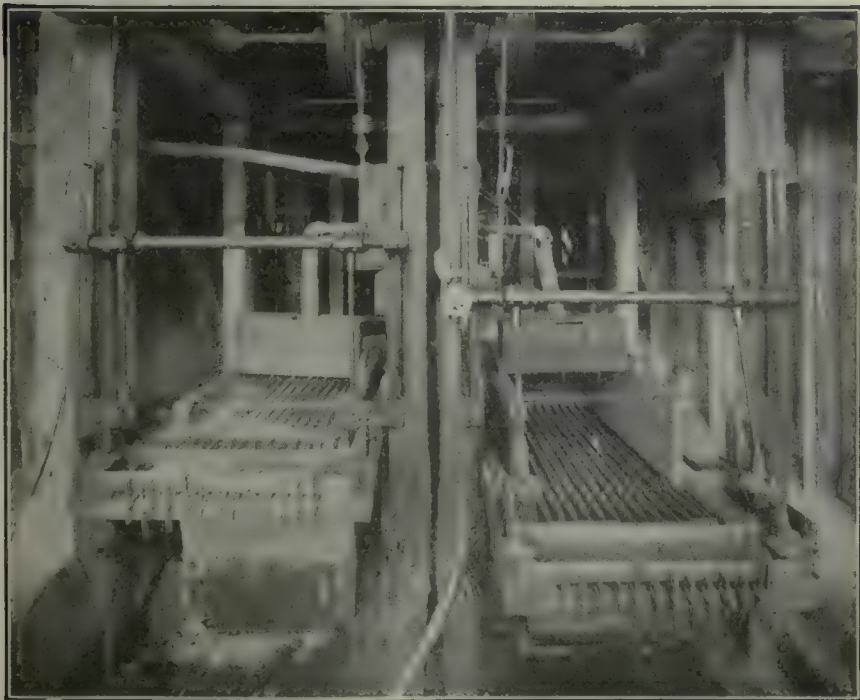


FIG. 6. SECOND CUTTING OPERATION

marking the stone and with the chisel breaking and trimming the end to somewhere near a regular shape. It might be worth noting that at this point only about 25 per cent. of the original rock remains.

On the softer grades of stone, such as chocolate, the machine shown in Fig. 8 is used to cut the stones to the

way around. The cutter proper is removable from the head so that it may conveniently be ground when necessary.

When cutting files of various styles as square, triangular and odd shapes from Arkansas stone, the machine shown in Fig. 16 is used. This consists of a disk of steel the edges of which are serrated every quarter of an inch. Into each serration is pounded carefully a paste of crushed diamonds that is covered with solder to hold the charge in place. This saw will cut the hardest Arkansas rock with ease. The machine is seldom used, however, owing to its prohibitive cost on small and special stones.

The Pike Co. also makes an artificial stone that is useful for those not desiring to purchase the more expensive natural stones. These artificial stones are made from emery or corundum in two grades—one fine, the other grade 100.

The emery is kept in iron trays and is dampened by adding water. In Fig. 17 is shown a view of these trays



FIG. 7. CHIPPING ARKANSAS STONES

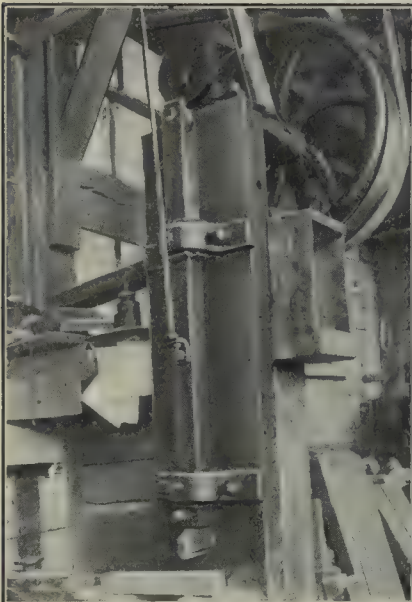


FIG. 8. TRIMMING CHOCOLATE STONE



FIG. 9. METHOD OF FINISHING OR SURFACING ARKANSAS OR WASHITA STONES

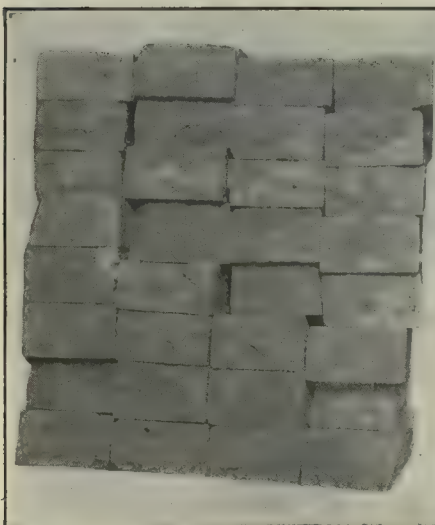


FIG. 10. NUMBER OF STONES READY FOR FACING ENDS

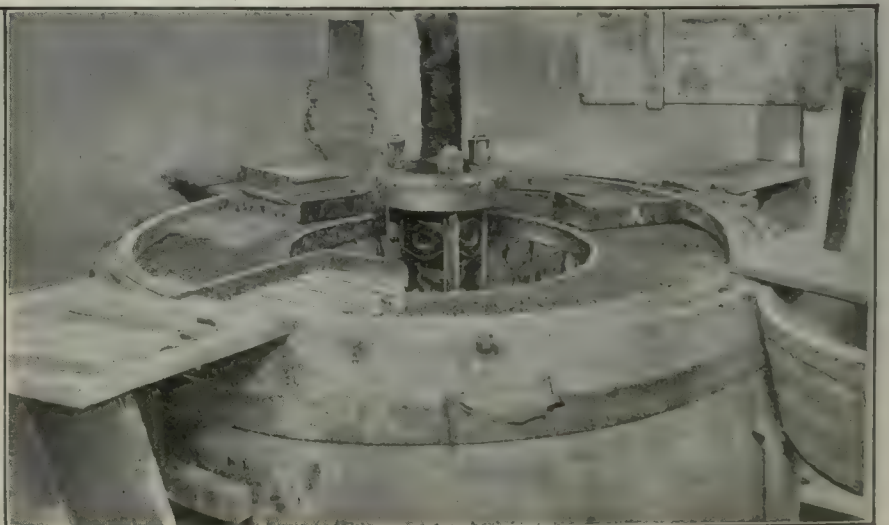


FIG. 11. GRINDING SCYTHESTONES WITH A STEEL-SURFACED WOODEN WHEEL AND SILICA SAND



FIG. 12. THE GRINDING OPERATION



FIG. 13. ENDING SCYTHESTONES

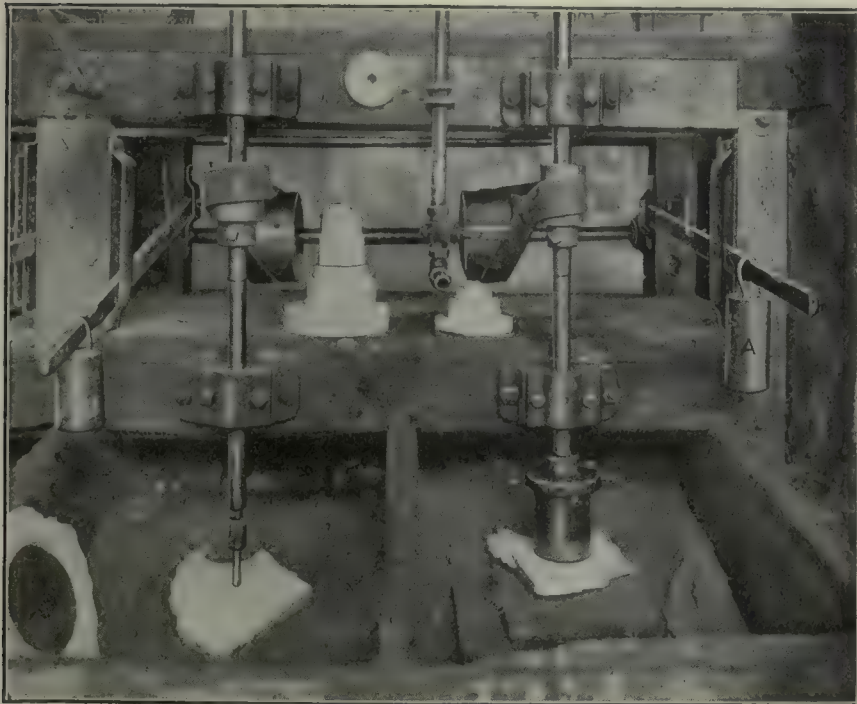


FIG. 14. CUTTING ARKANSAS WHEELS

with the two grades of emery. The prepared emery is placed in a mold and slicked to shape. It will be noted that the stones are made of the two grades of emery—one side fine, the other coarse. After one side of each grade of emery has been made they are placed in the mold *A* with a steel block *B* on each side. The mold is then placed under the arbor press, Fig. 18, and pressure exerted to hold the two parts of the stone together and in shape. The stone in the mold is then placed under the hydraulic press, Fig. 19, and pressure at 200 lb. per sq.in. is applied, pressing the emery grains firmly together. The stones are then placed in the furnace shown in Fig. 20 and baked for 12 hr. at 400 deg. F. It will be observed that plates are placed outside of the stones to keep them from changing their shape. In Fig. 21 are shown the stages Arkansas and Washita stones pass through, as described in this article, from the

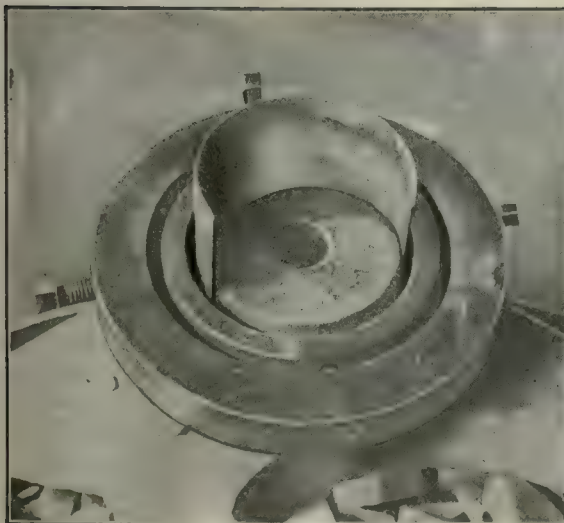


FIG. 15. TYPE OF CUTTER USED

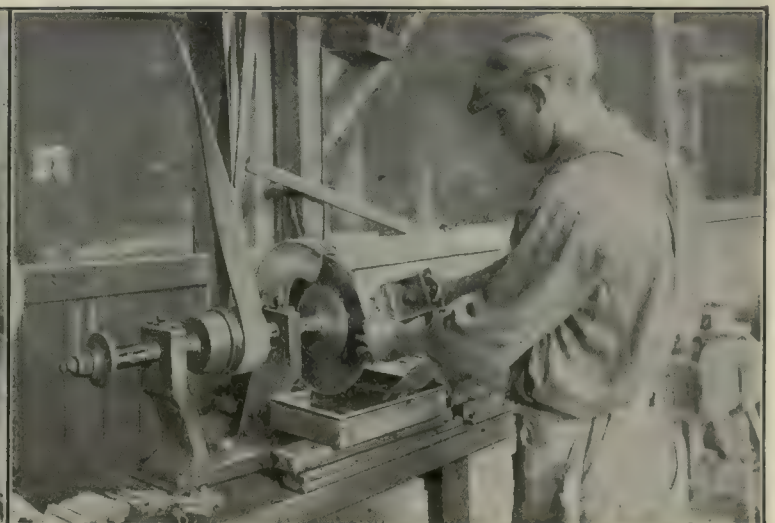


FIG. 16. CUTTING ARKANSAS FILES

condition in which they are received at the factory to that in which they are shipped. An illustration of various types and styles of stone, such as soft and hard Arkansas,

The ingots are first crushed to about the size of egg coal. Afterward it is further crushed and reduced to the various-sized grains required in the manufacture of sharp-



FIG. 17. TRAYS WITH EMERY

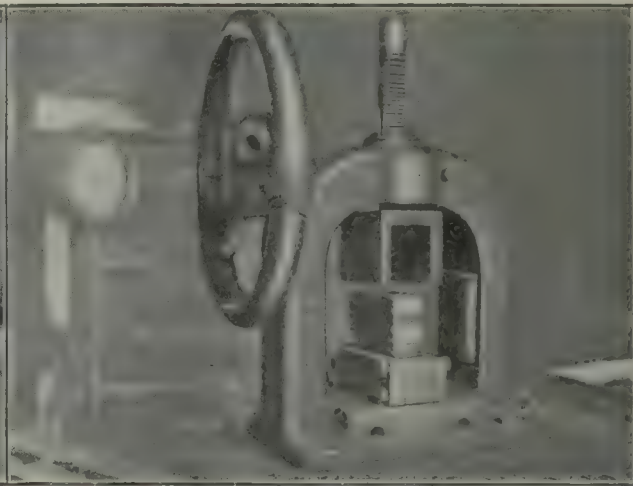


FIG. 18. PRESSING DOWN THE MOLD

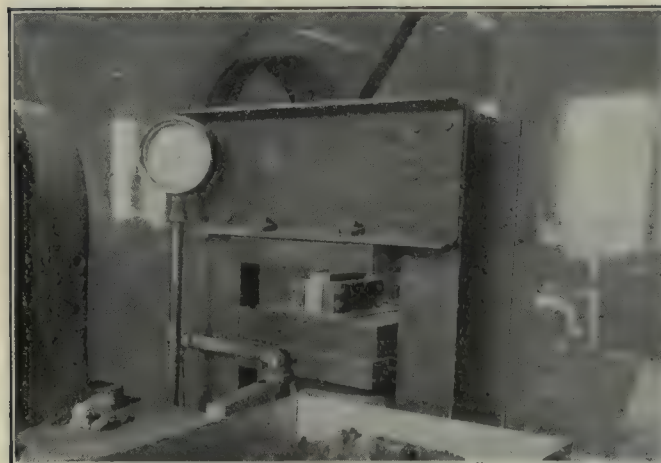


FIG. 19. HYDRAULIC PRESS FOR STONE



FIG. 20. BAKING THE STONES

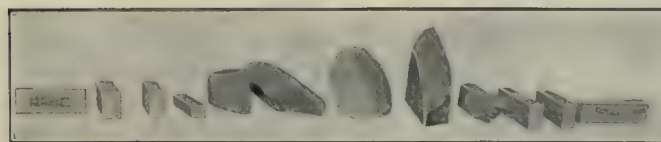


FIG. 21. FROM ROUGH TO FINISHED STONES

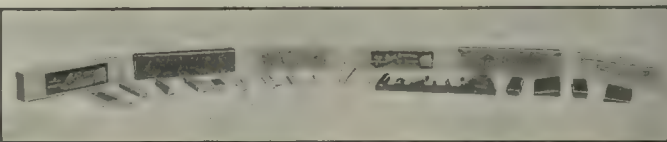


FIG. 22. SAMPLES OF VARIOUS STONES

Washita, India and Crystolon, is shown in Fig. 22. The Pike Manufacturing Co. is the sole selling agent for the famous India oilstone that is manufactured by the Norton Co., of Worcester, Mass. This artificial oilstone, used almost exclusively in machine shops, is made from alundum, an electric-furnace reproduction of the natural mineral corundum. Chemically it is a crystalline aluminum oxide made by fusing the mineral bauxite in the intense heat of the electric furnace. Bauxite is mined in open cuts and thoroughly dried out in immense calciners. It is then delivered to the furnace room where it is put directly into specially designed electric furnaces of the arc type having an internal temperature of 4,200 deg. When the furnace is filled with the molten material the current is switched off and the mass allowed to stand for several days until it is cold enough to handle safely.

ening stones and other abrasive articles. The next manufacturing steps are quite similar to those already described in making emery stones.

■

Precision Gage Making

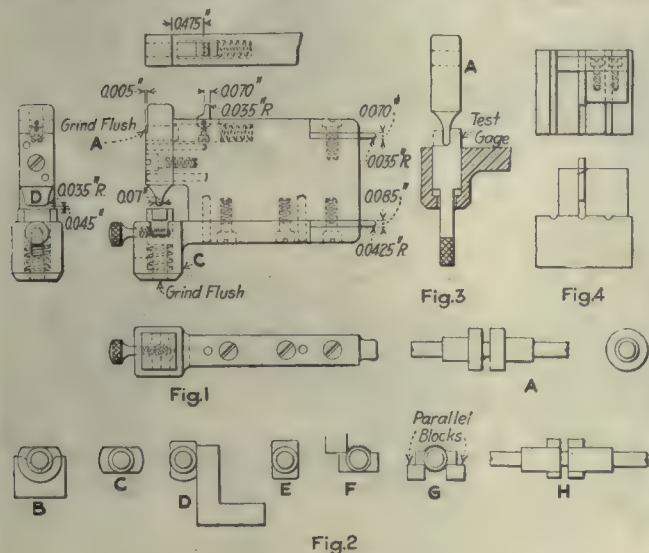
BY GUSTAVE A. REMACLE

The body of the gage, Fig. 1, is made of machine steel and is the only part of the gage not hardened. As there were two of these gages to be made, several of them were worked up to better advantage at one time. The pins *A* were turned, hardened and ground while in one piece. The making of *B* is interesting, as it illustrates a method of obtaining accurate results on odd shapes. While absolute precision in size was unnecessary,

it was important to secure the correct shape and to fit the hole in the boss *C*.

The series of operations for producing a pair of these pins is shown in Fig. 2. After roughing the stock all over in the bench lathe, a parting tool was run in where the pins were to be separated later. The pin indicated at *A* was turned to the finish size, $\frac{3}{8}$ in., while grinding allowance was left at the small ends. Although the miller at first came to mind as best suited for the task of removing the stock necessary to create the two lugs, the job was finished on a surface grinder in less time than would have been consumed in setting up the miller; also, a degree of accuracy was attained well within the limit allowed.

At *B* the stock was ground away until the wheel barely grazed the finished $\frac{3}{8}$ -in. portion. At *C* the boss was



GAGE-MAKING OPERATIONS

reversed and rested upon the magnetic chuck, and the opposite side was ground in a similar manner. Both sides were then equidistant from the center of the piece. By following this principle throughout and using a micrometer for determining the amount of stock removed from the various sides the lugs were easily finished.

In operations *F* and *G* a series of cuts running transversely removed all the stock necessary to leave the lugs finished. The finishing cut on the lug was run in until the sharp corner of the wheel barely grazed the finished portion. The lugs still contained a series of steps left by the wheel, as may be seen at *F* and *G*. To remove these steps, the piece was put between centers in the bench lathe and a tool so placed that it cut when moved transversely. The element was soon ready for hardening. During the preceding operation the piece was turned slightly after each succeeding cut.

Owing to the fact that the greater portion of these pins was finished, while only the ends were to be ground after hardening, the greatest care was exercised in this process. Instead of allowing the pin to rest upon some more or less uneven surface in the furnace, I hardened it in a small furnace, holding it in a pair of tongs and revolving it constantly while heating. The pin was dipped vertically into the bath. When it had been hardened, it was placed between centers in the lathe and tested for accuracy.

A slight error was corrected by heating to a straw color and bending a little in the direction opposite to that of the original bend, then cooling in this position. When the pin ran true on centers, it was ground and lapped. Any high spots that could not be lapped, owing to the lugs, were stoned off, thus permitting entrance into the hole in the boss *C*, Fig. 1.

Elements *C* and *D* were assembled to the gage body, the dowel pins fitting so as to provide for easy removal of the gaging pins, the centers of the holes for which were laid off with a height gage. For boring and reaming the hole for the pin *A* the gage body, with the pin *D* assembled, was swung in the bench lathe, the body resting upon an angle plate which in turn was strapped to the faceplate. The gage body was placed as nearly square as possible on the angle plate, and the angle plate was so located upon the faceplate that the prick-punch mark ran true.

The shoulder was removed from the gage and the hole bored and reamed to $\frac{1}{4}$ in. It was then assembled and a hole bored at the same setting, allowing about 0.002 in. for grinding. Other surfaces on this pin having previously been machined to shape, it was hardened. The surface in contact with the gage body was ground to have a flat true surface, reassembled to the body of the gage, which was left undisturbed in the lathe, and the hole ground with a diamond-charged lap. The boss *C* was swung on the faceplate in the lathe and bored concentric to the point laid off with the height gage.

The smaller hole was bored first, 0.002 in. being left for grinding. The boss was then reversed on the faceplate, the small hole already bored being located by a plug in the center of the faceplate. The larger hole was bored, 0.004 in. being left for grinding. After hardening of the boss the holes were ground in the same manner as the boring.

It was important that the center of the radius 0.070 on *D* should be in line with the center of the gaging pin *B*. An extra allowance of stock had been left at *A*, Fig. 3. The test plug shown was ground away 0.035 in. beyond the center line. By grinding the stock from the face until the test gage came in contact with the gaging point, correct alignment was assured. The various radii on gaging points were machined in the shaper, a goose-neck tool being used for the purpose. Flat stock was used for the tool proper.

These tools were made by reaming holes from the back with a taper reamer, the hole being left a trifle small. After hardening, the tools were ground off the face until a plug of the required size passed through, thus determining the radius the tool would cut. When the end had been ground off until only half the hole remained, the tool was ready for use. After the gaging points were hardened, they were lapped with a cast-iron block containing grooves of the correct radius. In Fig. 4 are shown the lap and right-angle block for holding square the part to be lapped.

The elements were carefully machined at the radius and, after hardening, were ground on both sides until the radius was reached and the desired thickness obtained. Therefore, very little lapping was necessary to bring the radii up to the requirements. When grinding the pins flush with the gage, test blocks were inserted in place to locate the gaging points properly.

Methods Used in Manufacturing Machine Tools

By ROBERT MAWSON

SYNOPSIS—In this article are shown tools, jigs and fixtures used in manufacturing parts of machine tools. In the design of the tools special attention is given to locating and holding devices.

The various sizes of vertical millers manufactured by the Becker Milling Machine Co., Hyde Park, Mass., are known to the readers. In this article are shown some of the especially noteworthy jigs and fixtures found effective in machining elements employed on these machines.

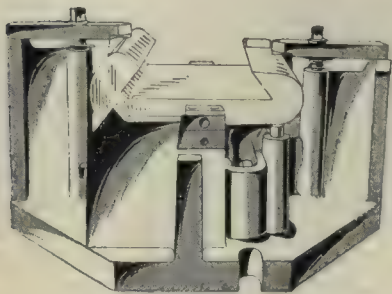


FIG. 2

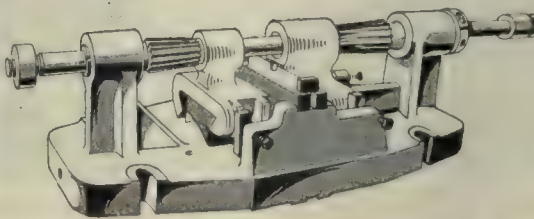


FIG. 3

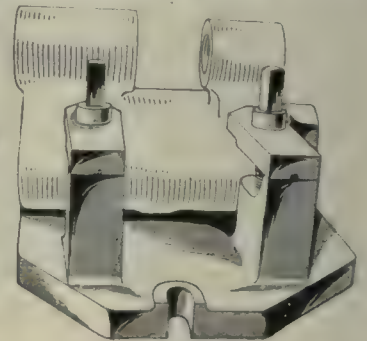


FIG. 4

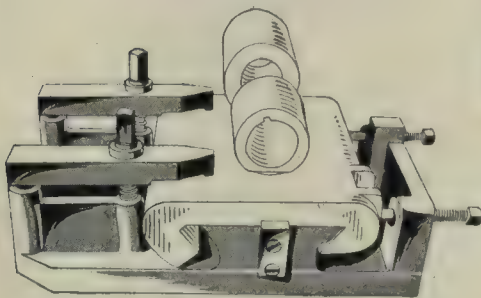


FIG. 5

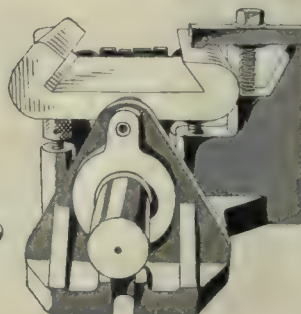


FIG. 6

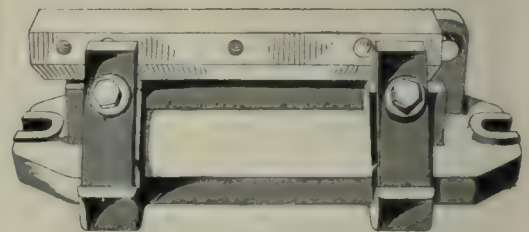


FIG. 8

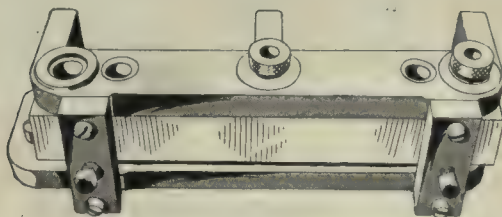


FIG. 9

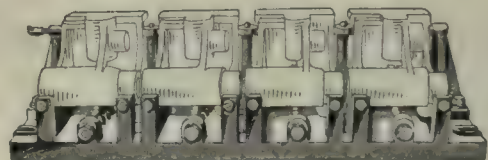


FIG. 11

JIGS AND FIXTURES USED IN MANUFACTURING MACHINE-TOOL PARTS

FIGS. 2 AND 2-A

Operation—Milling head, Fig. 1. The rough casting is placed on height pins and forced against a steel pad at the end with a screw.

Surfaces Machined—Base and dovetail surfaces, using 5-in. end mill and 4-in. dovetail cutters. These tools operate at 64 r.p.m. with a feed of 0.3 in. per revolution.

FIGS. 3 AND 3-A

Operation—Boring head, Fig. 1. The casting is located by the surface, which was machined in the previous operation.

Holes Machined—One hole tapered at $1\frac{1}{4}$ in. to 2 in. in $2\frac{1}{2}$ in., and one hole tapered 2 in. to $2\frac{1}{4}$ in. in 4 in.

FIGS. 4 AND 4-A

Operation—Milling head, Fig. 1. The casting is located by a machined dovetail surface that fits into the previously machined base. It is forced back into position with two setscrews.

Surfaces Machined—Faces of large bosses. For this work, 4-in. straddle mills are used operating at 90 r.p.m. with a feed of 0.3 in. per revolution.

FIGS. 5 AND 5-A

Operation—Milling head, Fig. 1. The casting is again located by the machined base and dovetails. Setscrews force it into position, and straps hold it securely.

Surfaces Machined—Ends of base, using a 3-in. end mill operating at 105 r.p.m. with a feed of 0.27 in. per revolution.

FIGS. 6 AND 6-A

Operation—Finish milling or planing dovetail surfaces in base. The casting is located by a bar that fits into the previously bored hole. The casting is placed in correct alignment with the adjustable poppet screws shown.

Surfaces Machined—The two dovetail surfaces in the base.

FIGS. 8 AND 8-A

Operation—Milling gib, Fig. 7. The rough casting is placed against a stop pin in the fixture and is held securely with the two straps shown.

Surface Machined—The upper edge, using a 3-in. milling cutter operating at 120 r.p.m. with a feed of 0.3 in. per revolution.

FIGS. 9 AND 9-A

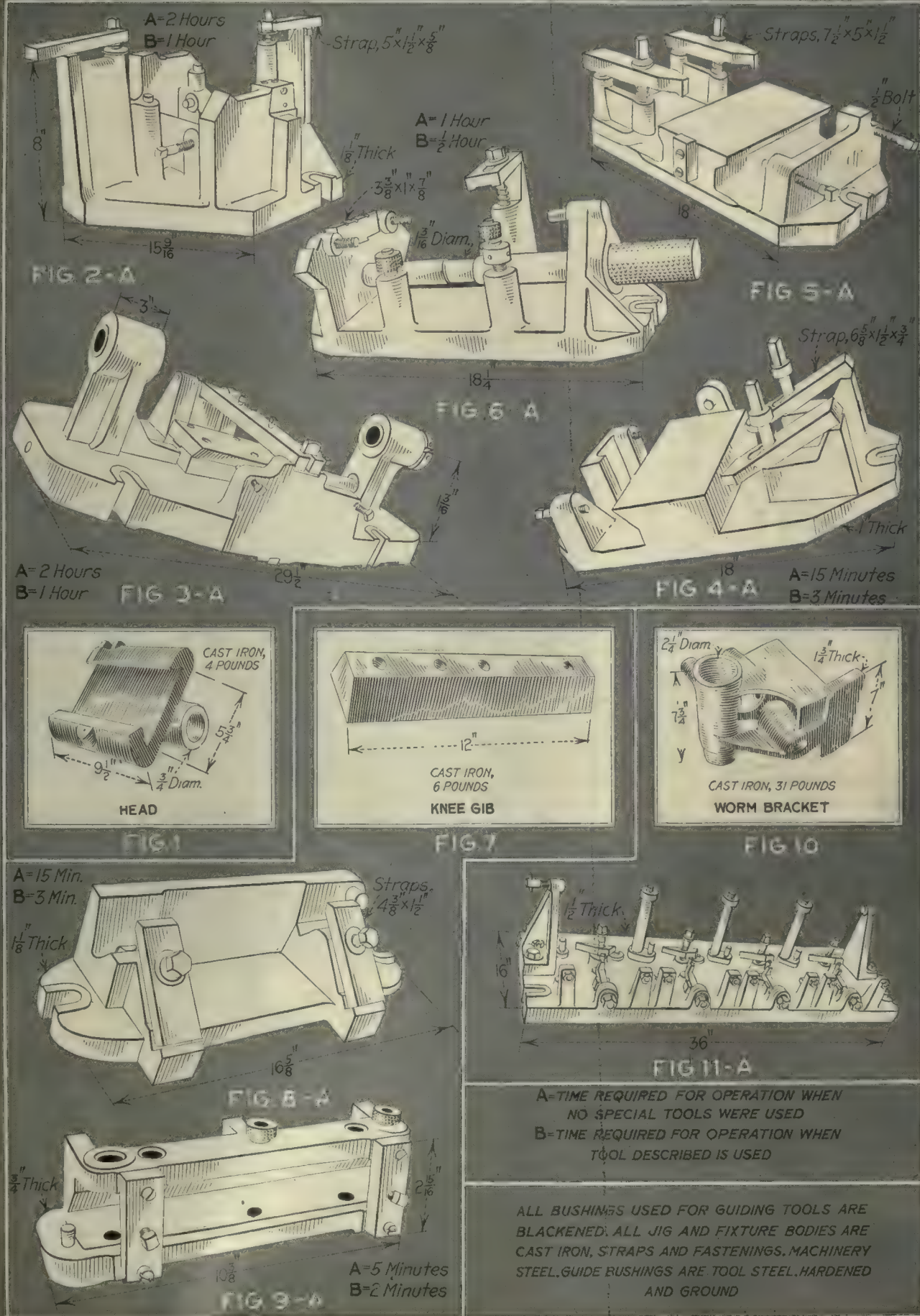
Operation—Drilling gib, Fig. 7. The casting is slid in from the end of the jig against a stop pin.

Holes Machined—Four No. 8 drilled and three No. 13 drilled.

FIGS. 11 AND 11-A

Operation—Milling spindle-feed motion bracket, Fig. 10. The rough castings—four in number—are placed in the fixture resting on pins. Hook bolts are then tightened against surfaces in the castings. Straps are also used to hold the parts in position.

Surface Machined—Base, using an 8-in. end mill operating at 40 r.p.m. with a feed of 0.27 in. per revolution.



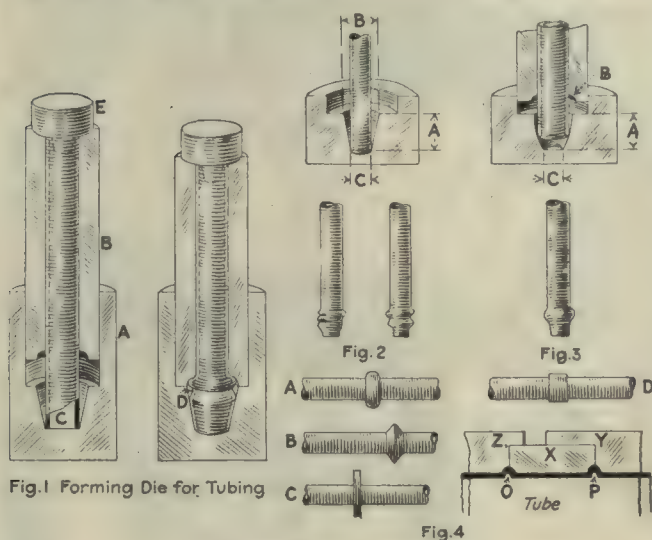
Forming Die for Tubing

BY GEORGE G. LITTLE

A number of $\frac{1}{4}$ -in. brass tubes $1\frac{1}{2}$ in. long, used for hose connections, required one end to be enlarged to prevent the hose from slipping off while under pressure. Soldering a sleeve or nipple on the end was too expensive, so it was decided to form the end.

A piece of 1-in. round cold-rolled steel was counter-bored as shown at *A*, Fig. 1, and another piece *B* was made to fit inside. After a few trials the right length of tube *C* was determined. By placing a tube in the die as shown and forcing *B* down into *A* the shape *D* was formed.

The block *E* had a lug that fitted into the upper end of the brass tube, and the work was done in a small arbor press. There was no trouble in removing the tube from the dies, this being done by driving out with a punch



TUBE-FORMING DIES

from the upper end of *B*. The dies were not hardened and lasted till the lot was finished.

In making these dies I discovered something of the reasons, conditions and measurements that go to control the shape and action of the tube in forming.

The original tube was $\frac{1}{4}$ in. in diameter and had a $\frac{1}{2}$ -in. wall. As the hose connection was not important enough to have to be made just as was intended, the double bulge was left as it came and no thought given to the reason for it. It will be seen that the depth of the hole *A*, the diameters *B* and *C*, together with the thickness of the tube wall, all have a hand in the shaping of the formed end, Fig. 1.

Fig. 2 shows the tube dotted in place and resting on the bottom of the die, while in Fig. 3 the tube rests about halfway down in the hole *A*, owing to the bottom of the hole being smaller than the outside diameter of the tube. The top of the hole *A* is also smaller in this die.

Fig. 2 is the shorter of the two bottom dies. The tube *A* is out of this die, while the tube with the single shoulder and straight tapered end is out of the die shown in Fig. 3. The upper half of the die was cut down in length to make tube *B*.

No extra piece was used on the upper end of the die while forcing down, but the tube was placed, as shown, in a No. 3-A Greenard arbor press. A piece of $\frac{5}{16}$ -in.

cold-rolled steel was used to press the tube out of the upper part of the die, as the tube swells in the die and must be forced out.

By experimenting with the diameters, the depth of the hole *A* (Figs. 2 and 3), the length of tube, the thickness of wall and the counterbored end of the upper die *B*, Fig. 3, the shape of the formed end can be controlled, within limits, of course.

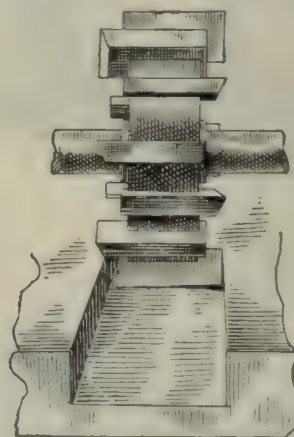
If the hole *A* is made too large in diameter for the size of tube being worked, you get a wrinkled surface, as shown by Fig. 2; and when the tube is not long enough for the die, Fig. 3, will be the result. The die must be shaped so that the end of the tube will be made smaller in diameter and not allowed to swell too much at the shoulder in proportion to the length of the formed part.

I think it is also possible to form shapes, as shown in Fig. 4, by using two parts of dies formed as the upper half of Fig. 3. This would give the shape *A* in Fig. 4. Then a second operation with the proper dies would make *B*, *C* and *D*. If it were desired to make a piece with two swelled places, a die could be made in four pieces, as shown at *X**Y**O**Z*, Fig. 4, *X* being in halves. The part *P* is first formed as at *A*; *O* is formed by using the two halves of *X* for the center, and *Z* as the upper half of the die, Fig. 3, which would then form the second bulge.

Adjustable Slot-Milling Cutter

BY F. G. SMITH

When slots are to be milled an accurate width, it is the usual practice to have an interlocking cutter, which can be packed out to compensate for wear. We had a rush job of this description, but had no suitable cutters and no time to get them. Something had to be done, and we did not fancy wasting time and money by going through the spot twice. Our brainy man was told that



ADJUSTABLE SLOT-MILLING CUTTER

here was a chance for him to live up to his reputation. He got busy. In a little while the work was going on, and we made a first-class job of it.

Each tooth of an inserted-tooth cutter of the type illustrated was set out alternately to right and left, as shown, to give the correct width. It worked well. Interlocking cutters are fairly expensive tools, and their life is somewhat limited. These cutters of ours have a very long life and a big range of adjustment. When they are worn out, all that is needed is a new set of blades. The body of the cutter, of course, lasts indefinitely.

Departments of the Repair Ship "Prometheus"

BY FRANK A. STANLEY

SYNOPSIS—The toolroom on the ship bears the same important relationship to the machine shops and other mechanical departments as the usual toolroom bears to shops ashore. It carries probably a greater diversity of tools and attachments than the conventional toolroom, owing to the great variety of work and to the different locations of the repair ship from time to time.

In an earlier article descriptive of some of the departments on the United States naval repair ship "Prometheus" illustrations were presented covering the main machine shops and showing a good share of their equipment, which represents an outlay of well over \$50,000.

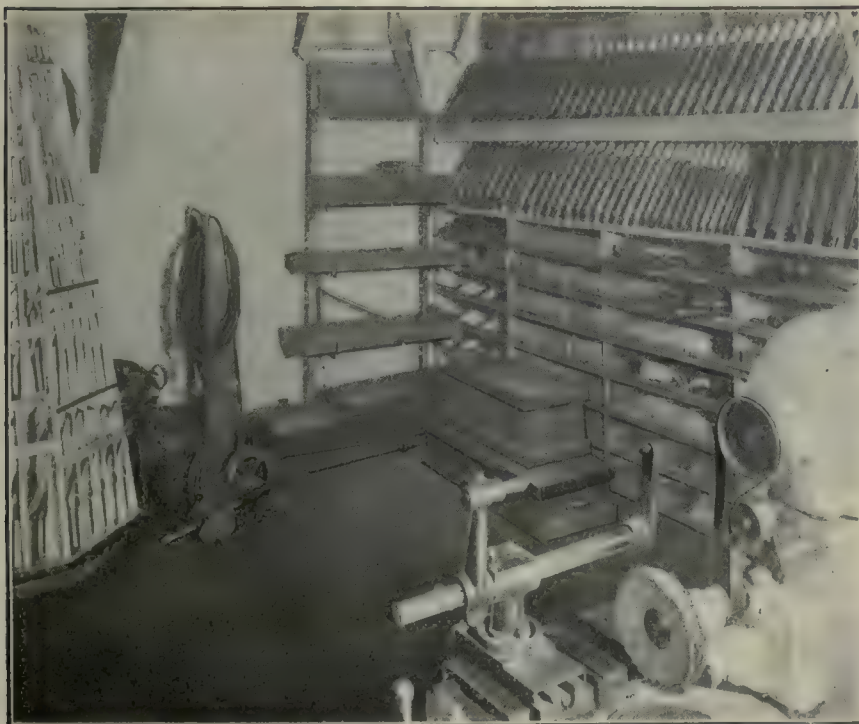


FIG. 1. TOOLROOM OF THE "PROMETHEUS"

Included are a large number of tools of all kinds and sizes, which enable the ship to take care of practically any kind of machine-repair job that might arise with the fleet at sea. The layout of the shops there presented gave a good idea of the floor arrangement, whereby space is utilized to the greatest advantage and at the same time attention is given to the peculiar difficulties that might arise in using certain kinds of tools on a ship not riding on an even keel, as would be the case in rough weather.

To a certain extent the same considerations had to be kept in mind in the installation of tools in the departments shown in the accompanying illustrations, although the machinery here is smaller, with lighter parts which are more easily handled and controlled, if it is necessary to use them during the roughest conditions of machining at sea.

It is a perfectly natural condition that with the complete line of machine tools installed in the main shops there should be a well-fitted toolroom for checking out small tools and supplies, just as in the case of shops ashore. Nevertheless, to the landsman it seems a matter of unusual interest to find such a conveniently arranged department as this toolroom on the "Prometheus." A general view, showing one end of this room, is given in Fig. 1. Aside from the fact that certain of the overhead deck angles are visible in the picture, it might well be supposed that this was the conventional toolroom of the usual shop, except that perhaps it has a rather more completely filled line of reamers, drills, taps, etc., than one would expect to find in a general toolroom.

This is obviously necessary for the reason that the ship

must be all things to all vessels and must have for her own work and for the work to be carried on for other vessels of the fleet every conceivable kind of tool or part that may be called for, unless it is found more feasible to make certain of these tools on the spot when required. This is not usually the case, of course, and for that reason pretty much every size of drill, tap, reamer, die and the like will be found in this toolroom or in the stores adjoining it. At the left of the picture will be seen the revolving twist-drill rack, more or less along the lines of the usual revolving stand found in general toolrooms, except that in this case the fact that the toolroom floor, or deck, quite often rolls and pitches to an angle of anywhere up to 30 deg. or more makes it necessary for the tools to be confined in their compartments. The rack itself stands about 6 ft. high and turns upon a ball bearing. It is mounted upon a heavy piece of gas pipe, with a base of ample dimensions to maintain its position perpendicular to the deck surface. The whole affair is easily swung

about by the hand to bring the required size of drill into position. The general construction is so well-known as not to require any explanation.

It will be seen that each face of the stand has pockets, or compartments, for four to a half-dozen or more drills, depending on their size. Extending across the face of each section at the right is a flat metal strip which is hinged at one end and which drops down behind the latch at the opposite, or open, end. When a drill is to be removed from its place, this metal locking strip is swung up, allowing the tools behind it to be taken out of their pockets. This arrangement effectively takes care of the tools under any and all conditions of tossing about in the sea, keeping the drills from falling upon the deck, with the attendant possibility of injuring the workman or nicking the cutting edges themselves.

Looking again at the illustration and particularly at the right of the center, it will be seen that the racks for reamers both straight and tapered are the conventional type of sloping open-faced affairs, where a sufficient angle of inclination has been possible to assure the tools staying in position without special means of clamping them. The section of the shelving below the reamer racks is of the common form, except that the bottoms of the shelves slope downward from the front by about 20 deg., so that material placed in them, whether small parts in the metal receptacles or varying in character, as tongs, files, hammers and the like, cannot fall out with the lurch or roll of the vessel.

This idea of taking care of tools—small tools, machinists' tools and machine appurtenances, like chucks, face-

be instilled into the mind of a newcomer on such a ship. We are accustomed, if we are careful at all, to place our spare lathe chucks, faceplates and other equipment where they will not be covered with dirt, oil and chips or fall into the machine. But at the best they are usually put alongside or against the legs of the machine; or possibly hung upon pegs in the wall near-by. As a rule, we feel that when this equipment is off the floor and secured against the wall we are doing about all that can be expected.

On board a repair ship, however, we have to go several steps farther. We must set the chucks and faceplates clear of the deck; otherwise, they will slide to and fro with the roll of the ship, bruising themselves and other objects. When it comes to hanging tools upon supports

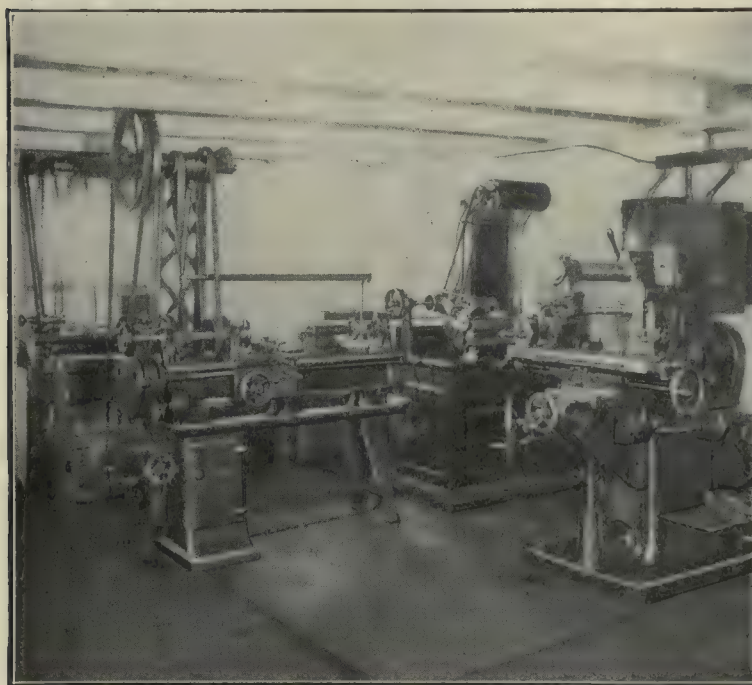


FIG. 2. OPTICAL SHOP ON U.S.S. "PROMETHEUS" AND SOME OF THE EQUIPMENT

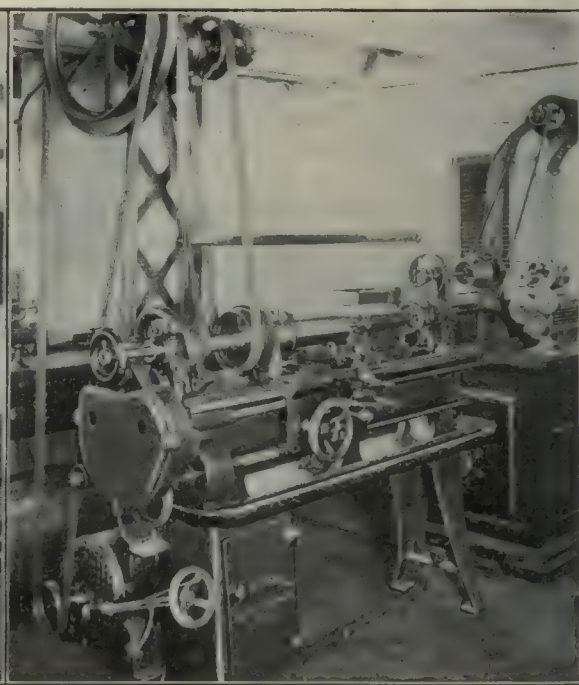


FIG. 3. DEVICE FOR TOOL MAKERS' LATHE IN OPTICAL SHOP

plates, steadyrests, big pipe centers and a multitude of other apparatus—must be closely adhered to on a ship of this kind, for when at sea her shops, like all the other departments, are pitching and swaying in every direction. Sometimes there is such a degree of roll that even with the best provision for securing the tools it seems likely that some must drop from their racks to the deck. It is only by paying strict attention to these details that trouble from this source is avoided.

This is one of a number of peculiarities relating to shopwork on a repair ship that the machinist familiar only with shore work must become accustomed to aboard such a ship as the "Prometheus." If he has been in the habit of having a number of lathe or planer tools alongside the machine, even on the conventional tray with a ledge an inch or more in height around the edge, he must get used to the idea that this tray is likely to slide off the machine at any time unless he sees that it is placed properly with its resting feet between the ways of the machine. Even then it may slide endwise off the tail end of the lathe. For this reason, tools carelessly thrown upon the machine may drop off and possibly injure themselves or the operator. This taking care of the cutting tools immediately under his observation is about the first thing that has to

be done on the wall, we have to secure them there also; otherwise, they will drop off and be in worse shape than if they were originally left on the floor. This necessity has led to the devising of special means in the way of boards or racks suspended on the inner shell of the ship, on the wall of the ship herself, to which are attached substantial bent-up studs for faceplates, and large wooden plugs, upon which lathe chucks may be slipped and fastened by tightening the jaws into the wood.

At the rear end of the room will be seen a form of rack for holding sets of taps and dies, both for straight work and for pipe threads. The tool boxes in this case are placed upon projecting arms with hooks so set that they cannot slide out endwise or fall from the rack. The opposite side of the room is fitted up in similar fashion for holding all sorts of equipment. Every tool, when brought back to the room, is immediately put in condition and returned to place, so that it cannot get loose.

The toolroom is fitted with grinding apparatus and sharpening equipment for all sorts of tools. It has a complete line of air tools for use around the ship and carries also a stock of hoisting apparatus and miscellaneous equipment not commonly found in general toolrooms ashore. Of all repair departments one can conceive of,

The motor itself will be seen in this case behind the tool makers' lathe, on a bracket near the base of the cabinet, under the head. The handwheel for its control

Another important department on the "Prometheus" is the optical shop, shown in Figs. 2 and 3. It is fitted up with precision machinery, including tool makers' lathes, bench lathes, grinding machines, toolroom miller, engraving machine, etc., all suitable for taking care of high-grade instrument work such as arises on vessels at

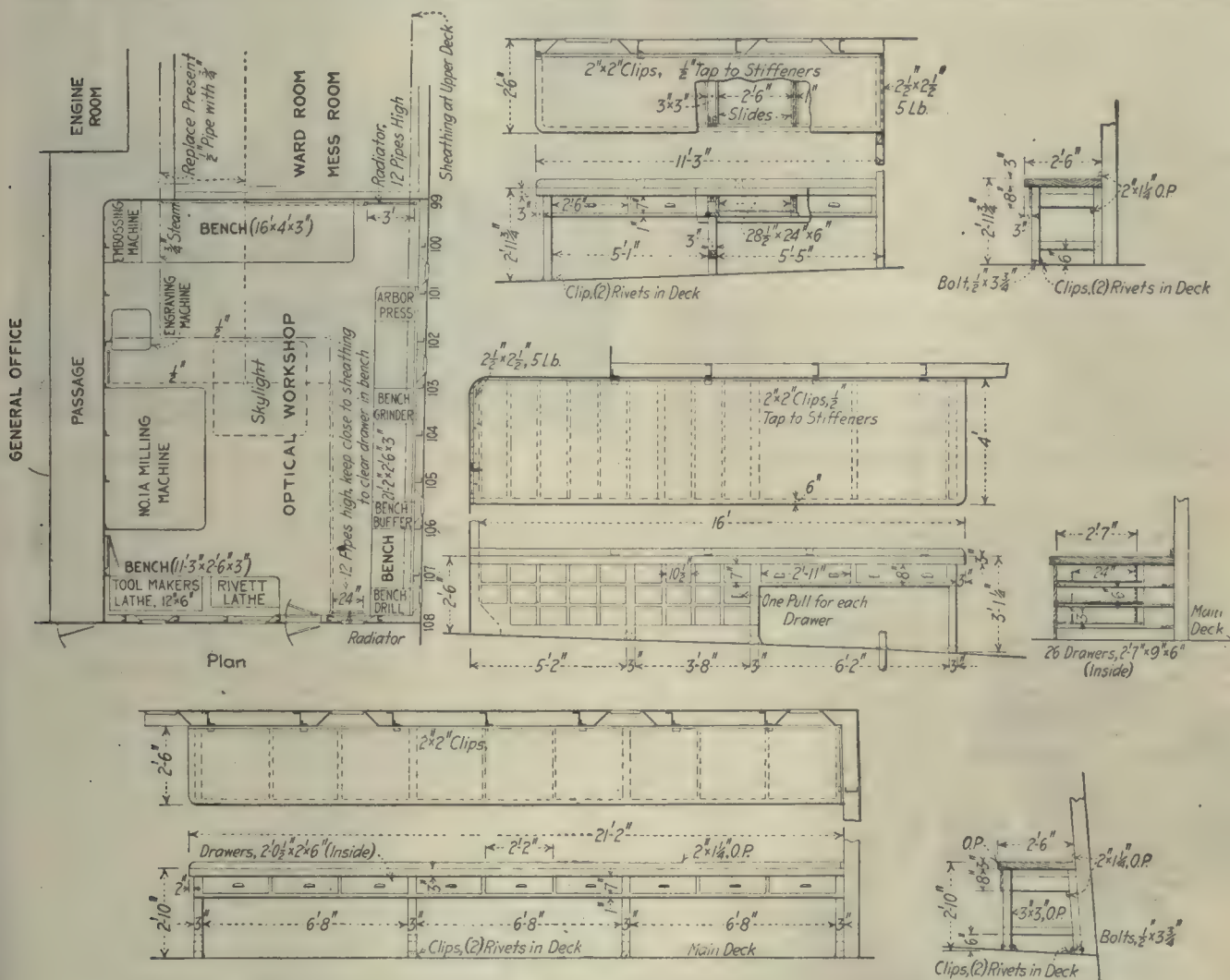


FIG. 4. OPTICAL WORKSHOP; GENERAL ARRANGEMENT AND DETAILS OF WORK BENCHES

This continuous shifter rod has always been recognized as a convenient feature even with small tools. It is particularly helpful with long lathes, where the workman often has to take several steps before he can reach the shifter rod at all. This is of the ordinary vertical type. It is very handy indeed in the ship repair shops to have

Tool makers' lathe, 19 in. by 5 ft.	Pratt & Whitney
Universal miller No. 1-A.....	Brown & Sharpe
Bench lathe, 8-in. Rivett.....	Rivett
Sensitive bench drill.....	Francis Read Co.
Sensitive drill	United States Electrical Tool Co.
Engraving machine.....	George Gorton Co.
Two bench grinders.....	James Clark
Arbor press, Greenard bench....	Bartlett
Electroplating equipment.....	World dynamo

this type of horizontal rod, which may be reached from any point in front of the machine. The method of driving the universal miller is shown in Fig. 2, as well as the general drive for the grinder.

This room, like other shops on the ship, is well lighted artificially, and through the day has ample illumination by means of the liberal ports shown at the left in the illustration. This optical shop happens to be at the rear end of the deck superstructure, so that it opens out upon the open decks past the center of the ship, where plenty of light is available, unobscured by other deck structures.

As this department is the one where all the high-grade tool work of small size is handled—that is, the precision work of the ship—it is of unusual interest. The layout of the workshop is therefore presented in Fig. 4. This shows the method of placing the tools, benches, etc., and also gives details of the bench equipment, which will be of considerable interest. It should be pointed out that it is thought desirable on ships of this kind to have benches unusually deep to provide ample working space as well as to make sure that the work shall not easily fall off to the deck.

The storage drawers underneath are also correspondingly deep, as they fill an important place in taking care of equipment that it is not wise to leave lying loose, where it may roll into obscure corners or be lost entirely. The bench details show not only the woodwork, but the structural steel work for supports, clips for attaching the legs

These benches were laid out and made at Mare Island navy yard. As a matter of fact, all the furniture used on the ship was constructed at that yard. It will be understood that such equipment must be unusually strong and



FIG. 5. DRAFTING ROOM OF U.S.S. "PROMETHEUS"

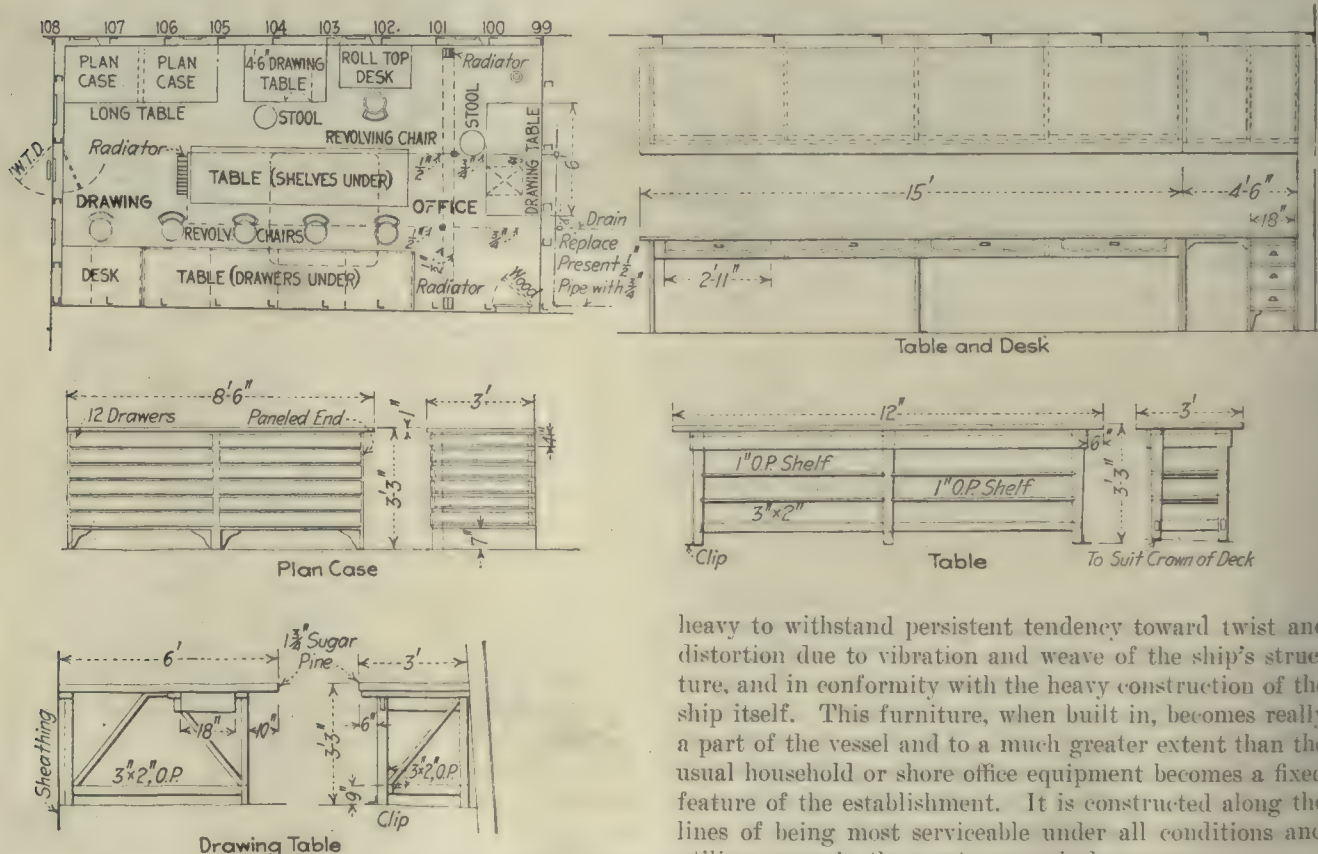


FIG. 6. GENERAL ARRANGEMENT OF DRAWING OFFICE AND DETAILS OF FURNITURE

to the deck and the angles to the longitudinal bench members, as well as other features of importance. The bench is a composite affair of channels, L's, angles and woodwork.

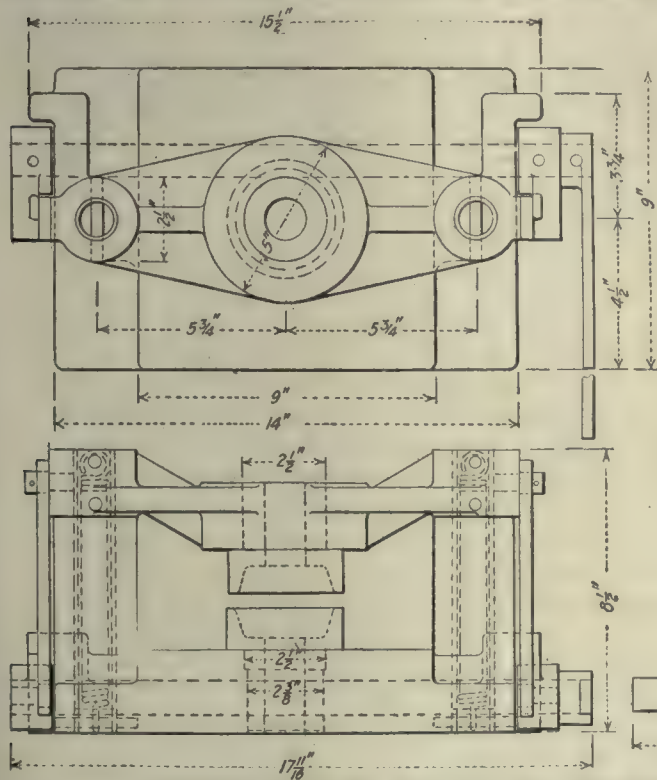
heavy to withstand persistent tendency toward twist and distortion due to vibration and weave of the ship's structure, and in conformity with the heavy construction of the ship itself. This furniture, when built in, becomes really a part of the vessel and to a much greater extent than the usual household or shore office equipment becomes a fixed feature of the establishment. It is constructed along the lines of being most serviceable under all conditions and utilizes space in the most economical manner.

One interesting feature peculiar to the fact that this bench equipment is used on board ship is illustrated by the detailed sectional views showing the change in the slope of the ship's walls as one glances along the length of the bench. Thus, at one point the wall structure is practically perpendicular. At another point it slopes forward until it reaches an angle of several degrees, and at

the same time the plan of the deck assumes more camber here, so that the front legs of the bench and the top of the bench itself are the only two members at right angles to each other. A study of these details will reveal some interesting points well worth the notice of people intrusted with the fitting up of ships with furniture and similar equipment.

An example of the complete use of all available space is well brought out by the installation of the large number of small drawers at the left-hand end of one of the long benches in this department, where 26 such drawers are shown in position, for holding all kinds of material and pretty well filling in all the space between the sloping deck and the bench top.

Another important department is located on the ship directly across from the optical shop just illustrated. This is the drafting room, which occupies on the port side of the vessel a space 26 ft. long by 14 wide, in which are installed several heavy drawing tables suitable for laying out all sizes of work. The benches and cases in this room are fitted with filing drawers of suitable size for original drawings, tracings and blueprints. The general arrangement will be understood from Fig. 5, this view of



SPRING-OPERATED REAMING JIG DESIGNED FOR AGRICULTURAL-IMPLEMENT PARTS

the room looking toward the after end of the ship. A large skylight directly over the center of the room provides ample means of ventilation, in conjunction with ports at the side and astern, and gives ample daylight illumination. The lamps for artificial lighting are shown between the deck beams overhead.

The general arrangement of the equipment is illustrated in Fig. 6. This shows clearly the layout of the tables, desks and cabinets and also illustrates in detail the type of furniture built especially for this purpose by the Mare Island yard. Here again it is quite important that the drawing tables and furniture in general be firmly attached to the deck plates forming the floor of the drawing office. At the same time they must fit snugly against the inner wall of the vessel.

The method of building up the woodwork upon the structural-steel members is brought out clearly in the different elevations and sections. Enough dimensions are retained to give these drawing details a degree of interest to all readers acquainted at all with drawing-office equipment. The corner posts, it will be noticed, are all of substantial sections and, like the intermediate supports, are firmly attached to the deck by angle clips, which assure them against movement in any kind of weather. The position of the port lights is clearly shown in the plan of the drawing office in Fig. 6, and the location of the skylight overhead is also indicated by the dotted line.

The steel deck in this office is covered with linoleum. All the lights throughout the ship are carried in special spring sockets, adopted for shock-absorbing purposes, to prevent the constant jar and vibration of the ship from putting the bulbs out of commission too frequently. These sockets are so arranged that very little vibration gets as far as the lamp, and there is therefore not much greater liability of loss of lamps in this way than is the case with the same kind of bulbs in the customary fixture ashore.

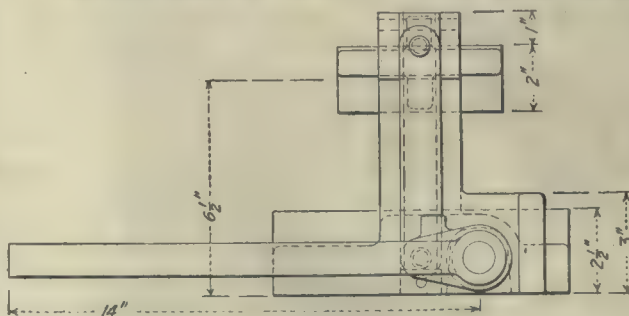
Spring-Operated Reaming Jig

BY EDWARD L. ROBENOLT

This jig was designed for reaming bushings, small gears, sprockets and other small castings used on harvesting and agricultural machinery and has proved very useful.

After the jig is once lined up with the drilling-machine spindle, all that is necessary to change from one job to another is to change the bushings. These are made to fit the bore in the bushing plate and jig frame. The bushing plate can be reversed, and in this way two more inches of space can be gained with the same jig.

The operator lifts the handle A, which opens the jig and allows the work to be placed within the bushings.



Then the handle is released and the part is securely clamped ready to be machined, there being no other device to bother with.

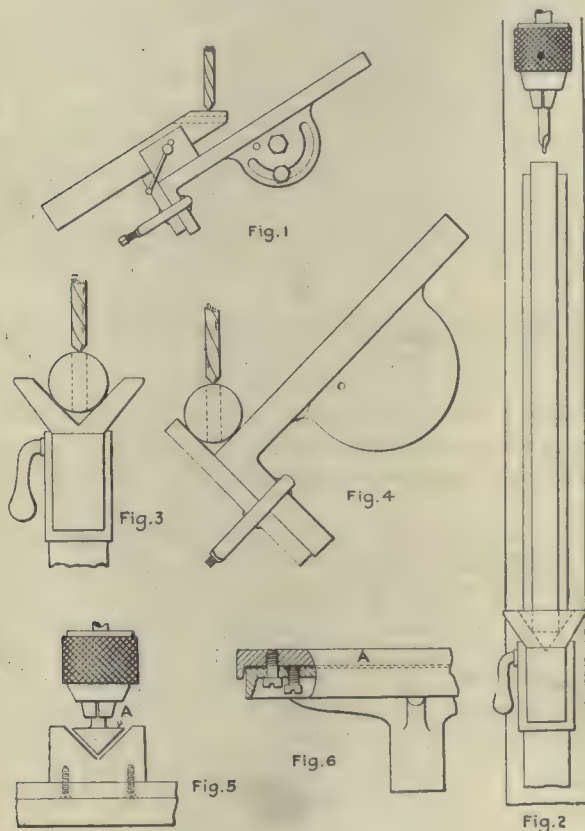
Using the Small Drilling Machine

BY R. A. GUSTAVUS

A drilling machine that is universal in its scope is generally well liked by those who use it on machine and tool work. Of course, it should be accurately constructed; otherwise it will cost more to do certain jobs that must be squarely drilled or lapped.

In Fig. 1 is shown how easily a piece may be drilled at an angle when the table can be tilted to the desired inclination. The shell-boring tool that is to be drilled has been first clamped in the drill vise, which in turn is located by the drill-press table and parallel piece that is clamped to the side of the table.

If the drill press has an extra slide extending along the post almost to the floor, and also a female center, the latter will be much used for rapidly centering work for turning in the lathe. The application of this female-center method for centering lathe work is shown in Fig. 2.



VARIOUS DRILLING DEVICES

If a V-rest may be inserted in place of the female center, it can be used to good advantage for drilling holes through round stock, as shown in Fig. 3. A good feature of this V-rest, if it is properly constructed, is that the corner of the V is always in line with the drill, thus insuring the drill's going through the center of the piece. The method of holding the round stock in the drill vise and carefully setting with square and scale consumes much time, and drilling by eye usually produces poor results.

If the above-mentioned rest is not at hand and the table is of the swivel kind, a suitable rest for round stock can be obtained by tilting the table as in Fig. 4 and clamping a piece of flat stock to the side of the table, as shown. In order to insure the corner of the V thus created being in line with the drill, a piece is turned as shown at A, Fig. 5, and applied in a similar manner—that is, the table is swung around until the piece A, which runs true in the chuck, fits into the V.

If none of the foregoing features are present and much round stock is to be drilled through the cross-section, a V-block fastened to a piece of flat stock, as shown in Fig. 5, may be properly located and clamped to the table of the press.

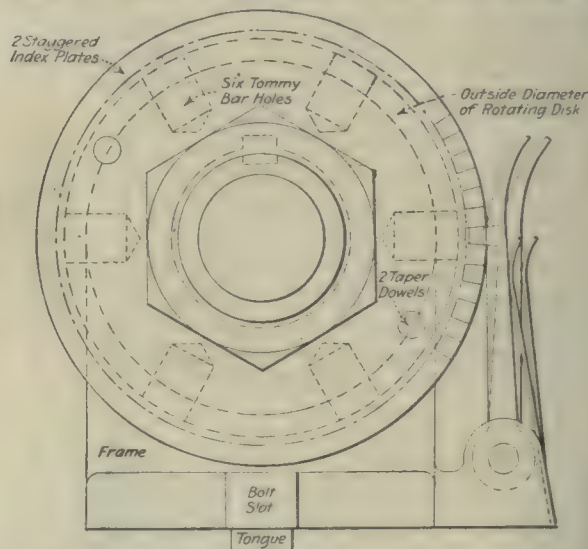
It is an old trick to lay a parallel plate upon the table of the drill press and proceed to true this by means of sweep and indicator. While this procedure will not insure drilling squarely if the spindle of the press is shaky, it will improve matters somewhat. Much time is lost, however, when each tool maker who wishes to drill or lap a hole squarely has to resort to this method. In a small shop we possessed a small drill press, the table of which was so much out of square that it could not be used for most of our drilling. A casting was obtained and machined as A, Fig. 6. Four sets of screws like those shown in cross-section enabled us to true the table.

Avoiding Indexing Errors

By ROLAND V. HUTCHINSON

Where one operator runs two or more machines, a board at each machine with the move chalked, painted or stenciled on it will often help to keep his mind from wandering too far off the job.

The type of dividing centers having a worm gear with several rows of holes in it is commonly used, and there are numerous errors credited to it in the hands of semi-skilled help. With this class of labor the machine is usually set up by a gang boss or other skilled operator, and what is the most obvious thing for this man to do to avoid errors? Is it not to plug up the holes not to be used in that specific circle in which the plunger is



DIRECT-INDEXING DEVICE

working? Finished round hardwood stock such as is bought for pattern makers' use is excellent for this purpose and may be cut into the correct lengths and stored away in a box until needed.

Direct indexing is no doubt the sure way of avoiding spacing errors; but as has been pointed out by one correspondent, when the divisions are high in number, the indexing plates are subject to greater shock than is advisable for the continuance of their accuracy.

The sketch shows an end view of a direct-indexing device that was made to overcome this weakness and yet provide rapid and accurate spacing. Two index plates were made, cut together, staggered and doweled. Two exactly similar pawls engage these plates. Obviously, when one pawl is seated, the other is riding on the land of the other plate, ready to drop in when the device is rolled by means of a tommy-bar inserted in a disk.

Introduction of Shop Management in Typewriter Plants

By L. P. ALFORD

SYNOPSIS—Some six years ago the Remington Typewriter Co. began the installation of scientific management in its plants. H. L. Gantt was retained as consultant. This work can now be considered as thoroughly established, although, of course, modifications and improvements will always be made. In this article and three others that will follow, the general results and basic principles of the work will be presented.

The Remington Typewriter Co. operates in the United States four factories engaged in building typewriters and manufacturing their accessories and supplies. These factories are located in Ilion, N. Y., Syracuse, N. Y., and Bridgeport, Conn.

Some seven years ago the beginning of the unification of the factory methods was started. Up to that time the administration of each plant was largely independent of all the others, and it was difficult to obtain reports in a form permitting intelligent comparison. The advantages of using the same classification of accounts, the same method of finding costs and the same accounting system are apparent to every reader. The possibilities of improving production by introducing into each factory the best of the methods in the others are likewise easily appreciated. Once the same methods are in use in all the factories, the transfer of men from one place to another, either temporarily or permanently, may be made with full assurance that they can take up their new duties at once without going through a period of learning.

When undertaking this work of unification in the four factories it was obviously advantageous to install the best system possible. With this purpose in view H. L. Gantt was retained as consultant. His work has been going steadily forward for some six years, and he considers that the four typewriter plants now present the most representative installation of his system of shop management as applied to machine shops.

Within a few weeks I have had the privilege of entering all four of the factories mentioned. The visits were made with the purpose of studying the broad results that have been obtained and of gaining a first-hand knowledge of the principles that have made the results possible. Thus this article and those that follow will be devoted to results and principles, without making any attempt to show detailed methods.

The reason for this is that men and principles are always of vastly greater importance than systems. It is true, although still a matter of some dispute, that the same principles can be worked out through different shop systems and attain the desired satisfactory results. A logical presentation might call for a statement of principles before a setting forth of results. But the value of principles is best shown by the results that they bring. Thus our starting point can well be a brief discussion of the general results that have been obtained from the installation of scientific management in the plants of the Remington Typewriter Co.

1. The invested capital has been reduced relatively to volume of product. This has been brought about largely by a cutting down of the quantity of raw and finished material in storage and work in process. Other factors have been the sale of one plant, its amalgamation with another and a reduction in the number of machine tools and amount of manufacturing equipment needed.

2. The factory production has been increased in the proportion of 100 to 164. While this has been going on, one factory has been given up; its equipment moved to another, the number of standard machine tools has been decreased, and only a few special machines have been added. During the same period the number of working hours per week has been reduced from 59 to 50; the number of employees per unit of product has been materially lessened. The actual working time has had still another reduction by the introduction of a ten-minute rest period into each half-day.

3. The wage payment to employees has increased in the proportion of 100 to 123. At the same time there has been an average saving of 18 per cent. on the labor cost of 5,000 jobs in one factory. These have been studied and placed on a task-and-bonus basis.

4. The average labor cost has been reduced in the proportion of 100 to 80.

5. A steady improvement in the quality of the finished machines has taken place during the installation period.

6. All factory employees and executives have been carefully trained for their duties.

7. Both executives and employees now have the satisfaction of knowing that they are working under a well-thought-out plan in which each man's duties are defined, and which provides for the advancement of those who make good.

8. From top to bottom there has been cultivated and now exists a spirit of coöperation and good will among all the executives and employees.

9. The factory executives are now relieved from the supervision of routine affairs and are free to deal with the exceptional matters which need study and must be carefully considered before they are decided.

Any one of these nine general results is important in itself. Taken together they present a broad result, which at once establishes the assumption that the principles from which the effects have come must be right. But before turning to a statement of what those principles are, it is necessary to sketch the general policy and attitude of the management of the Remington Typewriter Co. as this existed before the work of installing the system of management began and as it has been developed and worked out up to the present time.

The progress of industry seems to be paralleling that of our political fortunes and to have the same stages. The relationship existing between employer and employee under these three sets of conditions may be referred to as "master and slave," "patriarch and dependent" and "man to man." The last is one of democracy in industry, where each deals with the other in the straightforward relationship of one free man with another.

Here the employer recognizes that the workmen are free moral agents, and the employee accepts the same principle as applying to his executives. Each is working for the best good of the business, for thereby each profits. The relation is that of friendly business, because that is the only one which is mutually advantageous. Thus each side accords to the other the freedom of action and the rights that exist between all right-minded business men who are working for things that are equally beneficial. This relation is an outgrowth, perhaps, of that positive American idea that the human individual has an intrinsic value, that he has a right to get the most out of his native endowment and to enjoy in his own way the product of his own labor.

The attitude of the executives of the Remington Typewriter Co. toward their workmen is the direct outgrowth of this democratic spirit applied in industry. From this fundamental human relation have flowed a number of details of policy. Freedom of discussion and negotiation is encouraged between the executives and the workmen. Either side is free to propose modifications in existing terms of employment and arrangements, or even to suggest something entirely new. The management is always ready to discuss and investigate all proposals. The workmen on their side have the right to send representatives or a committee at any time to confer with the management, and the individuals who form this committee are treated entirely without prejudice. A man is not fired simply because he has been on such a committee.

Of course, the management does not always agree with the viewpoint of the workmen. When this is so, the adverse decision is frankly stated and the reasons therefor clearly given. Everything is above board.

To sum up what scientific management is, I can do no better than to quote from an address¹ given by Fred J. Miller, general factory manager of the Remington Typewriter Co. The quotation is his definition of scientific management evolved as a result of his experience with it in the factories under consideration. It is as follows:

The best definition of scientific management I have been able to give is that it consists in an arrangement such that the right thing is done, at the right time, in the right manner, by the right person.

By the right thing I mean a thing which has been carefully studied and a definite conclusion arrived at as to whether or not it should be done at all, or whether or not some other thing would be better.

The right time means that the first and all successive operations upon a piece must be scheduled or planned so that the completed piece or pieces will be ready for the stockroom when needed and (remembering inventory values) not much before they are needed.

The right manner means that each operation performed upon any piece is done in a way that has been carefully worked out by study and by the development of the best possible method. It means also that the best possible machinery, tools, etc., have been developed and provided for doing each operation, having reference of course to time and circumstances.

The right person means a person who has been selected with reference to adaptability to the work to be done, who has then been carefully instructed in the right method of doing it, has been convinced that it is to his interest to do the work in this way and shown that he will be paid liberally for so doing.

To complete the foundation for the articles that are to follow, this first one can very properly close with a statement of the general divisions or classes of the work that have been made in order to secure control. The first class includes all the shop work that is routine in its

nature; that is, all the work that we know how to do from previous experience. This work is directed and controlled from the "manufacturing office." In other words, it is the function of the manufacturing office to collect information in regard to the sequence of operations on all the manufactured parts, the machines on which the parts are made (together with their shop location), to record, or estimate if necessary, the number of parts produced per hour, the quantity and kind of material required to make such parts, the number of parts per finished unit of output, the tool number required for each operation and its location, and to keep an exact balance of material on hand and on order.

From this information can be graphically shown the work that has been done and the work to be done; in other words, the load on the shop and how it is being carried.

This office receives all orders for manufacture, and from its charts can tell what can be done and when it can be done. It is one of its functions to make promises and to keep them.

The second class of work includes that which is new; that is, things which are entirely outside of the routine and concerning which the shop has no previous experience or exact knowledge. Thus, the making of all kinds of shop investigations, the engineering work of the plant, making time studies and setting tasks are all in this second class. Control is centralized in what is known as the "engineering office," where all questions of "how" are answered.

This subdivision of the work is basic in all the places where Mr. Gantt's system of shop management has been installed. The reason for it is to separate that which is done over and over again and becomes routine from that which is done for the first time and must be carefully studied step by step. Each class of work requires a different type of man—the first, one who is content to do the same thing time and time again; the second, one who prefers to do a thing but once and is always interested in that which is new.

Greatest Petroleum Production

That 1915 was the most successful year of production in the history of the petroleum industry is shown by statistics just compiled under the supervision of J. D. Northrop, of the United States Geological Survey.

The total quantity of crude petroleum entering the world's markets in 1915, which amounted to 426,892,673 bbl., exceeds the former record, established in 1914, by 28,194,307 bbl., or 7%.

WORLD'S PRODUCTION OF CRUDE PETROLEUM IN 1915 AND TOTAL YIELD SINCE 1857

Country	Quantity, 1915		% of Total	Quantity, 1857-1915		% of Total
	Barrels of 42 Gal.	Metric Tons		Barrels of 42 Gal.	Metric Tons	
United States....	*281,104,104	37,480,547	65.85	*3,616,561,244	482,208,266	60.10
Russia.....	68,548,062	9,353,077	16.06	1,690,781,907	222,984,256	28.10
Mexico.....	32,910,508	4,388,068	7.71	123,270,377	16,420,008	2.05
Dutch East Indies....	12,386,808	1,710,445	2.90	148,999,921	20,087,939	2.48
Roumania....	12,029,913	1,673,145	2.82	130,012,387	17,477,875	2.16
India.....	17,400,000	986,667	1.73	80,789,711	10,771,961	1.34
Galicia.....	4,158,899	578,388	0.98	136,032,500	18,918,364	2.26
Japan and Formosa.	3,118,464	415,785	0.73	30,169,622	4,022,666	0.50
Peru.....	2,487,251	331,633	0.58	16,794,223	2,239,229	0.28
Germany....	995,764	114,000	0.23	13,961,333	1,875,974	0.23
Trinidad....	1760,000	100,000	0.18	2,819,430	375,924	0.05
Argentina....	516,120	75,900	0.12	1,033,121	151,693	0.02
Egypt.....	221,768	29,509	0.05	1,308,496	174,466	0.02
Canada.....	215,464	28,729	0.05	23,709,074	3,161,210	0.39
Italy.....	39,548	4,500	0.01	842,000	119,279	0.01
Other.....	110,000	1,333	0.01	372,000	49,600	0.01
Total..	426,892,673	57,298,786	100.00	6,017,457,366	801,038,653	100.00

* Marketed production. † Includes British Borneo. ‡ Estimated.

¹Delivered at annual meeting of the Efficiency Society, December, 1915.

Loading Primer Bodies

EDITORIAL CORRESPONDENCE

SYNOPSIS—The final operations of primer making, as in other industries, consist largely of inspections and handwork. This article shows the ingenious inspection devices used, the precautions against fire and explosions and the methods employed.

After the priming bodies, together with the anvils and plugs, have been made as described on pages 309 to 315, Vol. 44, they go to the loading factory to receive their charge of detonating and explosive compounds.

The article referred to described the packing of primer bodies in boxes holding 10 layers of 100 each. On being received at the loading factory the top of the box is removed and the whole thing turned upside down on a broad bench. The box is then lifted off, leaving the contents

The length of this anvil is tested in a simple multiplying device, as shown in Fig. 1, where the outer face of the anvil rests on the gage plate and the anvil projection touches the feeler that actuates the multiplying lever. Two marks on the scale give the maximum and minimum, which in this case is 0.096 to 0.098 in.

TESTING HOLES BY LIGHT

The holes are tested by placing the anvils over a sheet of ground glass having an incandescent bulb beneath, as in Fig. 2. This throws the light through the holes, so that the operator can easily see light through the three holes in each anvil, even though they are drilled at an angle. The operator is partly inclosed, so as to shut out bright daylight, which might tend to confuse.

In order to facilitate the handling of these anvils a special form of rack has been made, as illustrated in Fig.



Fig. 1

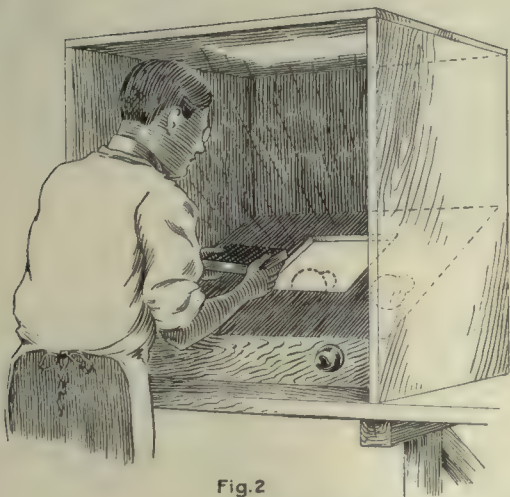
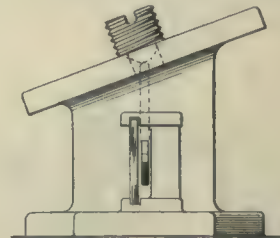


Fig. 2

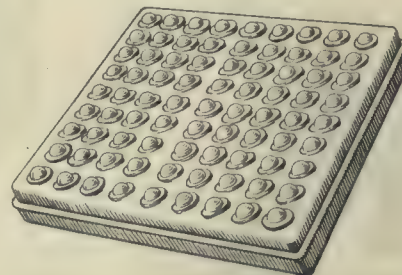


Fig. 3



Fig. 4

FIGS. 1 TO 4. INSPECTION AND HANDLING DEVICES FOR PRIMER PARTS

in a pile, the layers being separated by the corrugated cardboard previously mentioned. The primers are then placed open end up in wooden trays, each tray holding 50 bodies. This is the unit in which they are handled through the different departments, the first being that of the preliminary inspection, to be sure that the primer bodies are correct in every particular before loading.

The anvil and plugs are also inspected, particularly for the flash holes, for if these are not clear it is impossible for the fire to reach the powder in the body of the primer. The rounded end on the anvil is also carefully inspected, as the distance between this and the explosive in the cap is of great importance if they are to fire properly.

3. This is of light sheet metal and holds 81 anvils, 9 on each side. The holder is easily loaded by simply scattering anvils over the top. A little practice enables the girl to fill these holders very quickly, and they are then passed to the inspector through an opening in the side of her cage.

This holder is made in two parts, the lower containing 81 rather sharp pegs *A*, which fit up inside the hole of the anvil and center the anvils so that the rounded end will point upward. The lower part is removed as soon as the holder has been filled, only the upper part being necessary to hold the anvils over the ground glass for the eye test. After the inspection of the primer parts is finished, and the per-

cussion caps, which are shallow, drawn copper cups that have been partly filled with the proper mixture of explosives and covered with a thin disk of tinfoil, have been brought to the operator, everything is ready for assembling.

The first operation is to put the caps in place, which is done while the primer bodies are in the trays previously referred to. The caps are picked up by a ball hand-spring chuck, Fig. 4, and a ring of Pettman's cement is placed on the outer edge to seal the cap into the body. This is

apt to set off the explosive, the same as when the primer is fired.

The assembling fixture, Fig 6, consists primarily of the frame *A* and the screwdriver spindle *B*. This is driven by the handwheel at the side, through the bevel gear *C*. The handle *D* controls the vertical movement of the screwdriver, which is made solid on the splined shaft and is shown at *E*. The primer body is held in position by the plate *G*, which forms a guide for the screwdriver and is

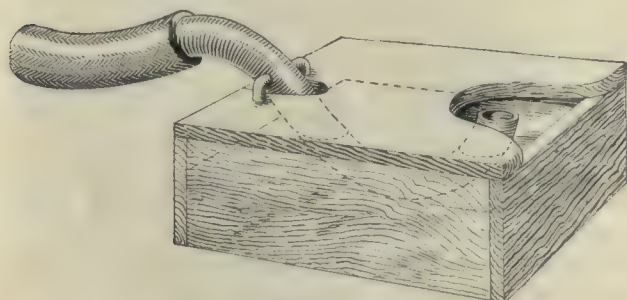


Fig. 5

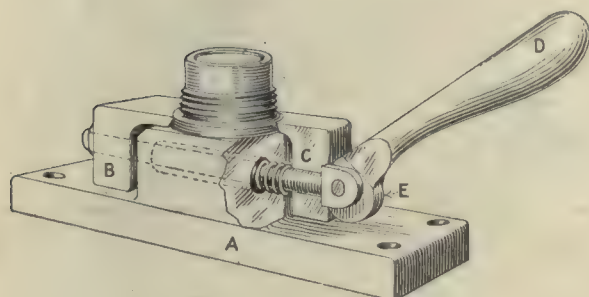


Fig. 7

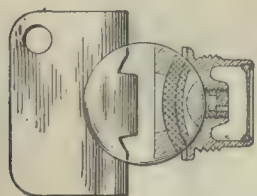


Fig. 8

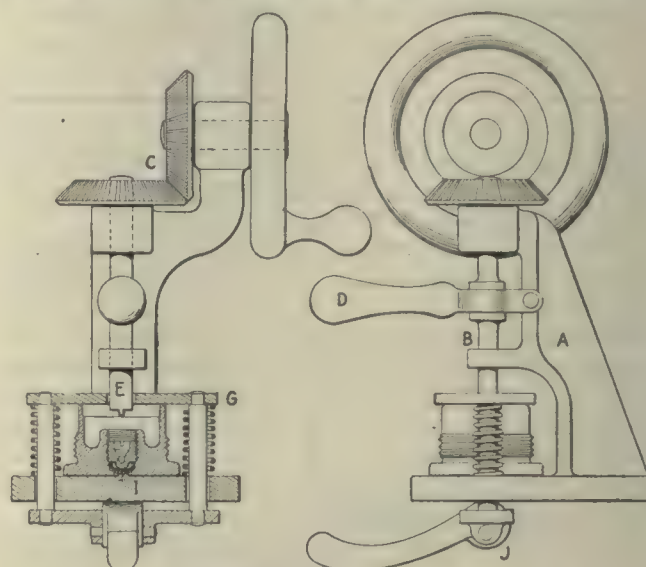


Fig. 6

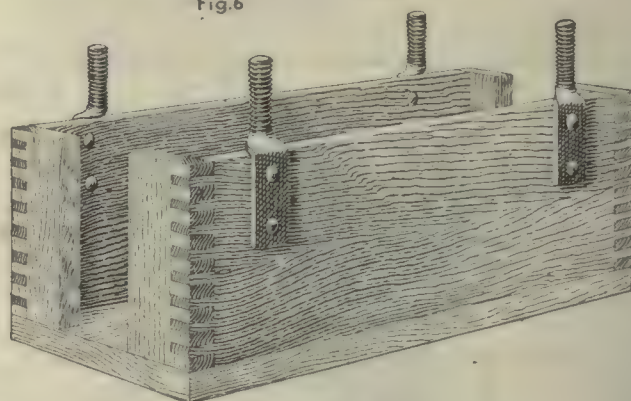


Fig. 9

FIGS. 5 TO 9. FINAL ASSEMBLING AND GAGING DEVICES USED FOR PRIMERS

done by an ingenious little device seen in Fig. 5, the central portion being practically a hollow tube and bringing a ring of cement up against the cap as it is held in the position shown.

SCREWING IN THE ANVILS AND PLUGS

The board of bodies with the caps in place goes to a bench, where the anvil is screwed in by the little machine shown in outline in Fig. 6. This is a mechanical screwdriver, operated by a small pair of bevel gears and a hand-wheel, as shown. The primer body is held under the screwdriver by the yoke, which is operated by a hand lever beneath the bench. The anvils are screwed down solidly on their seats; and as both the depth of the cup and the projection on the anvil have been previously gaged, there is practically no danger of their making contact. The surplus cement is cleaned out with a soft stick. The caps are all seated in the body by being lightly pounded, using a soft-nosed stick for this purpose. Metal would be very

actuated by the cam *J*, shown beneath. This pulls the plate *G* down against the primer body, the spring shown releasing it as soon as the cam is moved in the opposite direction.

The distance from the face of the primer body to the rounded or outer surface of the cap is then carefully gaged, the limit here being but 0.004 in. This is now automatically taken care of in the assembling of the anvil. The hardened-steel plug *I* in the base of the clamping fixture, being located the proper distance above the surface, forces up the end of the cap, should it be necessary.

Afterward, the bottom of the primer is inspected to insure the caps being at the proper distance, this being done in a machine almost identical with that illustrated in Fig. 1. Then the primer bodies are turned over in the tray, and the small copper ball is put into the anvil. The plug is next started in the hole, so that the ball will not come out. These plugs are screwed into place with a three-prong screwdriver.

The next operation is to close the metal around the plug by forcing a hollow-coned die over the central portion of the primer body, closing the thread so as effectually to prevent the plug from backing out. This is called "dabbing" and is done in a foot-power press on the order of the well-known sprue cutter. The operation is performed about as rapidly as a man can handle the primer, a production of probably 30 a minute being steadily maintained. Men are shifted from this to other and less laborious work every two hours, so as to avoid excessive fatigue.

The surface of the raised portion is then cemented in a machine similar to that seen in Fig. 5, and a small paper washer is put in place to prevent the grains of powder from working down into the flash holes. This is also done very rapidly, the small paper washers being spread on the bench and picked up with the end of a soft wooden stick, which is occasionally moistened on a damp sponge.

LOADING THE PRIMERS WITH POWDER

The bodies are now ready to be loaded with the coarse-grained powder that surrounds the central portion. This powder is already measured in regular 16-page paper shells, which come in cases containing 20 boxes, each box holding 120 paper shells and each shell containing a proper load for the fuse.

The powder is poured into the primer body very rapidly, as there is no danger of its getting into the flash holes. The girls who do the loading become very expert, and by using both hands they fill a tray of 50 primers in remarkably short time.

Then the closing disks are put in place, each previously having a paper washer cemented on the inside. A ring of cement is placed around the outer edge of the closing disk, a brass tube of the proper dimension being used for this purpose. It is simply dipped into the cement and placed on the top of the closing disk, which makes a ring around the outer edge. The sharp edge of the primer body is closed on the disk by another foot press.

The primer then goes to a regular crank press, which puts the finishing crimp on the end and at the same time stamps the proper marking on the base of the primer. This handles about 9,000 primer bodies in 10½ hr.

GUARDING AGAINST FIRE

All the tables where powder is used are covered with a linoleum or rubber pad and are surrounded by a water trough perhaps 3 in. wide. All loose powder is brushed into the water, so as to avoid any accumulation that might become a source of danger.

The final inspection is primarily for the thread on the body, in order to make sure that it has not become distorted in any of the closing operations. The thread gage is held in a chuck and revolved by a small friction that turns it in either direction. Any large body passes along the bench to the special vise, Fig. 7, which holds it while the hand die is being run over the thread.

This vise consists of a body *A*, raised in the center and carrying two studs that fit the wrench slot in the back of the primer body. The two jaws *B* and *C* are closed on the primer body by means of the handle *D* and the cam *E* at the end. This pulls the two jaws toward each other, the spring shown surrounding the central bolt forcing the jaws apart as soon as the lever is released.

The completed primers are lacquered by dipping, this having been found much more satisfactory than the spraying process. The primers are handled very rapidly, placed

in a wire basket tray, dipped, lifted out and drained, then placed in front of a fan, which dries them in about 2 min.

After this they go into the trays once more, and the upper side of the closing disk is covered with Pettman's cement. Here again various more or less complicated methods have given way to the simple expedient of flooding the top with the cement on the end of a small round brush. This is done very quickly by hand, after which the primers are set aside to dry as long as necessary. The final gaging is for the cap distance from the bottom, the form of gage shown in Fig. 8 being used for this purpose.

The primer bodies are then packed in a special box that holds 10 trays, the style of box being shown in Fig. 9. It is open at the end to allow the trays to be put in place and removed easily, and is provided with four bolts, so that a cover can be readily and substantially adjusted and held by means of wing nuts. This box holds the trays while the primer bodies are going to the shop, where they are put into the cartridge cases, and also for the testing, thus completing the loading of the primers, which can be done in large quantities in less time than it takes to describe the process.

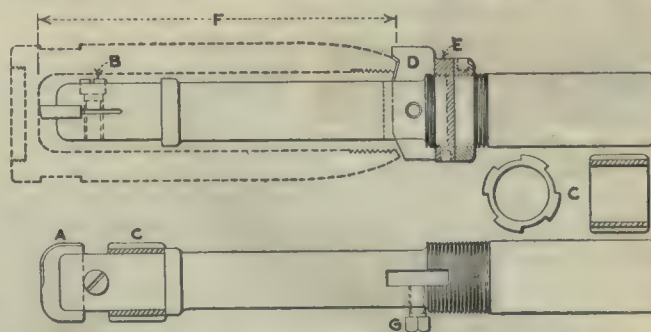
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Chamfering and Radius Boring Bar for Shells

By F. G. SMITH

The illustration shows a bar that has been found most useful in the manufacture of 18-pounder shells. As will be seen, this bar finishes the radius at the bottom of the hole and at the same time cuts the internal and external chamfers at the mouth of the shell.

The radius cutter *A* is held in position by the screw *B*, the saw cut at the back of the cutter giving sufficient spring to grip the cutter securely. The end of the bar is steadied by the phosphor-bronze bush *C*, which is free



RADIUS BORING BAR

to rotate, and is held in position by the collar turned on the bar and by the projecting head of the screw. The bush is milled away, as shown, to allow the passage of chips and lubricant.

The chamfering cutter *D* fits in a slot that allows longitudinal movement. A fine thread is cut on the bar, and the locknuts *E* give a quick and easy adjustment to keep the distance *F* correct; they also provide a solid backing for the cutter. The setscrew *G* locks the cutter in place.

I was somewhat doubtful when getting out this tool as to whether the double chamfering cutter would turn out a sufficiently good job, but the result is quite satisfactory.

The Importance of Fixed or Overhead Expense

By J. P. BROPHY*

In every kind of business, regardless of its size, fixed or overhead expense must be considered. If you are manufacturing, it is dangerous to forget the overhead or to figure it in a careless manner. The money invested in land and property should be regarded as an investment with an earning force. Every ounce of fuel and every dollar's worth of labor must be considered in this expense.

In the office nearly every purchase made is an item of overhead expense, from a lead pencil up to the most expensive supplies, including the janitor's pay, telegrams and every other thing that goes to keep the office in operation. And all the help that is nonproducing must be considered, even to those doing the simplest things.

In a factory where machinery is used the cost of such machinery must be taken into consideration, its depreciation from year to year, every item of expense in repairs, new appliances and everything that is necessary to production. Water, light, etc., must not be forgotten. They are chargeable as an overhead expense. The wages of the timekeeper, foremen, superintendent, manager—everyone who does not actually produce—are a part of the overhead charge.

Those who fail to take these items into consideration are liable to discover when placing a price on their product that they have blundered.

If you manufacture something on which the actual labor cost (which means the wages of the employees doing the work) and the cost of material is \$1 when the part is completed, some 50 to 150 per cent. must be added to get the shop cost. This makes it, say, \$2.50. If your profit is 25 per cent., that must be added to this sum. Traveling expense is another item that must never be forgotten. There are numerous other little things, of which I cannot speak here, that must also be included in this fixed or overhead expense.

NEED FOR EXPLANATION

It creates in some instances a peculiar feeling in the mind of the producer, when he is under the impression that your profits are so exceptionally high. It is a difficult problem for the manufacturer, if he attempts to explain this fact clearly to the man who produces; and the latter may still have a doubt in his mind after the manufacturer is through with the explanation. The workman imagines that if the piece can be manufactured for \$1 and he performs all the labor, that if it is sold at \$1.50, the manufacturer is making a lot of money. The only motive in explaining this matter here is to show clearly to those who produce that their notion in a case of this kind is erroneous, and to help to dispel this idea. Any number of people who manufacture name the selling price of their product without going to the trouble to discover for a certainty what their fixed expense is. They are then likely to find at the end of a month or a year that their profits are not nearly as large as they anticipated, or perhaps find that they are on the wrong side of the ledger.

It is understood of course that the really up-to-date companies study very carefully all the expenses to which

attention is called in this article, in order to be positively sure that their profits are as much as they should be. Were this not done, it would be possible to overlook a great amount of current expenses that should be considered in establishing prices. This matter comes up constantly when placing prices on parts necessary for repairs. In many instances something that looks insignificant to the man who orders it demands a price, perhaps, of \$3 when the buyer thinks it ought to be no more than \$1.50. He figures he might produce the piece in, say, two hours, forgetting the expense that has to be attached to the labor and material cost before arriving at the real selling price.

Because of all that I have said here, you will realize that a good education is necessary among business people to apply the points brought out in this article. Real business qualifications mean reaching into the corners, aiming to discover the little things, for the old saying still holds true that then the big things will take care of themselves.

Investigate the insolvency courts or business failures and you will discover that overhead charges puzzle many smart men. Seventy-five per cent. of them are weak when fixed expense is considered. They merely make a guess, and after their money is gone they still ponder over their failure, trying to figure it out. Their business friend made good; he was not much of a schemer, and they cannot grasp how it could happen.

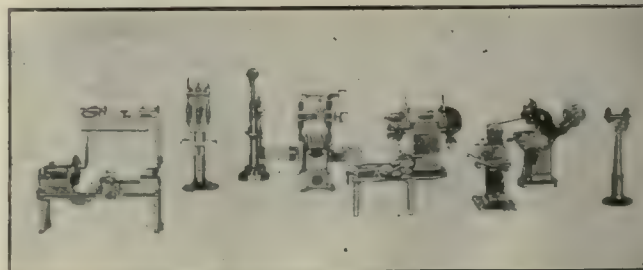
Not many miles from where I am located, a matter of great importance was discussed a few years ago. When the matter of overhead expense came up, some intelligent men were strongly under the impression that this "overhead" meant the wires, poles and nothing else. It took considerable explaining and argument to convince them what overhead expense really was. This is mentioned simply to show that some clever people have but a slight conception of the actual importance of this part of a business. The consequence of neglecting it is failure and disappointment.

❧

Miniature Machine Shop

By A. J. MILLER*

The accompanying illustration is a photograph of actual working models of a number of machine tools, made by a clever bench mechanic, Adolph Skeininzilinski, in our employ. The 6-in. scale back of the planer will give



A MINIATURE MACHINE SHOP

a good idea of the comparative sizes. All of the work was done by hand, and each model is an exact reproduction of the machine it represents.

*Vice-president and general manager, Cleveland Automatic Machine Co.

*Master mechanic, Root & Van Dervoort Engineering Co.

Drilling and Turning Machines with Hydraulic Feed

SYNOPSIS—The machines described owe their development to the demand for high production incident to the manufacture of munitions. The principles involved are, however, applicable to quantity production of any drilled, faced or turned work falling within their capacity.

The illustrations show a line of drilling, turning and facing machines developed and built by George de Laval, Paterson, N. J., at the plant of the East Jersey Pipe

In Fig. 1 is given a front view of the drilling machine, which is also used for facing by substituting a facing tool for the drill. In this machine the work is held stationary, and the drill or facing tool rotates. The spindle carrying the drill is driven by a large pulley. There is no gearing of any kind, the belt pulley being mounted direct on the spindle. Also mounted on the spindle is a smaller pulley that drives the cutting-lubricant pump *A*.

The thrust of drilling is taken by a large ball thrust bearing *B*. The drill *C* is of the ordinary type used for deep-hole drilling.

It has a high-speed steel bit, two chip grooves on opposite sides and holes through it for the distribution of the cut lubricant at the point of the bit. The lubricant is pumped through a hole in the spindle. The work is held in the carriage *D*, which slides on two cylindrical bars, one at the back and one at the front of the machine. A seat is machined in the carriage for the reception of the work. This seat is of course in line with and concentric to

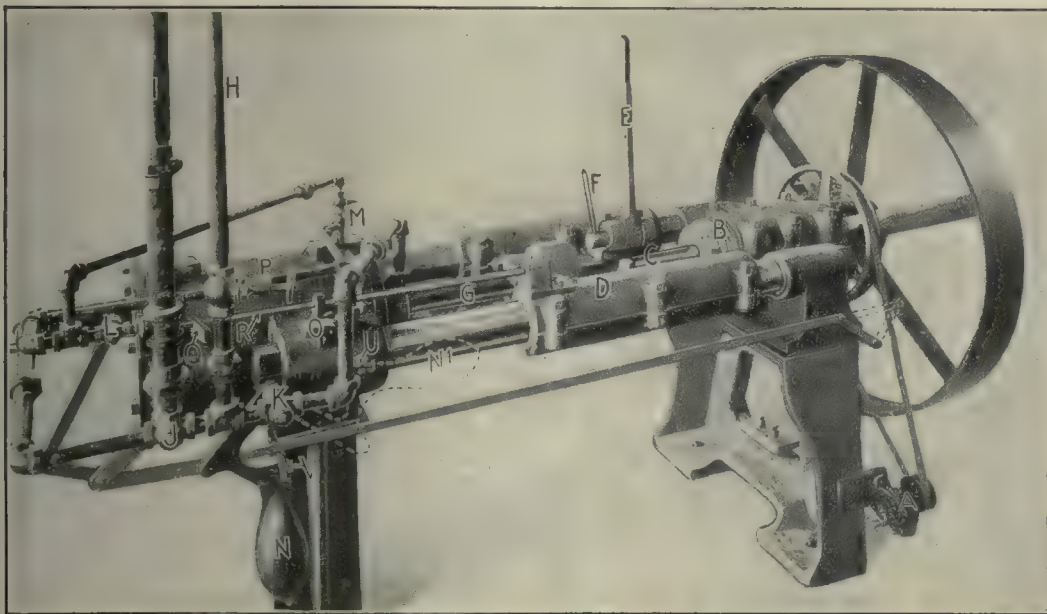


FIG. 1. DRILLING AND FACING MACHINE WITH HYDRAULIC FEED

Corporation and the International Steel and Ordnance Corporation. Apart from their extreme simplicity the notable feature of these machines is the utilization of hydraulic power for the drill feed in the drilling machine, for the carriage feed and tail-stock movement in the turning machine and for the facing-tool feed in the facing machine. A large installation of these machines has for several months been in successful operation in a plant manufacturing high-explosive shells. It will be as well to take up the explanation of the machines in the order in which they are used in this installation and later show the simplicity of the layout of this part of the plant.

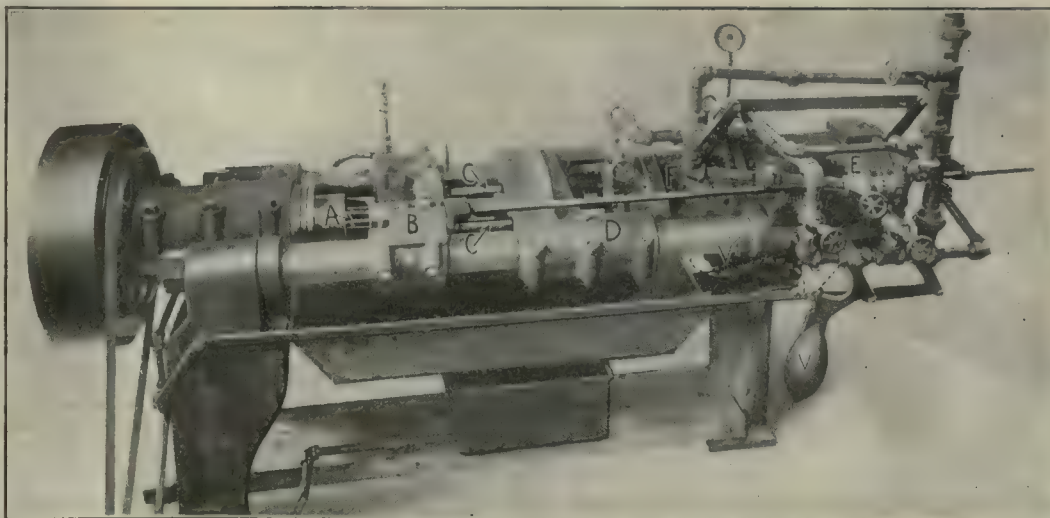


FIG. 2. TURNING MACHINE WITH HYDRAULIC FEED

the axis of the drill. The method of chucking the work is the acme of simplicity. The eccentric lever *E* is used to clamp the work in the machined seat in the carriage. Owing to the very slight eccentricity of the head of the lever *E* and to the fact that the rough bars being drilled vary

slightly in diameter, additional adjustment of the lever *E* has been provided in the shape of an eccentric pin fulcrum *F*. This permits adjusting the head of the clamping lever *E* to or from the seat in the carriage without in any way detracting from its gripping power.

The carriage and work are forced toward the drill by the forward end of the piston rod *G*. The other end of the piston rod is provided with an ordinary piston that fits the hydraulic cylinder. The piston is packed at both ends with hydraulic packing, as it functions in both directions. The feed water for the hydraulic cylinder enters through the pipe *H*, and the discharge is through the pipe *I*. For both feed and discharge comparatively large pipe is used to obtain the necessary rapidity of action. At *J* is a three-way reversing cock that alternately admits the water to the rear of the piston from the feed pipe *H* and from the rear of the piston to the discharge pipe *I*. At *K* is a one-way cock that admits water from the feed to the front of the piston and causes it to reverse and withdraw the carriage and work. The one-way cock *L*, when closed, prevents escape of the water from the front end of the hydraulic cylinder when the carriage is reversed. It will be noticed that the cock *L* is on the same pipe as the hand-operated cock *M*. The duty of this cock and pipe is to permit the gradual escape of the water from the front end of the cylinder during the advance of the piston. By adjusting this cock *M* the rate of feed of the carriage can be regulated to suit the work being drilled.

The main operating lever is shown in full lines at *N* and also in dotted lines at *N*₁. When in the position shown at *N* the valves are open to discharge for the return of the piston and carriage to the starting position. When in the position *N*₁, shown in dotted lines, the piston, carriage and work are advancing. It will be observed that the main operating lever *N* is provided with a heavy bulb to accelerate its action. When the lever *N* is raised it engages a latch that holds it up. This latch is disengaged by the adjustable trip finger *Q* coming in contact with the tripper *O*.

The operation of drilling is as follows: The work to be drilled is clamped by pulling down the eccentric lever *E*. While this is being done, the main operating lever is in the position *N*. Having clamped the work, the operator raises the lever *N* to the position shown by the dotted lines at *N*₁. The latch *U* engages the projection *V* of *N* and holds it in this position. This movement of the main operating lever has caused the cock *J* to open and permit the feed water from the pipe *H* to enter the rear of the cylinder. It has also opened the cock *L*, letting the water from the front of the piston pass out through it and the cock *M* to the discharge pipe *I*. The rate at which the water passes from the front of the hydraulic cylinder determines the velocity of the feed and is controlled by the cock *M*. As the carriage, pushed by the piston rod, advances, it carries the trip rod *R*, on which the trip finger *Q* is mounted. The trip finger *Q*

at the end of the stroke contacts with the tripper *O*, which withdraws the latch *U* and allows the main operating lever *N* to drop. When it drops, the various links connected with it operate the reverse cock *J*, closing the rear of the cylinder to the feed pipe *H*, and open it to

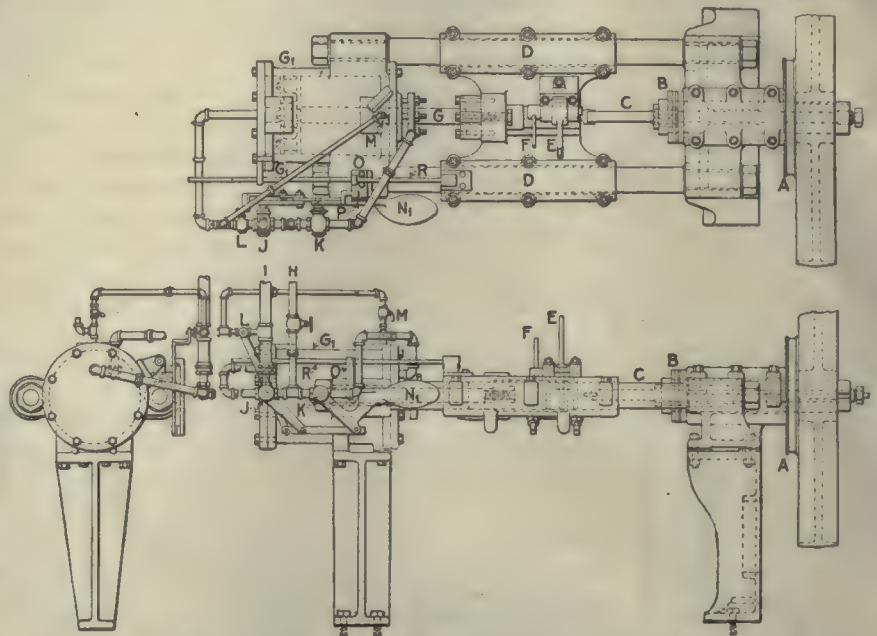


FIG. 3. DETAILS OF THE DRILLING MACHINE

the discharge pipe *I*; open the cock *K*, connecting the front of the hydraulic cylinder with the feed pipe *H*; and close the cock *L*, which controls the feed during the forward stroke of the piston.

It will be seen that in the piping a number of unions have been used. The employment of these in the positions shown permits the entire piping system to be

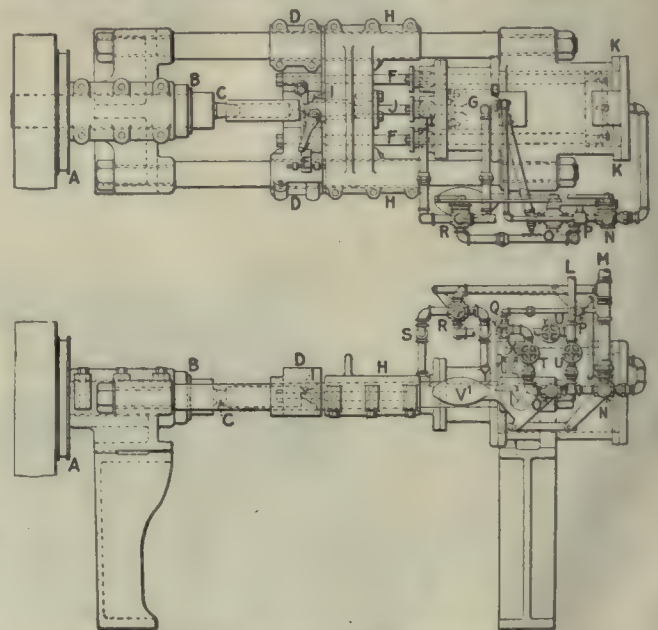


FIG. 4. DETAILS OF THE TURNING MACHINE

readily removed from the machine, should occasion arise making this necessary.

The steel that is being drilled in the installation previously referred to has carbon content 0.58 to 0.68: carbon and manganese, 0.75 to 1. Its tensile strength is 135,000 lb., with 95,000 lb. elastic limit. The machine

is run at 130 r.p.m., the drill is $2\frac{1}{2}$ in. in diameter and the feed from $1\frac{3}{4}$ to 2 in. per min.

As previously stated, the facing machine differs from the drilling machine only in the substitution of a facing tool for the drill. The facing lathes are used on the same steel. They are run at 90 r.p.m. with a feed of about $\frac{3}{8}$ in. per min. The entire end of the work, 3 in. in diameter, has been faced off for a length of $\frac{3}{4}$ in. in 2 min.

The turning machine shown in Fig. 2 differs from the drilling and facing machine in several important

When the photograph was taken, the machine was rough-turning work about 3 in. in diameter by 12 in. long, with a $1\frac{3}{4}$ -in. hole 10 in. deep in one end and an ordinary center in the other. The method of driving the work is by a toothed driver *A* which enters the $1\frac{3}{4}$ -in. hole. The work could, however, be held between ordinary conical centers and be driven by a dog or other means.

The tool carriage is shown at *B*. It supports a tool block carrying the turning tool. The tool carriage is fed by two piston rods, one on each side. These pass through clearance holes in the tailstock carriage *D*. A brief description of the hydraulic cylinder of this machine will at this point make the further explanation of this machine clearer.

In this machine the hydraulic cylinder is duplex, or perhaps more correctly there are two hydraulic cylinders mounted in tandem. The rear cylinder *E* furnishes the feed for the turning tool. The piston of this cylinder is provided with two piston rods, one on each side. The outer ends of these are secured to the tool carriage *B*.

The base of the front cylinder casting *F* acts as a head for the rear cylinder *E*. In its center is the cylinder that operates the tailstock carriage *D*, a single central piston rod connecting its piston with the carriage *D*. On each side of the front cylinder and passing through the casting from front to back are two clearance holes for the piston rods of the rear cylinder. The stuffing-boxes for the rear-cylinder piston rods are, for accessibility, at the front ends of these clearance holes.

The weighted trip lever and the system of levers and links, while not the same, are similar to those employed in the operation of the drilling machine. They perform the further duty of operating the tailstock in both directions. During the turning operation the tail center is kept in the center in the work by the hydraulic pressure exerted in the tailstock carriage operating the cylinder. Thus the pressure on the tail center is kept constant, and wear at this point is compensated for as it occurs. Figs. 3 and 4 in conjunction with Figs. 1 and 2 will assist greatly in understanding these machines.

In Fig. 5 is shown a layout of the installation previously referred to. As in this plant the water is metered, a pumping plant and sump have been provided. The discharges from the machines return to the sump, and the water is thus used over and over again. From the pumping station the water is pumped through a 6-in. main to the pneumatic tank shown diagrammatically and to a larger scale in Fig. 5. This is an ordinary steel drum 42 in. in diameter and 28 ft. high. Any sudden demand on the water-supply is provided for by the expansion of the air in the upper part of the pneumatic tank.

The pressure maintained in the pipe line is 45 lb. per sq.in. The city water service is 75 lb. per sq.in. To avoid delay in case of a breakdown of the pumps, the city water is piped, through a reducing valve, to the tank, and in case of trouble this source of power is instantly available.

Referring to Fig. 5, the pumping station is located at *A* and the pneumatic tank at *B*. The drilling machines and rough-turning lathes are shown at *C* and *D*. An operator handles two machines either on drilling or turning, but could easily take care of four, were it possible in this plant to arrange them in more accessible positions.

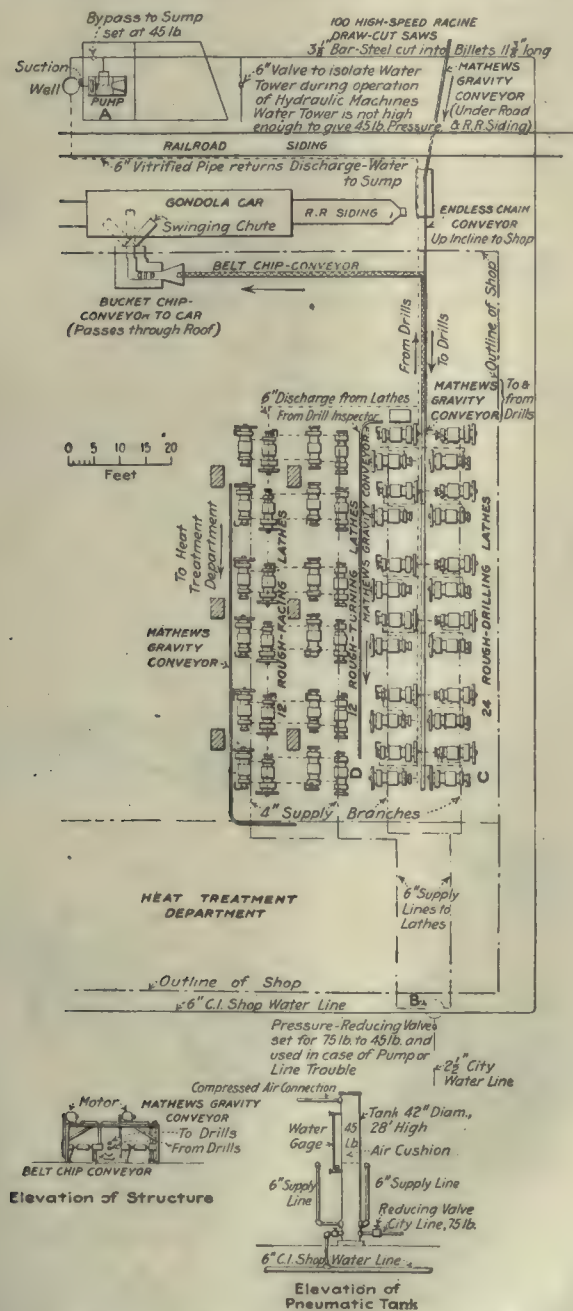


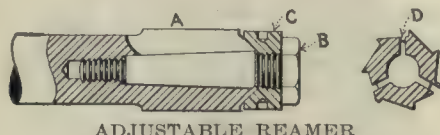
FIG. 5. LAYOUT OF THE INSTALLATION

points. In this machine the work rotates between centers, and except for the amount of feed the tool is stationary. In general the two machines are, however, very similar. The main spindle, its drive and the means of taking the thrust of the cutting tool and tail center by means of a ball thrust are identical with those in the drilling machine. The lubricant is, however, piped to the turning tool and not through the hole in the spindle.

Adjustable Reamer

BY CHARLES E. BLACK

The illustration shows an adjustable machine or hand reamer. It consists of three parts—the reamer proper *A*, split in three places, as at the points *D*; a taper pin *B*, for expanding or contracting as required; and *C*, a locknut for clamping when set. This reamer is very serviceable, as it can be adjusted from 0.010 in. below to 0.020 in.



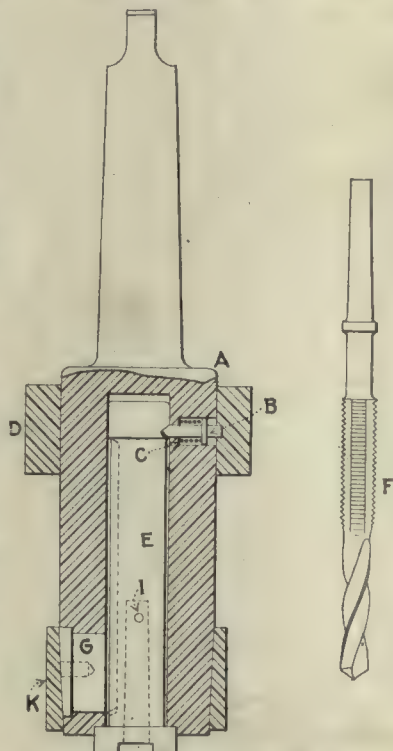
ADJUSTABLE REAMER

above size by merely loosening the locknut and tightening the pin *B*. I tried one myself in a screw machine, reaming 96 pieces with a $1\frac{1}{8}$ -in. hole 9 in. long in steel, and stopped to readjust the reamer just once.

Drilling and Tapping Tool

BY C. HERMGES

In our line of manufacturing we had to put a number of $\frac{1}{2}$ -in. tapped holes into so-called cable cases that were used for subsurface connections and switches on subsurface current lines. These cases were made of cast iron in various shapes so as to serve the different purposes. The thickness of the wall varied from $\frac{1}{2}$ to 1 in. Many times we encountered difficulties in tapping the holes. For instance, holes were not tapped square or were threaded too big on account of not being lined up right on the machine while tapping. Accordingly, the studs had to be straightened when screwed in, and sometimes special ones had to be made in order to prevent throwing away the casting. These troubles were overcome by means of the tool shown, which consists of a holder body *A* with the inserted index *B* and the spring *C*. The cam collar *D* serves to operate the index when turned contrary to the direction of rotation of the tool, in order to relieve the holder *E* carrying the combination drill tap *F*, when starting the tapping operation. After the operation is done, the machine is reversed and the tool is lifted up into position by the fingers. The hardened and ground holder *E* is provided with a clearance, so as to allow a certain rocking when released by the index, and out of recess. The key *G* is held



DRILLING AND TAPPING TOOL

in place by the collar *K*, which is slipped onto the body and held by only 5 deg. taper, so as to be removed with a wooden hammer. The key *G* has a tapped hole that can be used for inserting a screw, to draw it out of position. The combination tool *F* was made out of high-speed steel with a neck clearance big enough to run idle in the tapped hole when the operator misses the reversing point. It is inserted in the holder *E* by means of a taper, and flats are provided on the shoulder fitting in the holder, to avoid turning under stress. The pin *I* prevents slipping out while operating.

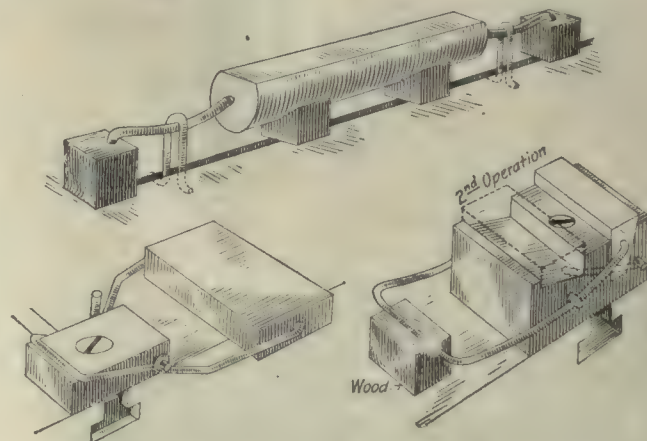
The essential feature of this tool is quick operation with high production possibilities, because no alignment is required after the hole is drilled through. The drill bushing of the jig needs only to be removed and the operator has merely to hold the ring *B* to begin tapping of the hole. Only one constant drill speed of 500 r.p.m. is used for both drilling and tapping.

Holding Devices for the Toolroom Grinder

BY G. A. ORR

There are some plants that will not use magnetic chucks on their surface grinders, for reasons which I shall not explain. In such instances various methods are resorted to for holding the work in such manner that the entire surface to be ground is exposed to the wheel.

The commonest method consists of holding the work firmly to the table of the machine while with a hot piece of pointed steel a mixture of beeswax and rosin is melted around the edges of the piece. This mixture will cool immediately and will suffice to hold the work securely.



HOLDING PIECES ON THE TOOLROOM GRINDER

Another method that is used extensively in a certain watch factory is partly illustrated. The manner in which these clamps perform their function can be plainly seen and needs no explanation. As occasion demands, these clamps are made, and they accumulate until there are enough to select from. Sometimes it is necessary to bend up a spring that can be used with a block at hand for a new job. These springs are made of piano wire of a diameter that warrants their serving their purpose.

Those who have not seen this method of holding work on the grinder in use will probably think the piano-wire hold-downs too weak for the job. It must, however, be remembered that the pressure of the cut on tool work is usually very slight.

Caps and Base Plugs for Time Fuse

BY FRED H. COLVIN

SYNOPSIS—A clever combination casting makes it easier to machine a difficult piece. The threading device is efficient and can be applied to other work.

The fuse caps and base plugs are made from one casting in order to facilitate machining. This casting is also of aluminum and subjected to the same heavy pressure as the body in order to insure density of the material. Full details of the caps are shown in Fig. 1, while Fig. 2 shows the shape of the casting at A, and the operations, the first being shown at B. This work is performed in a hand screw machine by holding the straight portion in a collet and boring and tapping the end that is later to form the cap. The tools and gages for this operation are shown in Fig. 3. The gage at H, Fig. 3, tests both the diameter and the length of the hole tapped in the cap. The threaded portion of the gage is surrounded by a steel sleeve held in place by a spring. On the outside of this sleeve is a line indicating the proper position when the thread in the cap is of the maximum length. The tolerance is 0.002 in. The next operation cuts off the

end that is to form the base plug, as shown at C, Fig. 2. It will be noted at A that the end of the plug is recessed, the exact shape being shown in the base plug details, Fig. 8.

Leaving the base plug for the present and continuing with the completion of the cap, the round end is formed in the usual manner, by either flat or circular forming tools, as shown in Fig. 4. The cap is then easily released from the threaded mandrel A by means of the left-hand

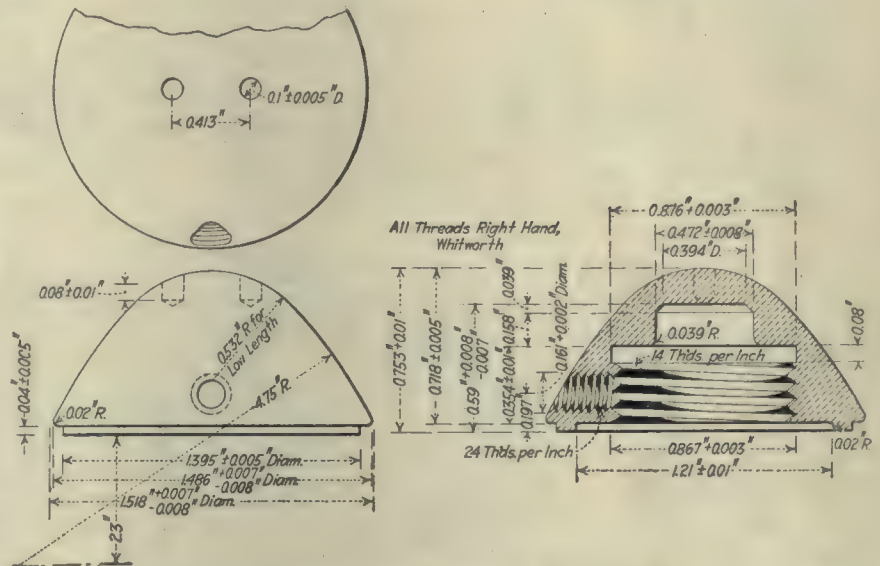


FIG. 1. DETAILS OF CAP

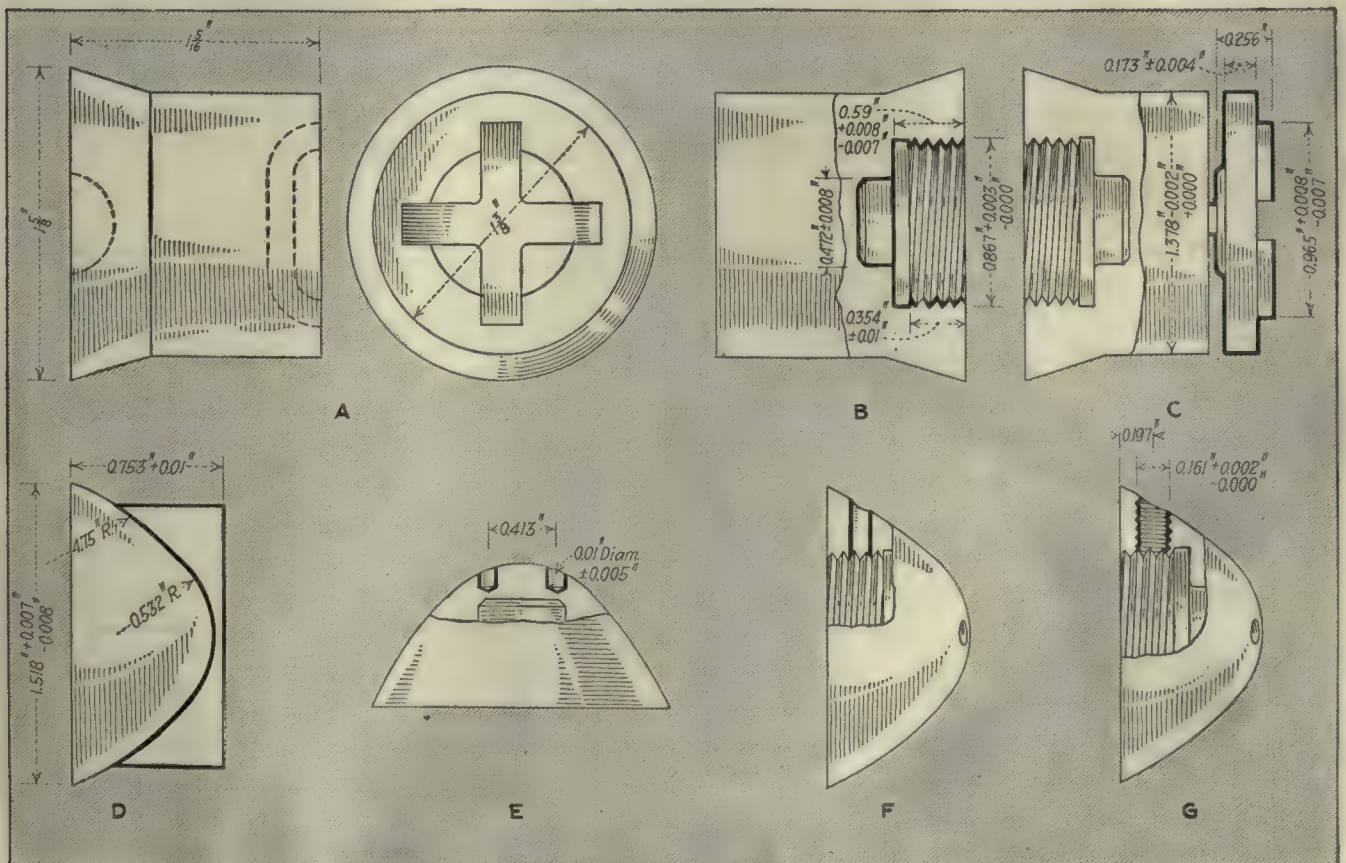


FIG. 2. SEQUENCE OF OPERATIONS ON CAPS

nut that forms a stop and enables the pressure to be easily relieved.

Next comes the drilling of the spanner wrench holes, as shown at *E*, Fig. 2, this being done in a simple jig *A*,

Fig. 5, with the aid of a double-spindle drilling head. The spindles have a center distance of 0.413 in. These holes are 0.10 in. in diameter, and both the diameter and the center distance are tested by gages, shown in Fig.

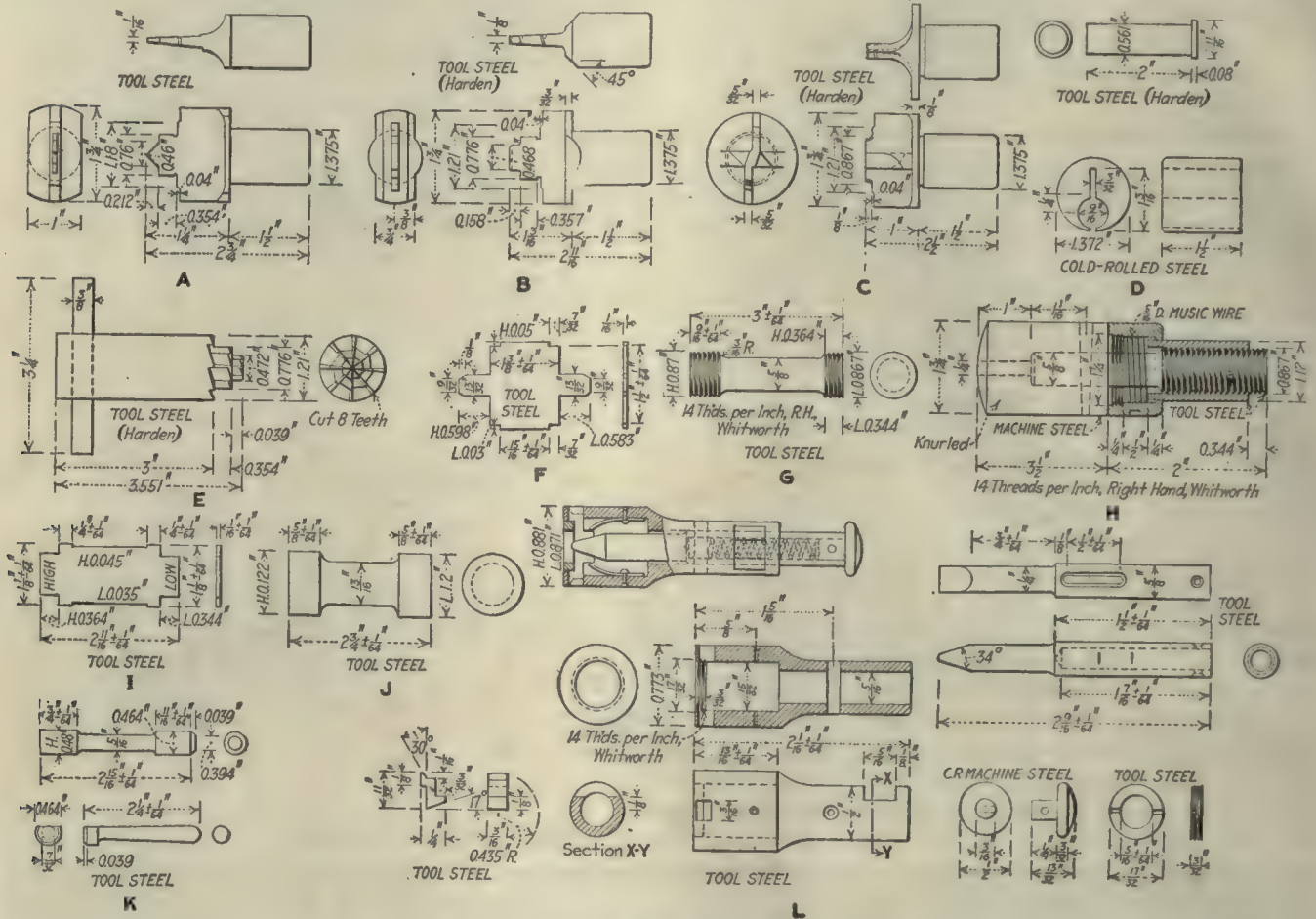


FIG. 3. BORING AND TAPPING CAPS

Tools—A, roughing cutter for inside of cap; B, cutter for inside of cap; C, form-facing tools for other end of cap; D, recessing tools for cap; E, hand reamer for inside of cap; F, depth of recess and depth of bore in cap; G, diameter and depth of screw recess; H, another form of gage for diameter and depth of recess; I, depth of threaded portion and depth of lip; J, diameter of recess in cap; K, form of bore in cap; L, diameter of undercuts in cap

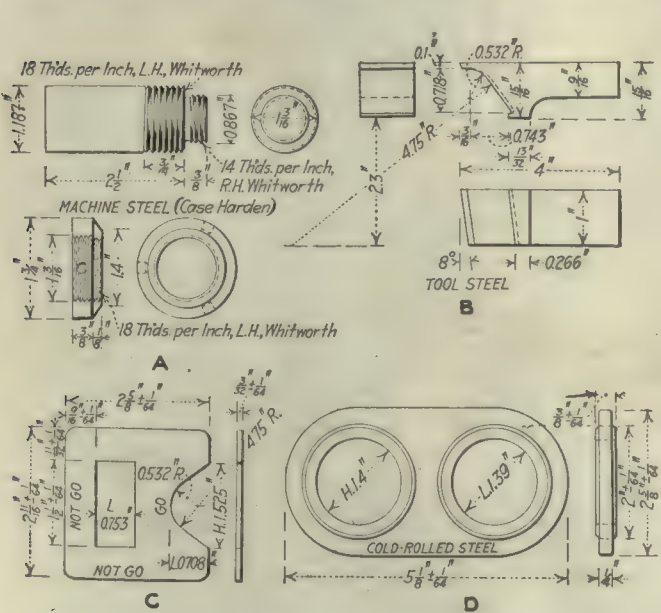


FIG. 4. TURNING THE OUTSIDE OF THE CAP

Tools—A, threaded mandrel for holding cap; B, flat forming tool for outside of cap. Gages—C, low length and shape of cap; D, diameter of cap. A similar gage tests the diameter of the lip on the cap

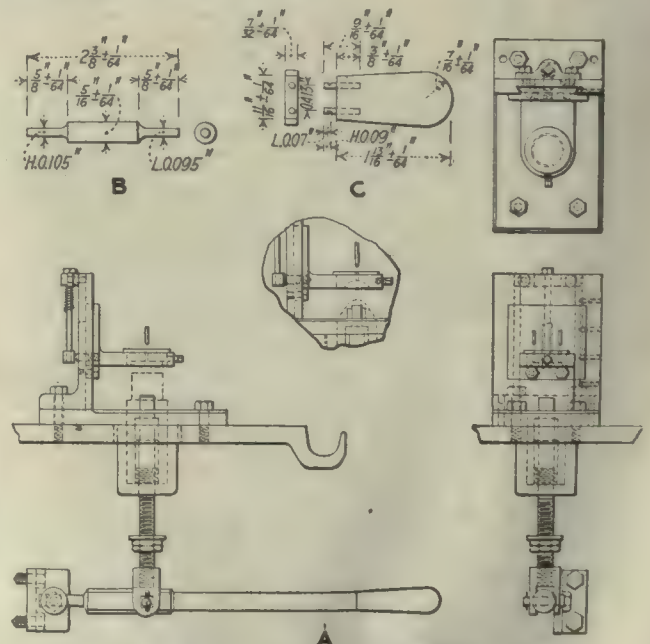


FIG. 5. DRILLING THE WRENCH HOLES

Special Tools—Sellw drilling head with fixed center; A, drilling fixture. Gages—B, diameter of holes; C, center distance of holes

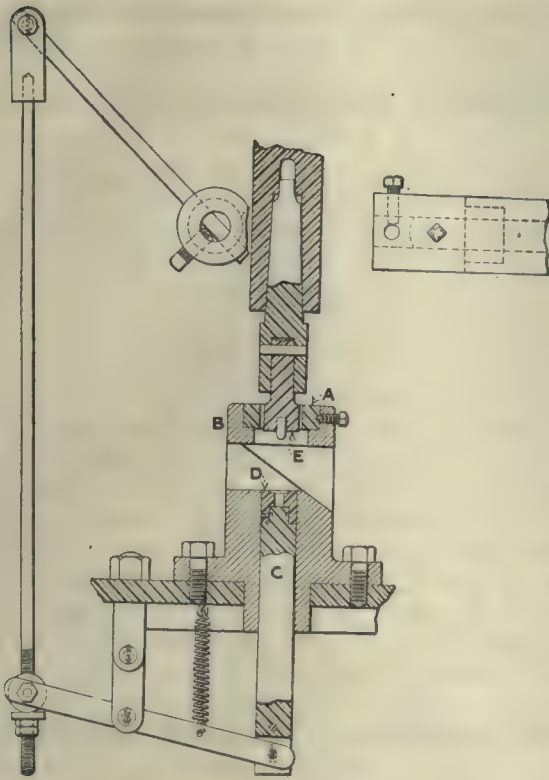


FIG. 12. DETAILS OF THE THREADING DEVICE

Special Tools—See Figs. 11 and 12. Gages—A, thread gage for outside of base plug

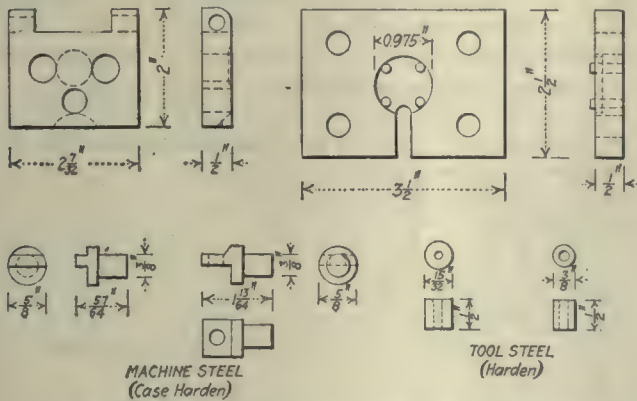


FIG. 13. DRILLING WRENCH HOLES, DRILLING JIGS FOR SPANNER HOLES, AND ALSO POWDER HOLES

Gages—A, center distance and diameter of wrench hole; B, diameter and depth of powder-hole recess; C, size of tapped powder hole

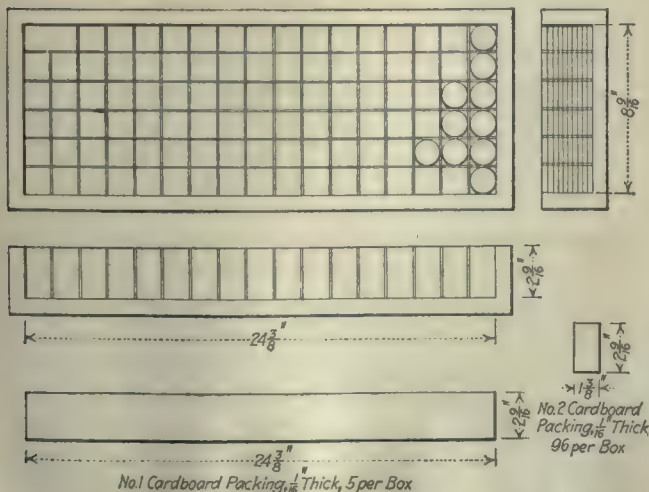


FIG. 15. PACKING BOXES FOR BASE PLUGS

ing is done by means of a special device arranged in a vertical drilling machine, after the outside has been finished. A general view of this is shown in Fig. 11, and the detail in Fig. 12. Here the die *A* is held stationary in the top of the holder *B*, which is fastened to the drilling-machine table. A plunger *C* comes up through the center of the die, and the plug to be threaded is laid on the end of this central plunger at *D*. Then the drill spindle, which carries a driver *E*, is brought down on the plug, the

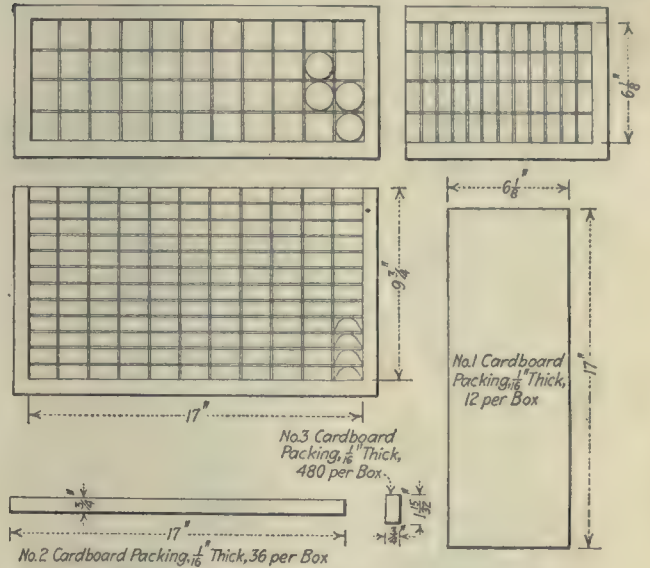
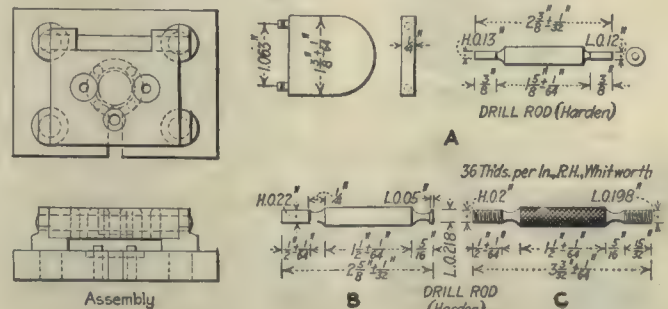


FIG. 14. PACKING BOXES FOR CAPS



driver fitting the cross-slots on the outer end of the plug and revolving it in the die at the same time it is supported by the plunger, to insure the thread being cut square with the axis of the plug. The plunger recedes as the plug is threaded through the die and allows the finished plug to drop out of a side opening, as can be seen. Details of the connections are shown and the whole device can be readily understood.

Next comes the drilling of the two holes for the spanner wrench and the hole for the loading screw. These operations are shown in *J* and *K*, Fig. 9, the fixtures and tools being shown in Fig. 13. The plug hole is also counterbored for the head of the screw and finally tapped to 0.198 in. with 36 threads per inch, Whitworth form.

The packing of these parts for shipment is also important, as being of aluminum they are easily damaged. The boxes used, with all essential details, are shown in Figs. 14 and 15.

Punches for Cutting Paper

By C. R. WHITE

If the average manufacturer familiar with general mechanical problems is confronted with a paper-cutting proposition, he is at a loss as to the best type of dies for this purpose. The reason for this is that nearly all paper-cutting contracts are let to those who make a specialty of such work. They employ special machinery in their factories and are as a rule secretive on this account. Figures on the life and production of dies for paper cutting and drawings of approved designs are also lacking.

In punching paper the general custom is to handle as many sheets as possible at once and have each punching good. If too many are attempted, the percentage of scrap

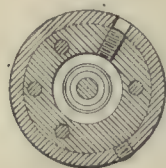


Fig. 1 Spring Knock-out Cutter Punch

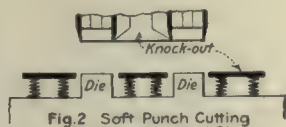


Fig. 2 Soft Punch Cutting on Hardened Steel Die



Paper Product being made



Fig. 3 Punch with Ends Ground to 1/64-inch Flat

PUNCHES FOR CUTTING PAPER

is out of all proportion to the production. Sometimes 100 sheets or more are fastened together with glue on one side and the end. This gluing is done similarly to the way in which writing pads are fastened on the ends. Sometimes eyelets clinch the sheets.

If it is desired to put a large quantity of sheets together, it is better to use one punch. If the paper is thin and the contour of the punching is very important, the necessity for using one punch is accentuated, since the product of gang punches is not uniform. This is because the top sheets press into those underneath, the adjacent surfaces do not lie parallel, and the material under each punch tries to adjust itself and pulls on the material under the other punches.

The design shown in Fig. 1 is one that is frequently employed, sometimes singly, but more often in gangs. The material is cut on wood (grain end up), brass, vulcanite (an improvement over wood and brass) and steel, which is the best when used as shown in Fig. 2. The great trouble with this type of punch is the upkeep, as the cutting edges fail quickly. Unless the hardener is very careful, the temper will be off, or there will be cracks. An improvement in this design is to cut the tip of the punch with a small flat, as is shown exaggerated in Fig. 3.

Instead of the spring knock-out arrangement hard rubber is used satisfactorily, and it is about 200 per cent. cheaper. The rubber is cut roughly to shape, left slightly larger than the holes it is to fit and about $\frac{1}{16}$ in. longer,

so that it will project out beyond the cutting edges. The rubber is put in place by pressing hard with the hand.

Compound punches, such as are selected for metal work, are used where a few thicknesses are punched at once, but they are costly to make and not as efficient. The best design of all is that shown in Fig. 2. It is the same as the punch in Fig. 1 with the exception that the cutting edges are ground with a $\frac{1}{64}$ -in. flat and the punch is soft. The die is hard. When the punch gives out, it is peened into place with a hammer or bar of convenient shape. After the press is started, the punch cuts itself on the die. Plenty of clearance is given between the die and the knock-outs.

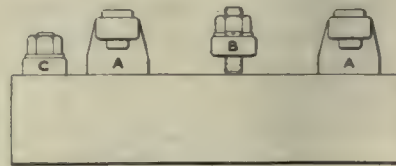
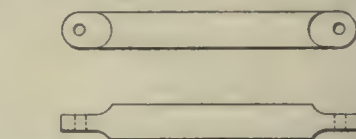
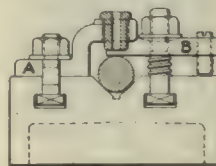
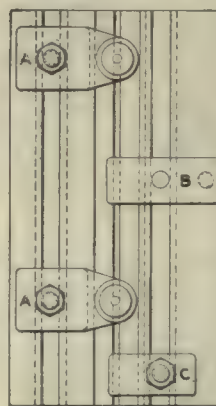
A girl can punch about 30,000 pieces per day of 8 hr. with this type of die, using 100 sheets at a time, with a single punch in operation. The upkeep is 50 per cent. less than that of the punch shown in Fig. 1. If it is desired, a smaller quantity can be punched at once. If the paper is rough, so that the surfaces do not slide on one another, a set of rolls can be made to push and pull automatically, one set on each side of the plate, but the production will be less.

Adjustable Cross-Drilling Jig

By S. G. FRANK

On some machines there are used a number of rods with a hole drilled at each end. These rods are from $\frac{5}{8}$ to 1 in. in diameter, and the spacing of the holes may vary. To take care of such conditions, the jig shown in the illustration was designed. This jig takes care of the whole range of sizes, is easy to set up, quick to operate and of cheap and simple construction.

The body of the jig consists of a block with a V cut down the center, and a T-slot cut down each side. On



UNIVERSAL TYPE OF JIG

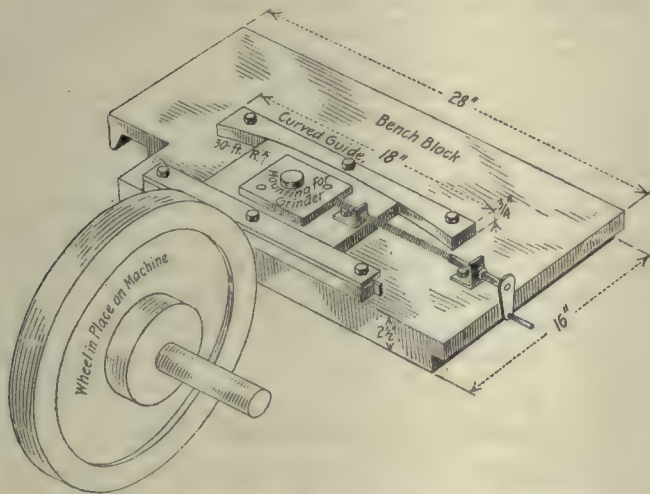
one side of the V are fitted small brackets A carrying the drill bushings. The brackets can be fixed in any position along the T-slot. On the other side of the V are fitted the clamp B and the stop C, which are also adjustable along the T-slot. For quick setting, a sample was kept of each rod drilled in the jig. By the use of these samples the jig could be set up for any job in a few minutes, and the product was interchangeable.

Letters from Practical Men

Grinding a Band-Saw Wheel

The rim of a large band-saw wheel had to be ground so as to form a radius of 30 ft. No lathe or other machine in the shop could take the band-saw wheel because of its large diameter.

A bench block was arranged as shown in the sketch and an electric tool grinder was mounted on the carriage.



GRINDING FIXTURE FOR BAND-SAW WHEEL

The block and carriage were set on two rigid machine-shop horses. The band-saw wheel was run by hand while the electric grinding wheel faced off the saw wheel rim, resulting in a perfect job in a remarkably short space of time. The band saw, which is 4 in. wide, runs true and satisfactorily.

WILLIAM L. WEBER,

Master Mechanic, Hamilton Mfg. Co.

Two Rivers, Wis.

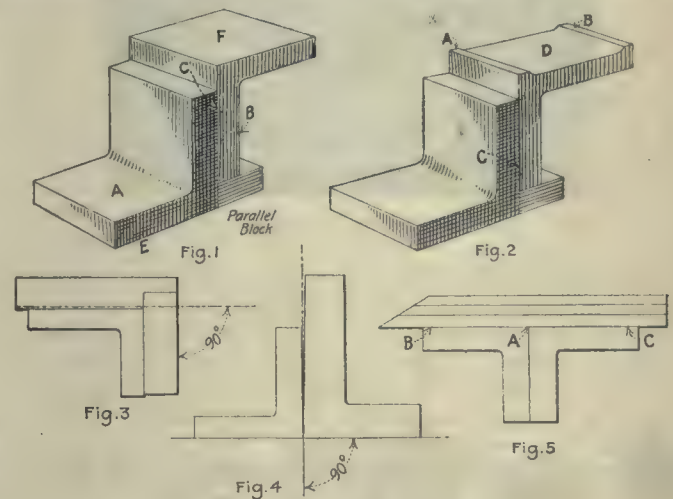
Accurate Angle Plates

One day while trying to grind an angle plate as nearly square as I could get it, I hit upon an idea which was new to me and which has since been of service on various surface-grinding jobs.

The magnetic chuck was true and the angle plate A, Fig. 1, was shy about 0.0005 in. of being square at point C. When I ground angle plate B, set up as shown, the result was that this angle plate was ground to the same angular error as the other. Applying the time-worn remedy of packing up, I placed a piece of cigarette paper under point E. Although this was the thinnest piece of packing obtainable, it proved to be too thick.

After considerable thought I removed the packing from point E and proceeded to grind away stock as shown at D, Fig. 2. Just enough stock was removed to bring points A and B square to the face C. Placing this plate upon the chuck D, side down, it was used to hold the other plate while the error was corrected. It was then a simple matter to finish the new one in good style.

As squares that were at one time true are often found to be more or less out of square, it is evident that they have changed through gradually becoming worn, or through the settling of the metal, or abruptly through a hard knock. In using the square, a piece can readily be tested in such a manner that the operator can be sure that no error exists in the square. One of the methods of verifying the truth of the square is as follows: If the angle plate shows up square when tested with the beam square, as in Fig. 3, the test is next applied as shown in Fig. 4, with the angle plate and square resting upon a good surface plate. If an error exists in both the angle plate and the square, it could not be detected in the test



ACCURATE ANGLE PLATES

given in Fig. 3. In the test in Fig. 4, however, the errors, being in opposite directions, will be easily detected.

Another simple test that may be relied upon if the angle plates have been ground as described is illustrated in Fig. 5. It is natural that if the base upon which the grinding is being done is true and the grinding is done properly, both angle plates will contain the same angle. Therefore, if they are anything but square, light will be seen either at point A or at points B and C.

Newark, N. J.

R. A. GEE.

Novel Method of Shearing Studs

A novel method of shearing or trimming is here shown. The piece is a gear blank 14 in. in diameter and 2 1/2 in. thick, put together from laminations, the outer sides being 1/4-in. boiler plate. A set of twenty-four 3/8-in. studs holds all together. These studs protrude on each side about 1/2 in. and were formerly cut off with a chisel before facing up. This operation has been reduced from 8c. a piece to 50c. per hundred by the method shown. One side is now trimmed in three strokes of the press, the shearing punch cutting eight studs at each stroke.

The punch is the only tool required for this operation, as the boiler plate through which the studs are screwed acts as a die for each separate stud, each stud being placed 2 in. from the rim of the blank.

The punch is 12 in. wide and 2 in. thick, with a very long taper starting 3 in. from the cutting edge. It is made in two sections, thus reducing its cost to a mini-



SHEARING STUDS IN A PRESS

mum. The blank is held in position by three locating straps, held by $\frac{3}{4}$ -in. bolts to the bedplate of the press. Two straps hold the blank on each side, and one keeps the blank from kicking out at the bottom in front.

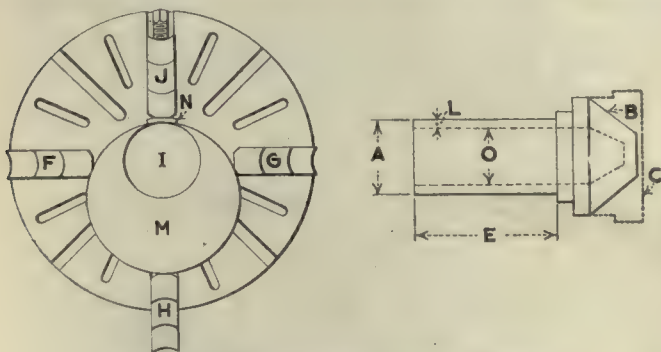
Pittsfield, Mass.

G. R. SMITH.

True Chuck for Work That Has To Be Rechucked

The following is a useful lathe kink that has saved me considerable time and worry on many occasions. It might prove useful to some readers of the *American Machinist*.

Several years ago while working in a small shop, I was given a job of turning 50 pieces on an engine lathe,



THE WORK AND THE TRUE CHUCK

with instructions that they were to be kept to exceptionally close limits and that the diameter *A* had to run absolutely true with the face *B*. After some thinking as to the best method of doing the job, I proceeded as follows:

Chucking the pieces, which had been already cut to length, plus allowance for finishing, I finished the three diameters and bored the hole in all 50 pieces. Then chucking a round piece of machinery steel *M* about the length of *E* and twice the diameter *A* in a four-jawed chuck by three jaws *F*, *G*, *H*, I bored a hole at *I* so that it would just break through under the jaw *J*, the latter not touching the piece *M* while boring the hole *I*, which was made a good slip fit for the diameter *A*.

The finished end *A* of the work was inserted in the hole *I*, and a piece of flat brass was placed under the jaw at *N*, to prevent the work from being marred. The jaw *J* was tightened just sufficiently to hold the job from turning, and the face *B* was finished to the proper contour. The dotted line *C* indicates the stock that was turned off in the second operation.

Since that time I have used the same method on several occasions and on different styles of lathe work and have had most satisfactory results.

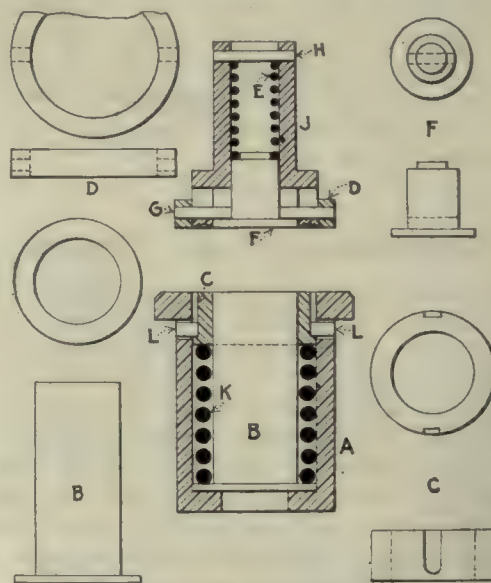
A few pointers might not be out of place for successful working of this method: If the walls of the work at *L* are very thin, turn a plug a slip fit for the hole *O*, which will prevent the jaw *J* from flattening the diameter *A*; do not be afraid to tighten the jaws *F*, *G*, *H* before boring the hole *I*; do not take very heavy cuts while reducing the stock at *C*; and finally, very little pressure is needed with the jaw *J*, if the hole *I* is bored a good wringing fit for the diameter *A*.

HUGO F. PUSEP.

Dayton, Ohio.

Leather-Washer Die

The illustration shows a punch and die for punching out leather washers $1\frac{1}{8}$ in. outside diameter by $1\frac{7}{8}$ in. hole. *A* is the die body; *B* is the center piece $1\frac{7}{8}$ in. in diameter; *C* is a stripper or ejector; *D* is an outside stripper, and *F* is an inside stripper for the punch. *G*



LEATHER-WASHER DIE

is a pin going through the strippers *D* and *F*. *E* is a spring for the same strippers. The pin *H* prevents the spring *E* from coming out. *J* is the punch body. The spring *K* is for the stripper *C*, and the screw *L* prevents *C* from coming out of the body.

HAROLD PEARSON.

Chicago, Ill.

Discussion of Previous Question

Gumption in the Small Shop

Mr. Van Deventer's interesting exposition of Dave Hope's ideas on gumption, on page 227, reminds me that my father's definition of this word was to "get up and get." A man may have this characteristic and yet be anything but a success.

There came to us one day an applicant for the position of stock keeper. His air of assurance and glib presentation of his capabilities secured him the position. "Shorty," as he was called, lay low the first two or three days, spending his time in sizing up his surroundings. A stiff-bosom shirt and white vest were very conspicuous parts of Shorty's dress, and pretty soon this fashion plate was running around the shop demanding of the foremen that they hustle up deliveries to the stockroom. In a very short time everyone was asking if the old man had resigned and who this noisy person was that appeared to be running things.

Within a week the stockroom employees had quit, and none of their successors lasted even that long, all due to the gentleman's forceful character. Before long, Shorty had evolved a stock-recording system whereby he could, on any one item, prove three different quantities on hand—one by the cards, one by the bin ticket and one by actual count.

When the boss decided it was time to dispense with such valuable services and trust to surviving the shock, Shorty displayed his gumption by promptly calling attention to the fact that he was entitled to a notice of dismissal. After a conference, however, it was decided that it would be cheaper to let Shorty depart with two weeks' pay tucked away in the pocket of that white vest than to permit the carnage to go on.

No doubt Shorty still has gumption, but its function to this day is probably to get up and get a new job.

Jersey City, N. J.

H. D. MURPHY.

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Where Are the Good Mechanics?

I wish to pass a few comments upon the issue raised by J. P. Brophy on page 236 and give some conclusions reached after years of experience as workman in both the old-time shop and the modern manufacturing plant. The lack of skilled all-around mechanics complained of is the natural result of modern practice. The class so rare in manufacturing districts is not extinct, being still in the majority in the shops of the South and the far West, where conditions are most favorable.

I cannot believe that the workmen of today are very different from those of 25 years ago or have any less ambition or poorer mental equipment. In the modern factory, however, the opportunity (and also the necessity) for acquiring a thorough knowledge of shop practice and the principles involved does not exist as in the old-time general shop, where apprentices worked under the direction of skilled mechanics and later were required to follow

a piece of work through different operations to completion. Neither is the workman's interest stimulated when he merely performs a certain operation on pieces in large quantities and often knows little of their relation to the finished product. On looking over my own experience I find that I received much helpful information in my apprenticeship from more experienced workmen, also by observing how they did their work; but there is little chance for intercourse between workmen in the modern plant.

I think the remedy lies in teaching green men instead of merely "breaking in." In breaking in a hand today he is too often taken to a machine and shown a set of motions he must go through. The rest is left to his initiative faculty—and luck, no explanation of the why and wherefore being given. When in difficulty he hesitates to ask the foreman and will keep up a show of being busy till he gets a chance to consult a fellow workman, who may know little more than himself. It is common to see tools abused and work that suffers from "remedies" adopted in ignorance.

The apprenticeship system is perhaps a thing of the past, but skilled mechanics are made, not born, and must learn by teaching and experience. Would it not be practicable in the case of large plants to set aside some old machines where green men could work for some time under an instructor before graduating into the factory, or to employ an instructor in departments where many such men are employed? The instructor would not be in any sense a taskmaster. He would be closer to the men than a foreman or a speed and feed man, and his advice would be more readily asked for and accepted. A man of experience and good nature in this capacity would raise the productive ability of the men and help to bridge the gap between the "firm" and the "hands" by supplying the personal touch which is mostly lacking in the modern factory.

I also think the more intelligent workmen should be given an opportunity to change from one department or machine to another at intervals, in order to stimulate their interest in the work and give them broader training so that they can fill higher positions. In spite of Mr. Brophy's complaint of opportunities passed up by some men, there are still, I am sure, many others of the right kind who will accept such chances.

Cleveland, Ohio.

FRED CRAIB.

I will try to answer Mr. Brophy from a foreman's point of view regarding his article on page 236, "Where Are the Good Mechanics?" The modern manufacturer should take a few points from the modern farmer. The farmer, before he can expect results, must sow the seeds, fertilize the ground, weed it and very often irrigate it.

What are the majority of manufacturers doing today toward producing the crop of good mechanics required in the next 10 to 20 years? Are they sowing the number of apprentices in proportion to the number of skilled help employed; fertilizing it by insisting that the ap-

prentice attend a trade school either evenings or during a portion of working hours and having the reports sent to the manager; irrigating it by praising when praise is due and weeding out those who prove unsuitable to a particular branch of manufacture?

I believe there are just as many good mechanics today as there were 10 years ago, but the demand is greater. The manufacturer of 10 years ago had no conception of what would be required today, so consequently did not prepare to meet the demand; but is it too late to start now to prepare for the next 20 years?

The solution is in the hands of the manufacturers themselves. They should at least have one apprentice to every four skilled workers and have a working agreement that one shall not engage any of the others' apprentices except under special circumstances. Train these apprentices in a systematic manner, and we shall have little cause to deplore the scarcity of skilled workmen.

Philadelphia, Penn.

JAMES ATKINS.

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Standard Holes--Why Not?

The objections raised to standard holes and varying shafts in your editorial, page 1137, Vol. 44, seem to carry but little weight in favor of varying holes, but only serve to bring forward the question of limits. In Newall's tables of allowances on shafts we find limits given for force, drive, push and running fits. Now apply these limits to the hole and make provision for two grades of each type of fit. The number of limit plug gages required would be increased to four times the number now used. This number must be doubled, as two sets of gages are usually made, one set for the shop and one set for use in the inspection department.

To keep the gages in good order and to replace them as required would mean a great deal of additional work in the toolroom, whereas by making all variations on the shaft a micrometer or limit snap gage will cover long ranges of work and adjustments can easily be made, thus doing away with replacement. This, to my mind, is the most important objection to varying the size of holes. To maintain standard holes, adjustable loose-blade reamers considerably diminish reamer troubles in all holes down to 1 in., and the cost of replacing broken blades (which is rare) is very small in comparison to that of replacing worn-out solid reamers of the same size.

Under 1 in. in diameter the replacement of solid adjustable reamers is not such an expensive item. This type of reamer can be made down to 1/2 in. in diameter and give good service, although under this size they become very weak.

In automobile work, however, there is as a rule no need to ream holes under 1/2 in. in diameter, although they are often called for by the drawing office. In the majority of cases a good drilled hole is perfectly satisfactory.

The provision and upkeep of any type of reamer do not constitute such an expensive item at the present time, reaming being superseded by broaching in all holes down to 5/8 in. in diameter. Well-designed broaches of tool steel, properly hardened and ground, will outlast any number of reamers and produce a truer and better hole.

This narrows the reamer question down to sizes under 5/8 in. As before stated, the number of holes under this

size which it is essential to ream is very small. Therefore the question of reamer difficulties carries but little weight in favor of varying-size holes.

As with limit plug gages, so with reamers (if used) and boring cutters. Either a separate set of tools of each size, fit and grade must be kept in the tool stores or the tools must be adjusted up and down for each batch of work. This means lost time and many journeys to and from the toolroom. When considering arbors, the expanding arbor certainly overcomes a difficulty in varying the size of hole, but this alone does not justify a change.

If, as stated in the editorial, standard holes are scraped and tampered with in the assembling department, then it is time to increase the limits on the shaft. For interchangeability the fine limits usually called for are a failure, for these fine limits cost a great deal to obtain and are promptly increased by scraping, etc., when the work is being assembled.

What is really required is a new table of wider limits for general work, such as chassis components, etc., with perhaps the exception of crankshaft and camshaft bearings. These wider limits could be more easily lived up to in the machine shop and would also save time and money in the fitting shop. Wider limits in the hole would also prove a saving, as a longer life would be given to broaches and reamers.

Therefore, in a few words, the great objection to varying-size holes is gaging and tools, while the objection to reamers for standard holes is nullified by the use of broaches. By giving wider limits of accuracy many objections to either side will drop out.

One question I should like to ask the readers of the *Machinist*: "What is a standard hole," or "When is a hole standard?"

P. J. TOMPKINS.

Surrey, England.

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Using Stools in the Shop

There seems to be an idea existent in most shops that sitting down while at work is a sign of laziness. In the article "Women and Machine Tools," page 1057, Vol. 44, mention is made of the fact that chairs and stools are provided for women, but are often taken away when a man comes on the job. Now, I do not think that is quite fair. I admit that women on the average are weaker than men, but men have a way of getting tired too. It is not stated whether the men have to work more hours at a stretch than women; but if they do, that is all the more reason why they should be provided with stools, unless they are put on a class of work that demands close attention all the time.

Recently I noticed a case where an operator was sitting down while his machine was working. The foreman promptly let the workman understand that such a practice was not tolerated. Well, if the men in the shop have to stand all the time, why not save money by discontinuing the use of chairs and stools in the office part of the works? The office staff of a shop generally comes out quite fresh—compared with shopmen—especially when no proper wash basins are provided for the latter, as is too often the case.

There should be no arbitrary rules governing the use of stools—utility and service should determine.

Wembley, England.

J. H. DAVIS.

American Machine Shops Abroad After the War

By J. B. BAGENRIEUX

SYNOPSIS—The author who points out this opportunity to Americans is a Belgian engineer and machine-shop owner who succeeded in escaping from Belgium on July 14. He brings first-hand accurate information as to the conditions in Belgian industries and offers a suggestion that has never before been made.

Since my arrival in this country a few weeks ago I have had the opportunity to read in a friend's office, where they are kept on file, several articles which have appeared recently in different newspapers and periodicals of this country concerning the great quantity of American machinery and products that will be required in Europe after the war. Some of these articles denote a profound knowledge of conditions abroad. In none of them did I find that tendency to exaggerate things which is often found in this class of literature.

Nobody, however, seems to have thought of the golden harvest that is sure to be gathered by the enterprising Yankees who, immediately after the invaders have withdrawn, will land in Belgium or France with a complete machine-shop equipment that could be installed rapidly in temporary buildings erected at a point situated, for example, within the triangle formed by the cities of Brussels, Mons and Valenciennes, or at any point between La Louviere and Charleroi.

There is not much left, even now, of the machine shops of northern France and Belgium. All equipment in them that was really first class has long ago been removed to Germany, the pretext given by the despoilers being that the Franco-Belgians refused to operate their shops for the enemy's benefit. All machines that are still in their places will soon be on their way to the Fatherland.

On July 7—that is, a week before I finally succeeded in making my escape out of Belgium—notices were posted all over the invaded land, ordering owners of industrial works to furnish the German authorities not later than July 21 with a detailed list and full specifications of the equipment in their possession, including machine tools, steam hammers, transmission shafts, countershafts, pulleys, clutches, belts, etc. Even the size of all foundation bolts and lagscrews had to be specified. All articles appearing on the lists furnished, including the belts and their lacings, had to be held at the disposal of the German authority, loose from their foundations, ready for removal, not later than July 28 at midnight, after which date they must be delivered on demand against a simple receipt signed by the Commandant of Fuss Artillery or his deputy. A fine of 5,000 marks and imprisonment of five years in Germany were the penalties for those who either omitted to declare or attempted to hide any article subject to declaration.

In November, 1914, the following machine tools, all motor driven, together with their accessories, which I had purchased during my trip to this country in 1913, were taken from my shop without notice and of course

without permission, after I had repeatedly told the Germans that I would never think of working for them:

- 1 Cleveland automatic screw machine.
- 1—48-in. (Niles) car-wheel boring machine.
- 1 Niles double-axle lathe.
- 1 Pond 48-in. engine lathe.
- 1 Pond 48-in. reversing planer.
- 1 Pond 48-in. rod miller.
- 2 Pond universal (4-ft. and 6-ft.) radial drilling machines.
- 1 Niles 100-in. boring and turning mill.
- 1—24- and 48-in. Rahn-Larmon extension-bed gap lathe.

My old belt-driven equipment, very good, serviceable, in first-class condition, was not disturbed, except that the belts were taken away, one or two at a time, by the soldiers stationed at the railway depot opposite my residence and shop. When they needed leather to repair their boots and accouterments, they just crossed the square, entered my place and helped themselves. My main-drive belt, 3-ply, 22 in. wide and 91 ft. long, was cut up in four or five pieces and went in one day, after several hundred barefooted Bavarians arrived in town to take the place of an equal number of beardless Saxon boys who were leaving for Verdun. We were at dinner when the Bavarians disembarked at the depot, carrying their shoes on a string across their shoulders. My daughter, seeing this, said: "This time, our big belt will go." She was not mistaken. Before noon on the next day the big belt was gone, and the Bavarian regimental shoemakers were making good use of it. It remained undisturbed during the first 20 months of the war, perhaps because it was so hard and stiff that they did not know how to tackle it, or perhaps they were reserving it for the great moving.

THE COMING "GREAT MOVING DAY"

We who have spent the last two years in Belgium never doubted for an instant, and the more outspoken among the Prussian officers never were backward in affirming, that if the invaders are forced to retreat before peace is concluded, they will take away with them, or destroy, everything that could be used by us in either making arms and ammunition or in reconstructing our country while the war is still going on. To be sure, the manufacturing machinery that has not yet been taken out of the country is far from being up to date; but antiquated as it is, it could be used to good account in an emergency such as the Franco-Belgians will face after they have forced the Germans back into their own land. The end of the war will then still be a long way off. Northern France and Belgium will be deprived of machinery. The mines themselves, without machine-shop equipment, will be unable to operate. We use so much machinery in our mines that a week's suspension of the ordinary repairs will bring everything to a standstill. The notices posted on July 7 seem to indicate that the time is close at hand which the German officers themselves have, for nearly a year, referred to as the *grand déménagement* (great moving day).

When the Allies enter Belgium, they will find only scrap iron, dismantled machinery, crippled mine equipment, broken-down railway engines and cars. Even now,

locomotives by the hundred, unable to run for lack of repairs, are sidetracked in the immense yards around the railway shops at Luttre, Ghent, Louvain, Malines and Mons. These are Government shops. The Belgian workmen refused to work in them after Aug. 22, 1914. The thousands of shopmen imported from Germany to take the Belgians' places have, since about last Easter, been gradually sent to the fighting line, to Verdun principally. Only a few hundred of them are now left—lame, grizzled, spectacled—who work 15 to 16 hours a day, sleeping and eating in the shops, to save them the fatigue of walking to and from work.

OPPORTUNITY FOR AN AMERICAN MACHINE SHOP IN BELGIUM

America is the place where the Belgians will be able to get supplies. But America is a very busy country just now and will certainly remain so for a long time. The reëquipping of the devastated Franco-Belgian country will be slow. In many a district no wheel will turn for many months. All efforts, at first, will be bent upon putting the mines in working shape, for without coal, nothing can be done. Lots of money and undying fame await the enterprising men who, on the morrow of the great moving, will land at Antwerp with enough equipment, supplies and cash to establish and operate a general construction shop. The more complete and larger the equipment of the plant the better it will be. There will be plenty of work for it at money-making prices. Until the country at large is reëquipped, there will be no lack of good men to work in the shop, although these men will all be 40 years of age and over. All the younger ones, by a recent Belgian decree, must serve their country either in the army or in munition shops in France and England.

This enterprise is not as simple as it looks. It must not be undertaken without a thorough study of all the conditions to be met to make a success of it. Enough lumber, galvanized material, windows, doors and hardware ought to be provided to permit building convenient halls and sheds to house the machinery and equipment. Even the nails and the paint will have to be carried across the sea. In ordinary times cement is cheap in Belgium; but as the great moving will leave the cement works of the country in no better shape than other things, it will also be necessary to provide enough cement for the foundations of all machines that must be put on solid bases.

As such halls as it will be found practicable to erect under the circumstances will be too light to stand the weight and strain of transmission shafting and belting, every machine must be independent, self-contained, motor-driven. The electric power needed ought to be furnished by a turbine-driven outfit, which necessitates a minimum of space and foundation. It may be advisable to provide a special generating set for lighting purposes. All wiring supplies and specialties ought to be sent from this country, including the wood screws, the staples and the nails. Water-tube boilers would evidently prove the best, given the importance of saving on space and foundation.

The kind of business that would have to be dealt with would probably be 95 per cent. repair work, but repairs of the most varied kind. The kinds of machine tools necessary ought to be selected with this class of work in view. It would be indispensable to run a foundry, a good pattern shop, a blacksmith shop, a sheet-steel shop, a

pipe bending and fitting department. It would not be a bad idea to carry on also a general coppersmithing business. Northern France and Belgium have always been renowned for their beer, spirits and sugar industries. The latter make a very extensive use of copper apparatus and utensils. All copper was removed from Belgium as far back as last winter. This left the breweries, distilleries and sugar mills with only their four bare walls. All will have to be rebuilt.

No such business as the one we are outlining can be carried on unless regular shipments of supplies from the United States be arranged for. Except perhaps for any scrap steel that can be worked again in the blacksmith shop, all will have to come from America. These conditions will prevail during the remainder of the war and for some time after peace is concluded. This fact will make it necessary to keep a purchasing agent in America, who will find it an easy matter to fill all requisitions for materials through the regular lines of steamers running between this country and Antwerp.

BEST LOCATION FOR THIS BELGIAN-AMERICAN SHOP

The best location for this undertaking would be in one of the smaller towns of the Walloon country, perhaps right on the Franco-Belgian line, where transportation by rail and canal is good and cheap. A good place would not be hard to find. Land, except in big towns, is nowhere expensive. All necessary ground could be rented, the right being reserved in the lease to buy the ground at a given price within a given time.

As to the labor question, it will present no difficulties until enough of the old industries have been rebuilt to create a great demand for men. This will probably not be the case during the first two years following the end of the war. Peace itself may not come for a year or two after the Germans leave Belgium. There will be no difficulty in getting all kinds of first-class men to start with—pattern makers, blacksmiths, foundrymen, machinists, coppersmiths, pipe fitters, boiler makers, etc. The works manager and possibly an assistant would probably have to be sent from America, but they must speak French. As to foremen, it will be best to select natives for these positions. They are accustomed to metric measurements, know how to handle Franco-Belgian labor and soon will be able to get out of the machinery as much as anyone else.

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Make Fire Drills Effective

BY W. J. WELLS

We had a fire drill the other day, the first in months. The foreman came around and told us that the bell would ring in about half an hour and that we were to go downstairs. Accordingly, when the gong struck, we all walked right downstairs and then right back again.

A few days later the gong sounded again; but as no one had told us anything about a drill we did not pay much attention to it, except to sniff for smoke, until someone said, "Fire drill," when we played follow the leader again.

It seems to me that the alarm for a drill should come just as unexpectedly as for fire. Then in case of an actual fire all would obey the alarm as for the drill and would no doubt be out of the building before it was known that there really was a fire.

Editorials

United States Munitions

An enormous sum of money for peace times has just been appropriated by Congress for munitions of war. The total is about \$100,000,000. In addition nearly \$12,000,000 is appropriated for machinery and tools, including the armor plant. This huge sum will be spent in the machinery-building industry of the country.

The army appropriation bill provides for the expenditure of \$50,000,000 in these items: Ordnance stores, ammunition, \$10,000,000; ammunition, etc., for target practice, \$3,000,000; manufacture of arms, \$5,000,000; for machine guns, \$12,000,000; for field artillery, \$10,000,000; for field-artillery ammunition, \$10,000,000.

Provision is made for spending \$250,000 from the first item for "gages, dies, jigs, tools, fixtures, and other special aids and appliances, including specifications and detailed drawings necessary for the manufacture by the Government and by private manufacturers." Similarly, \$200,000 is set aside for this same purpose from the second item, and \$200,000 from the last item. These three added together give a total of \$650,000 to be expended by the Bureau of Ordnance of the United States Army for small-tool manufacturing equipment. It is further provided that one-half of each of the first and last two items can be spent for the purchase of small-arms ammunition, field artillery and field-artillery ammunition, respectively.

The naval appropriation bill carries two items, one for ammunition for existing ships and another for ammunition owing to the increase of the navy. These two items combined total \$33,205,000. In addition to that, there is an item of \$189,000 for machinery and tools for the torpedo factory, \$1,411,222 for a projectile plant and an item of \$11,000,000 for an armor-making plant.

The fortification appropriation bill carries a number of items that in the aggregate amount to \$10,696,000, for the purchase and procuring of ammunition, with a provision that contracts for additional supplies may be placed to the extent of \$11,000,000.

A few of these appropriations extend over a period of two years, but most of them are for the fiscal year, 1917.

It is very evident that the machine shops of the United States must begin to acquaint themselves with the design, specifications and requirements for the production of all kinds of United States munitions. Much experience has been gained on European field-artillery ammunition, and this will, of course, be helpful. However, our designs differ greatly from those sent over from Europe—Americans believe for the better. It is commonly accepted that American munitions are more simple in construction and easier to manufacture than those that have been produced during the last eighteen months for the belligerent nations of Europe.

However, it is essential that nuclei of skill and experience shall be developed all over this country so that at a moment's notice we can begin to produce munitions at a tremendous rate. No one knows when such an emergency may be forced upon us. It is probable that these

large appropriations are but a beginning that will be duplicated and followed by others as the years pass by. A new duty is thus placed upon the American machine shop.

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What Is a Gage, a Die, a Jig, a Tool, a Fixture?

Only a little while ago, some of us were wrestling and sweating in an attempt to define a "machine tool." That was when the term was first written into a tariff bill and needed an official explanation. But a really intelligent description of a machine tool according to its properties has never been framed. Through decisions rendered by officials of the Treasury Department in custom cases a machine tool operated by hand or foot is not a machine tool; and every power-driven machine tool, to be a machine tool, must have a cutting tool.

A situation has arisen that perhaps calls for definitions of a few other common machine-shop things. In the Army Appropriation Bill recently passed by Congress there are three paragraphs providing sums to be used to procure "gages, dies, jigs, tools, fixtures and other special aids and appliances, including specifications and detailed drawings." These appropriations are to be administered by the Bureau of Ordnance, and these terms will have to be explained by that department. However, it is not likely that there will be much difficulty, for the elastic comprehensive expression, "and other special aids and appliances," can care for any needed manufacturing aid that cannot be specifically named as a gage, a die, a tool or a fixture.

Still, some of our readers may like the fun of trying their hand at writing definitions of these familiar machine-shop articles.

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A Complete Machine Shop for Belgium

A new suggestion as to what Americans might do in the rehabilitation of the war-destroyed sections of Belgium and northern France is contained in an article in this issue written by a Belgian engineer and machine-shop owner. He left Belgium on July 14, crossed the border into Holland, went to England and then to this country. The information that he gives in regard to the present industrial situation in Belgium is fresh and from first-hand knowledge. He fully corroborates the statement made by other refugees to the effect that the machinery of production in Belgium and northeastern France has been or will be removed or wrecked.

The new suggestion that he offers to Americans is the sending of a complete American machine shop into Belgium as soon as the work of rehabilitation begins. He emphasizes that such a shop should be complete in every detail down to the hardware for the doors and windows of the building and to nails and screws. The machine

tools should be motor driven, and a part of the equipment should be a generating outfit for power and light.

This is just the kind of opportunity that should appeal to Americans. Perhaps a few such shops will be one of the means for still further introducing American machine tools into the great industrial districts of Belgium and northeastern France.



Administration of New Boiler Code in Pennsylvania

The new boiler code that became operative in the State of Pennsylvania on and after July 1, 1916, through the department of labor and industry, marks an interesting addition to the numerous rules and regulations of this department of state government in Pennsylvania, and presents some important phases of administration in its practical enforcement.

To those familiar with the almost unprecedented amount of work put on the development of a boiler code by committees of the American Society of Mechanical Engineers (in itself a development of historic importance in the engineering field), and particularly to those who have been unsparing in their personal efforts to assist in this work, it will be more than a passing satisfaction to know that the new Pennsylvania boiler code is the standard code of the American Society of Mechanical Engineers.

In addition to the code itself, the Pennsylvania industrial board has adopted and published a set of rules of administration governing the inspection of boilers within the state. These auxiliary rules point out, among other things, the necessity for coöperation between owners or users of boilers and the inspection department in the work of inspection, and specify that upon due notice in advance any owner or user must prepare the boiler for external and internal inspection at the appointed time, by drawing the water, by removing the manhole and handhole plates and by thoroughly cleaning the boiler and its setting.

Inspectors of the department of labor and industry, through the division of boiler inspection, are now making inspections throughout the state for the enforcement of the new code provisions. The administration of such a new code in addition to a number of others already in force places new demands on such inspection departments, and in this case the force of department inspectors has been supplemented by casualty insurance company inspectors as well as by individual inspectors who may have passed certain set examinations held under the jurisdiction of the state department of labor and industry. In the case of these so called auxiliary inspectors, reports are examined by the labor department, and such conditions as may be designated faulty are investigated by the same department.

The authorities of the state in question, who are responsible for this step forward in state legislation, now anticipate a standard of inspection heretofore unattained in that state, and which is calculated to aid very materially in safeguarding the lives of employees in the industries as well as the public generally. The attitude of the state authorities toward intelligent safety precautions can hardly be evidenced in any better way than in this method; first, in the adoption of authoritative codes relating to various sources of industrial accident hazard

and then in the sympathetic and systematic administration of these same codes to serve the purposes for which they have been drafted.

Here then in Pennsylvania there is another prominent case of coöperative interchange of ideas between state authorities and engineering societies. The one, mentioned in a recent issue in these columns, called attention to the factory lighting code adopted in the same state on June 1, 1916, after its preparation in preliminary form by the Illuminating Engineering Society, and the other, this case of the adoption of a code prepared by the American Society of Mechanical Engineers. The practical use of the engineering talent in such national engineering bodies by state legislators cannot be other than of mutual interest and productive of special advantages to the state authorities. Pennsylvania has set the pace on two recent occasions, and subsequent legislation in other states will be watched for with considerable interest in the immediate future.



Iron-Clad Rules

Uniformity in applying a rule or policy, in both the shop and the office, is a desirable feature of any administrative plan. There is much to be gained from consistency in all dealings, but it is seldom that conditions are such that an exception should never be made.

Quite frequently one is told that his request would be met but for a certain rule prohibiting it, with the explanation that in the particular case in question the need for the prohibition is not apparent.

Any rule that is made so fast as to preclude an exception is likely to prove, at some time or another, to be detrimental. Shop and business conditions are ever-changing—flexibility of practice demands a certain flexibility in the governing policy of such practice.

While the following incident, as recently related by a consulting engineer, covers a minor point in business intercourse, it is sufficiently illustrative to show the danger of iron-clad rules:

To quickly finish some work at one time it was necessary to have a piece whose market value would ordinarily be from ten cents to a quarter. It was a part of a drawing instrument made by an advertiser in the "American Machinist"—a good friend of mine, in a business way, for years. This company has a rule that it will sell to no one direct, who is not an accredited dealer. After a long argument, however, the man at the telephone agreed to send the part. It never came, although it was of great importance. It had only to be sent to another part of the same city, and I gladly offered to pay the expense of a special messenger. Only my friendship for the firm keeps me loyal to it. A rule is a stumbling block in the way of a lot of people.

This incident suggests a too prevalent lack of tact and discretion in business dealing. Although handicapped by a hard and fast rule, the exercise of one of the qualities mentioned would in the case cited have avoided the bad impression made. It would have been a simple expedient to accommodate the engineer in the way requested and at the same time adhere to the established policy by effecting the transaction through the nearest dealer. Not only would the patron have been satisfied and the retention of his good will unendangered, but the dealer affected would have been reminded of the policy designed to protect him.

If iron-clad rules must be used, the ill effects occasionally bound to result might be mitigated by a firm desire to be tactful at least in the enforcement of the restrictions.

Shop Equipment News

Combination Disk Grinder and Saw Table

In the illustrated description of the disk grinder and saw table published last week on page 439, the manufacturer's name and address—Globe Inventing Co., Chicago, Ill.—were inadvertently omitted.

Oxyacetylene Apparatus

The illustrations show the latest form of oxyacetylene welding and cutting apparatus developed by the Alexander Milburn Co., Baltimore, Md.

In Fig. 1 is shown the generator, which is of the positive-pressure type, delivering gas at a uniform fixed pressure within a maximum capacity of 15 lb. per sq.in.

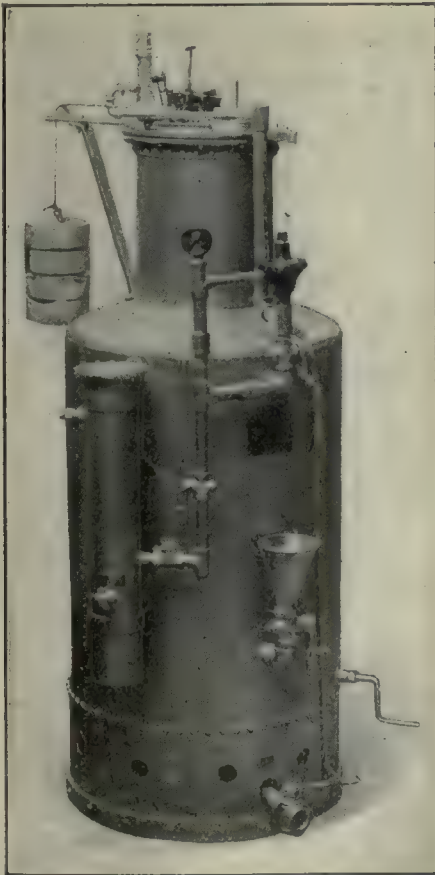


FIG. 1. OXYACETYLENE GENERATOR

The carbide-feeding device is a simple cylindrical drum at the base of the carbide hopper. The carbide rests on the surface of this drum in such a manner as to be entirely stable when the drum is at rest, but to feed promptly with the rotary motion of the drum. The drum is driven through a single bevel gear from a positive-acting gravity motor. The motor is controlled through an accurate governor by gas pressure on a diaphragm. This control responds so closely to the gas demand at the

torches as to produce an even carbide feed and uniformity of pressure. The parts of the feeding device within the machine have been made few and simple to eliminate clogging and binding.

The gas generating chamber, into which the carbide is fed, has a margin of 10 per cent. above the usual capacity of one gallon per pound of carbide. This large water capacity, together with the use of lump carbide and the even feed, is designed to maintain a coolness in the gas which is beneficial to its purity and to welding results.

The generator has a positive blowoff valve, releasing at 15 lb. per sq.in. and quickly reseating. A safety back-pressure chamber and hair-felt gas scrubber are built on the machine. The sludge agitator thoroughly sweeps the whole bottom with a rotary motion, facilitating proper cleaning. The sludge outlet is a strong gate valve with

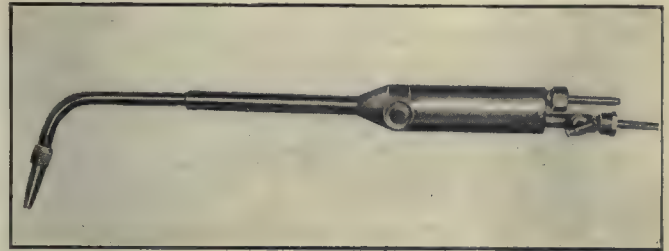


FIG. 2. OXYACETYLENE WELDING TORCH

large opening and positive lock. Safety devices and interference rods guard against mishandling.

The body is made of heavy-gage steel with oxyacetylene welded seams and dished, riveted bottom. Steel band reinforcement is added where required. All fittings are of galvanized malleable iron, galvanized steel and brass. Substantial flanges are used at all pipe outlets. The whole generator body is galvanized after completion, insuring gas-tightness and protection against corrosion. The base is ventilated by openings below the water bottom in order to afford a further protection against corrosion.



FIG. 3. OXYACETYLENE CUTTING TORCH

In the welding torch shown in Fig. 2 the mixing of gases begins just ahead of the grip, where both the acetylene and oxygen enter a conical chamber under pressure and continue throughout the passage to the head, being finally perfected within the tip itself. Pressure on the mixture becomes uniform through this thorough intermixing, resulting in steadiness and fine quality of the flame. Back-firing is eliminated by production of proper gas mixture at positive pressure and by correct design of

passages. The torch is substantially built of tubing and parts having ample weight for strength, but the torch as a whole is of comfortable weight and balance. The arrangement of the grip and valves insures ease in handling. Six interchangeable copper welding tips are provided to cover all ordinary ranges of work. Union hose couplings are used, facilitating connection and change of torches.

The cutting torch shown in Fig. 3 will operate either with oxygen and acetylene or oxygen and hydrogen.

The mixing principle for the heating flame is the same as in the welding torch. The heating gases are mixed throughout their passage from the handle to the tip and are delivered to the flame at uniform positive pressure.

The high-pressure cutting oxygen is controlled by a positive thumb valve which opens and closes quickly with a spiral motion. This valve remains fixed in either open or closed position without sustained pressure from the hand. The cutting oxygen is led to the center of the heating flame through the upper tube and a central orifice in the tip, producing a thin, sharp kerf.

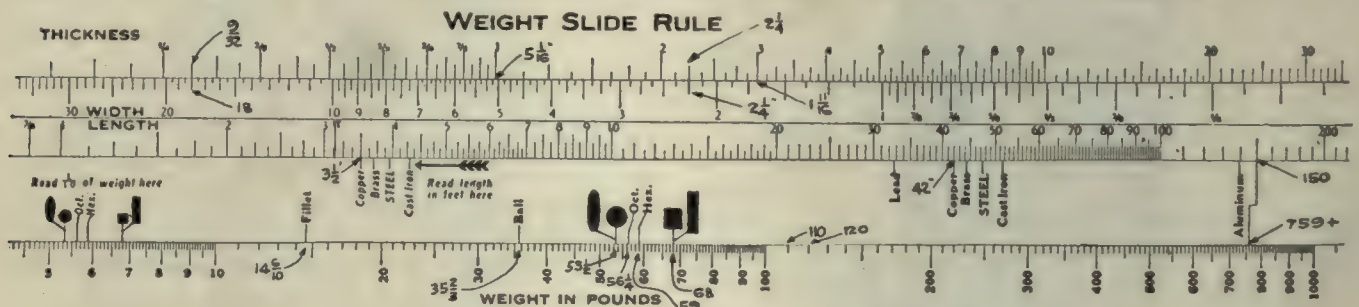
The torch head is simple and the tips one-piece. No parts are concealed in the handle, and all valve parts are accessible from the outside. Three interchangeable tips are provided for light, medium and heavy cutting, and curved tips for rivet cutting.

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Weight Slide-Rule

The illustration shows a slide-rule manufactured by Hornyak & Kelly, 5526 Walton Ave., Philadelphia, Penn. This device was specially designed to meet the requirements of estimators and all those whose business it is to figure weights of machine components and the like.

The dimension scales are graduated in inches and fractions and the weight scales in pounds and tenths. The



WEIGHT SLIDE-RULE ESPECIALLY DESIGNED FOR ESTIMATORS

weights of regular- and irregular-shaped objects made of metals and materials commonly used in engineering practice are readily and accurately obtained with the aid of this instrument.

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Roller Bearing

The new roller bearing to be described has no sliding friction, and as the load-bearing rollers are made of parallel, solid, hardened steel the bearing can be heavily loaded without fear of crushing the rollers.

Fig. 1 is a view of the bearing that shows the roller with the housing removed. Fig. 2 represents the details of construction.

Referring to the line engraving, the journal *A* has seated around its outer periphery a series of parallel load-

bearing or main rollers *B* spaced equally from one another by separating rollers *C*. The journal is provided with two annular ribs *D*, and the main rollers each have two corresponding grooves. This prevents all tendency to twist the main rollers out of their perfect alignment on the journal. The separating rollers *C* are smaller in

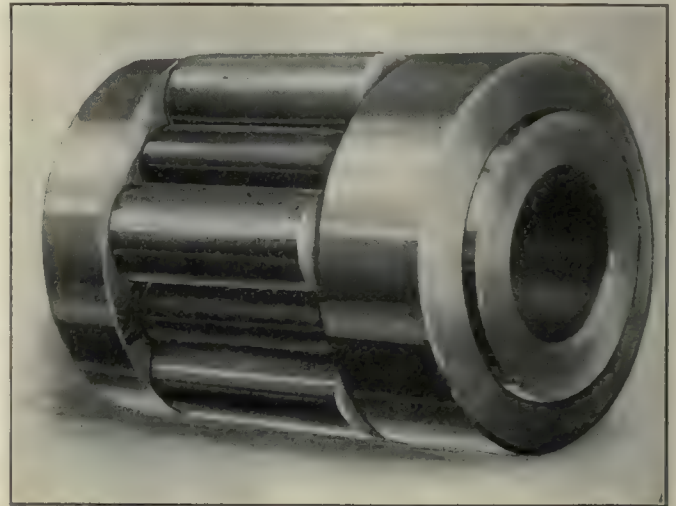


FIG. 1. ROLLER BEARING WITH HOUSING REMOVED

diameter and greater in length than the main rollers *B*, and have their ends, which project equally beyond the ends of the main rollers, grooved as shown at *E*. These separating rollers actually contact with the main rollers so that no roller in the bearing can revolve without every other roller in the bearing revolving; the separating rollers thus being adapted to space the main rollers equally upon the journal do not contact with it.

A pair of freely rotatable or floating rings *F* surround the journal, and the ends of the separating rollers are

mounted upon these floating rings by means of the grooves *E*. A pair of freely rotatable cup rings *G* surround the journal, and the interior of these cup rings encircles the projecting ends of the separating rollers, forming a track in which they can roll. The main rollers *B* are provided with short reduced ends *H* smaller in diameter than the separating rollers *C* extending within the cup rings. These ends prevent the main rollers from falling out of the bearing when the journal is removed or withdrawn from the housing. Collars are provided which are removably secured on the journal to retain the cup rings in position and prevent endwise movement of the separating rollers on the journal.

It will be seen that the separating rollers connecting with the main rollers will revolve in the reverse direction to the latter; also that the floating rings contacting with

the inner circle of the ends of the separating rollers will rotate in the same direction as the casing; the rotary cup rings will rotate in the same direction as the axle or shafting, while the floating rings will rotate in the reverse direction.

Wear of the rollers and rolling surfaces is taken up and automatically adjusted by a circumferential series of longitudinally tapered staves *K* which are concave on their inner faces and which are adapted to fit the interior of a taper-bored housing *L* which incloses them. The ends of the staves are dovetailed and are mounted in

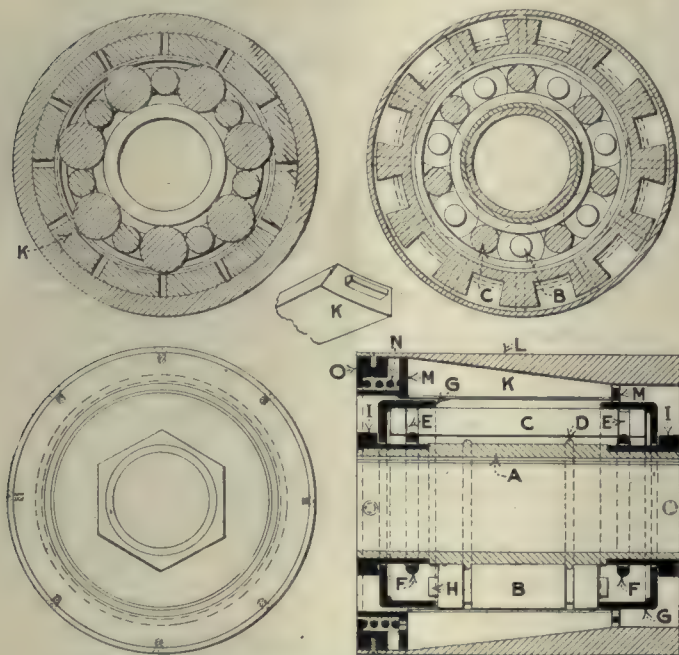


FIG. 2. DETAILS OF ROLLER BEARING

slots around a pair of serrated rings *M*. Longitudinal movement of the staves coincidentally with the pair of serrated rings toward the smaller internal diameter of the housing produces the effect of decreasing the internal diameter within the series of staves. To automatically produce reduction of the operative space within which the main rollers *B* roll, the dovetailed projections provided at each end of the staves *K* are adapted to slide in the serrations in the outer rims of rings *M*, the staves thus being held in longitudinal alignment with each other and being pressed forward by a coil spring *N* brought to bear between the face of one ring *M* and a collar *O* secured by the screws within the housing.

The bearing is a development of Delvante W. Crossland, 1608 Claus Spreckels Bldg., San Francisco, Calif.

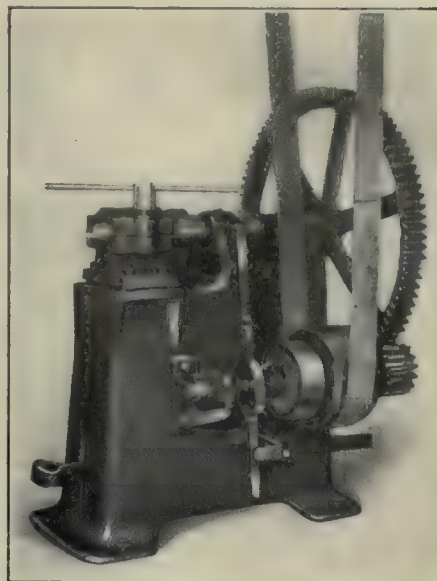
Mechanical Plug Wrench

While primarily designed for screwing in base plugs of shells, other applications of the machine shown to the general class of work involved will suggest themselves to the readers.

In operation the shell is held in the clamp shown. The plug is started by a few hand turns, and the pressure on the foot pedal brings a revolving wrench into engagement with the tit of the plug, thus screwing the plug home tightly. The tightness of the plug can be regulated by a friction clutch on the driving shaft. The

revolving wrench is released by pressure on the foot pedal and instantly returned to its original position by a spring.

As will be noted the machine is belt-driven and the power is transmitted through a single reduction gear.



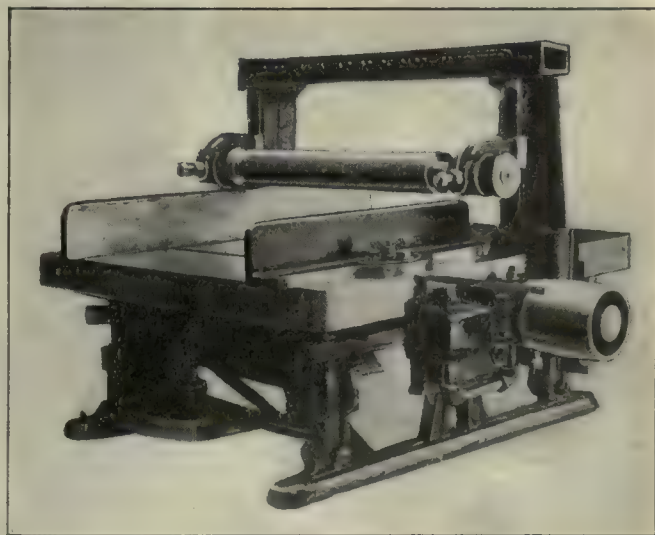
MECHANICAL PLUG WRENCH
Capacity, 6 in.; weight, 1,100 lb.

Various sizes of clamps are provided for the different size shells and the clamp may be readily tightened by the hand lever shown.

The machine is a late product of the Holden-Morgan Co., Toronto, Canada.

Combination Jointer and Planer

The illustration shows a bench planer and jointer built by the Globe Inventing Co., 4877 N. Hermitage Ave., Chicago, Ill. The thickness gage over the table can be set to any height up to 4 in., or can be set to plane



COMBINATION JOINTER AND PLANER
Table, 18x17 in.; weight, 160 lb.

work any angle up to 15 deg. The table can be lifted and swung to the back for convenience when adjustments of the knives are necessary.

A Cylinder-Grinding Fixture

By W. BURR BENNETT

Some time ago, a small shop had occasion to grind the bore of several hundred gasoline-engine cylinders. The cylinders were cast single—that is, one bore per casting. Not having an internal grinder, the fixture shown in Figs. 1 and 2 was designed and built. Although in a way it was crude, it accomplished the results required and was easily worth its cost. The fixture was applied to an old engine lathe that was first overhauled and put in good shape. The grinding fixture consists of a small driving pulley fastened to a driving shaft that runs in two bushings fastened in either end of the lathe spindle. The forward end of this shaft is a square slip joint for one end of a small universal joint. There are two of these universal joints, forming, with the intermediate shaft, a flexible drive between the driving shaft and the grinding-wheel spindle. This flexible connection was necessary in order that the slide could be offset by a feed screw, thus giving an eccentric path to the grinding wheel as the faceplate was revolved. It will be seen that the amount of offset of the slide is what determines the removal of stock.

The slide was a casting fitted to dovetails in the base which was bolted to the faceplate. This slide was hollow, and tapered down with four flat sides to a cylindrical bore on the end, into which was pressed a steel tube. This tube carried a bearing at either end in which the grinding-wheel spindle rotated. The front bearing was provided with a dust guard. As will be noted, the cylinder was mounted on a couple of hardwood blocks

and bolted to the carriage which was fed toward the head of the lathe with the proper feed. The greatest difficulty experienced was with wear in the universal joints. The slightest wear or play in the pins of these joints would cause severe vibration and consequent wheel marks in the cylinder. Some of the cylinders were

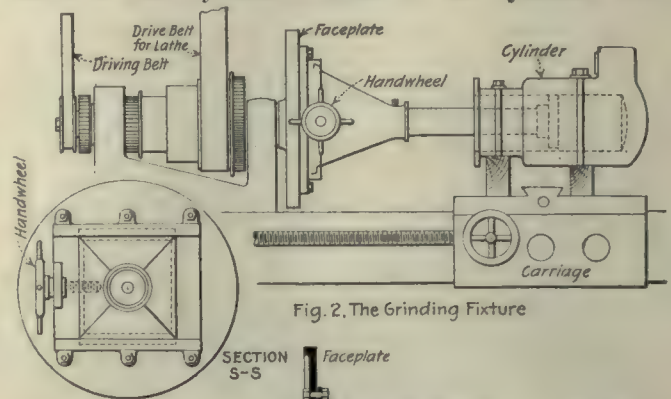


Fig. 2. The Grinding Fixture

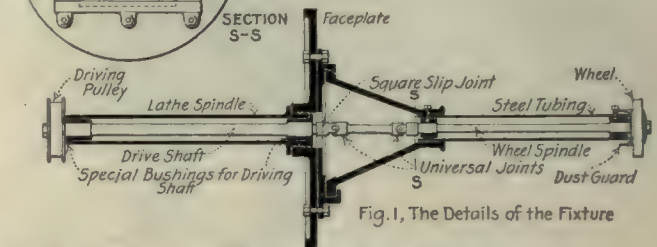


FIG. 1. THE DETAILS OF THE FIXTURE
FIG. 2. THE GRINDING FIXTURE

ground without cooling and others with water circulating through the jackets. Grinding was dry in each case. A 3½-in. wheel was used—one-half inch smaller than the bore of the cylinders.

Personals

Arthur L. Lewis has been appointed superintendent of Sleeper & Hartley, Inc., Worcester, Mass. Mr. Lewis was formerly with L. F. Fales, Walpole, Mass.

F. L. Herzog has joined the engineering division of Mackintosh, Hemphill & Co., Pittsburgh, Penn. Mr. Herzog was formerly chief engineer of the Philadelphia Roll and Machine Co.

A. W. Foote, president of the Foote-Burt Co., Cleveland, Ohio, has been elected president of the H. A. Lozier Co., succeeding H. A. Lozier who continues as a member of the board of directors.

Albert V. Brouillette, for some time assistant to the chief efficiency engineer, Remington Arms U. M. C. Co., Ilion, N. Y., is now connected with the New England Westinghouse Co., Springfield, Mass.

Obituary

William Bunting, president of the Bunting Brass and Bronze Co., Toledo, Ohio, died on Aug. 26.

Albert F. Rober, president of the Rober Machinery Co., Portland, Ore., died at his home in that city on Aug. 22.

S. S. Leonard, vice-president and manager of the Western Automatic Screw Machine Co., Elyria, Ohio, died in that city on Sept. 3, aged 62 years.

Emil Herter, for almost thirty years Thomas A. Edison's chief mechanical engineer, died in Orange, N. J., Aug. 23. Mr. Herter was fifty nine years old and prior to entering the employ of Mr. Edison was a pattern maker in the Government employ.

Machinery Wanted

An inquiry received from Pictet & Cousot, Engineers, Geneva, Switzerland, requests literature, catalogs, prices, etc., covering complete machine equipment for the manufacture of snap-fasteners, including spring-making machinery and machines for placing the fasteners on paper boards.

Business Items

Greenfield Tap and Die Corporation, Greenfield, Mass., has discontinued its Detroit branch office.

New York Tool Mfg. Co., 417-421 Canal St., New York City, has opened a new shop to look after contract work.

Brennan Wahl Company, Delaware Bldg., Chicago, Ill., is the new corporation succeeding the Brennan Engineering Co., consulting engineers.

The Brown Instrument Co., Philadelphia, Penn., has established a Detroit branch office in the Chamber of Commerce Building which will be under the direction of Wm. Printz, formerly assistant sales manager.

The J. N. Lapointe Co., New London, Conn., held its annual picnic on Aug. 26. The usual festivities prevailed and in the nature of a surprise the employees presented Joseph N. Lapointe with a huge American flag.

Colonial Steel Co., Pittsburgh, Penn., has completed the erection of, and is now occupying, a new brick and concrete one-story warehouse in So. Boston, Mass. The new warehouse provides a floor space of 10,000 sq. ft., with a capacity of over 1,000 tons of tool steel bars.

Trade Catalogs

Indicating and Recording Thermometers. The Foxboro Co., Foxboro, Mass. Bulletin No. 104. Pp. 56; 8x10½ in. Illustrated.

Hercules' Shears and Rod Cutters, Oil Hole Covers, Oil Cups. W. A. & C. F. Tucker, Hartford, Conn. Catalog No. 10. Pp. 8; 3½x6 in. Illustrated.

S. K. F. Ball Bearings. S. K. F. Ball Bearing Co., Hartford, Conn. Pamphlet, Pp. 62; 6x9 in. This describes S. K. F. ball bearings as applied to electric motors.

Chains and Sprockets. Diamond Chain & Mfg. Co., Indianapolis, Ind. Catalog. Pp. 56; 6x9 in. Illustrated. Describes also the "Diamond" tooth form for roller chain sprockets.

Automatic Screw Machine. Fitchburg Automatic Machine Works, Fitchburg, Mass. Catalog. 6½x9 in. Illustrated. This describes machine recently brought out by this company known as the "Radical."

Forthcoming Meetings

American Foundrymen's Association and American Institute of Metals. Annual meeting, Sept. 11-16, Cleveland, Ohio. A. O. Backert, secretary, American Foundrymen's Association, Cleveland, Ohio.

National Machine Tool Builders' Association. Annual convention, Oct. 24-25, Hotel Astor, New York City. Charles E. Hildreth, general manager, Worcester, Mass.

American Society of Mechanical Engineers. Monthly meeting, first Tuesday. Calvin W. Rice, secretary, 29 West 39th St., New York City.

Boston Branch National Metal Trades Association. Monthly meeting on first Wednesday of each month, Young's Hotel. W. W. Poole, secretary, 40 Central St., Boston, Mass.

Providence Association of Mechanical Engineers. Monthly meeting, fourth Wednesday of each month. J. A. Brooks, secretary, Brown University, Providence, R. I.

New England Foundrymen's Association. Regular meeting, second Wednesday of each month. Exchange Club, Boston, Mass. Fred F. Stockwell, 205 Broadway, Cambridgeport, Mass.

Engineers' Society of Western Pennsylvania. Monthly meeting, third Tuesday; section meeting, first Tuesday. Elmer K. Hiles, secretary, Oliver Building, Pittsburgh, Penn.

Rochester Society of Technical Draftsmen. Monthly meeting, last Thursday. O. L. Angevine, Jr., secretary, 857 Genesee St., Rochester, N. Y.

Superintendents' and Foremen's Club of Cleveland. Monthly meeting, third Saturday. Philip Frankel, secretary, 310 New England Building, Cleveland, Ohio.

Western Society of Engineers, Chicago, Ill. Regular meeting, first Wednesday evening of each month, excepting July and August. J. H. Warner, secretary, 1785 Monadnock Block, Chicago, Ill.

Philadelphia Foundrymen's Association. Meetings first Wednesday of each month. Manufacturers' Club, Philadelphia, Penn. Howard Evans, secretary, Pier 45 North, Philadelphia, Penn.

Technical League of America. Regular meeting, second Friday of each month. Oscar S. Teale, secretary, 35 Broadway, New York, N. Y.

Operations on the British 12-In. Mark IV Howitzer Shell

SPECIAL CORRESPONDENCE

SYNOPSIS—While all the operations peculiar to the 12-in. Mark IV high-explosive shell are covered in the following article, it has not been deemed necessary to go into details of operations which are common to the other sizes of shells and which have been fully covered in previous articles on British ammunition.

The shell shown in Fig. 1 is made from a forging approximately 40½ in. long, 13 in. in diameter, with a 7-in. hole 37 in. deep extending up from the base end. In one large plant where between 400 and 500 of these shells are produced each day the following manufacturing methods are pursued:

The first operation is cutting off to 38 in. in length. This is done on a special cutting-off machine with a

The tools are of high-speed steel, about $\frac{1}{2}$ in. wide. One tool operates on the nose end of the shell, while on the base end two tools of the same size and material operate on the shell simultaneously from the front and back. The front tool is ground square, while the rear tool has a rounded V-point to break the chip for the front tool. The spindle makes nearly 20 turns per minute, equal to about 65 ft. cutting speed on the work. The production is one shell cut off at both ends in 15 min. The cutting to length operation is shown in diagrammatical form in Fig. 2.

The second operation—drilling and reaming the nose end of the shell—is done in a jig on large radial drilling machines.

The shells are taken away from the cutting-off operation in National Chapman trucks specially constructed for the purpose. With these trucks one man can easily

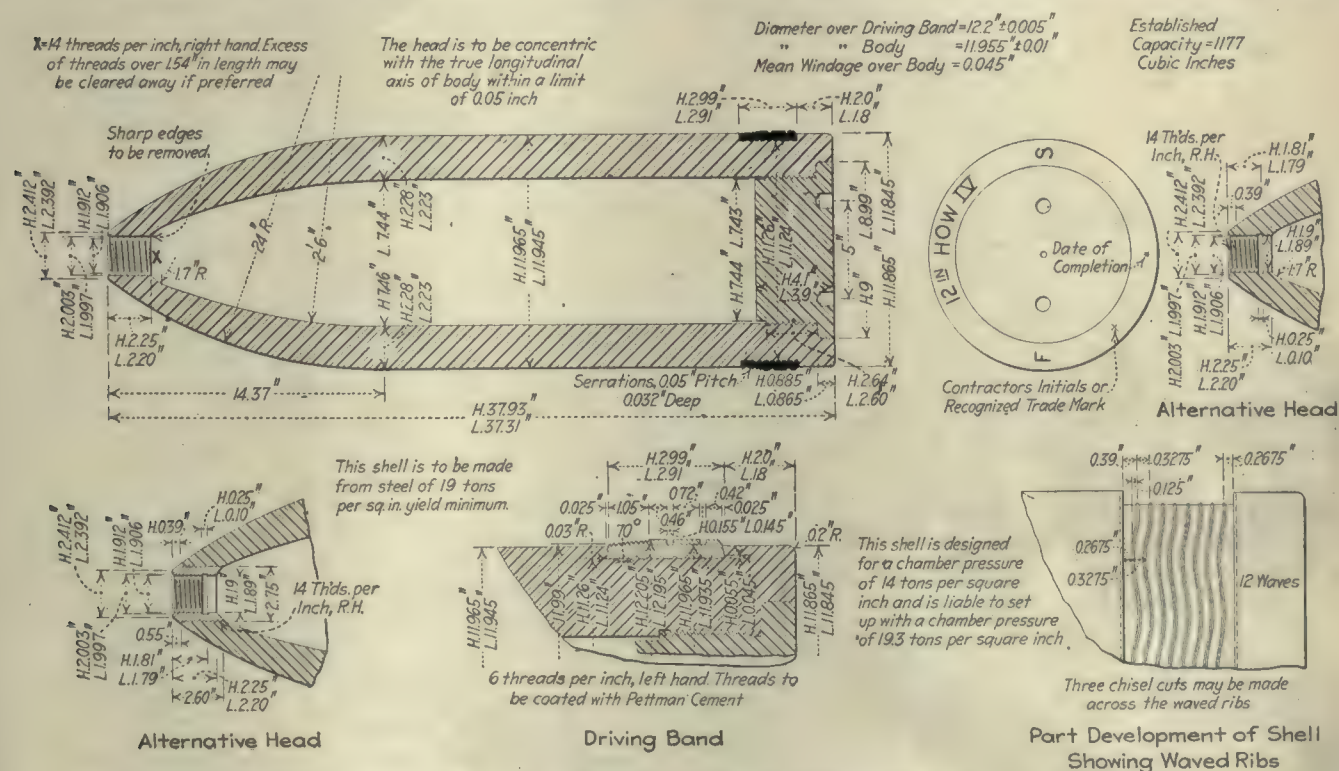


FIG. 1. BRITISH 12-IN. MARK IV HIGH-EXPLOSIVE SHELL

hollow spindle large enough to take the shell blank. The shell is pushed, nose end first, into the spindle. The nose end seats in and is centered by the internal conical end of the spindle. The rear end is centered and driven by four heavy setscrews spaced 90 deg. apart near the spindle end. Four similar setscrews on the nose end of the spindle are then tightened down on the work. The spindle is driven by a worm gear midway of its length, between the two bearings of the spindle. The machine is provided with three tool slides. One is at the front of the machine at the nose end of the spindle. At the base end of the spindle there are two tool slides, one at the front and one at the back of the machine.

handle shells weighing in the neighborhood of 800 lb. This make of truck is so well known that the end view of the 12-in. shell truck, shown in Fig. 3, will be sufficient. In this illustration *A* is the shell lying on the floor. The angular wooden pieces *B* run the whole length of the elevating part of the truck and are located at such height that when the elevating part is at its lowest position they will clear the sides of the shell below its center about as shown in the illustration. When the elevating part is raised, the shell rests on the wooden pieces *B*. The braces *C* bridge over the shell from side to side of the truck to stiffen it. The shells are lifted into and out of the jig for the next operation by a hoist and the clamp *E*, Fig. 3.

At *F* is shown the jig. Two of these jigs are placed back to back on the base plate of the radial. If there is enough work for two radials, they should be placed close together. Two laborers can then serve both machines. The post *G* for locating the work has a conical head that centers the top end by the conical bore. At the bottom, *G* is threaded for the conical centering collar *H*, which is run up after the top is located on the conical head.

The part *I*, carrying the bushing *J*, pivots on *K*. The index pin *L* locks the part *I* so that the bushing is in line with the center of the post *G*. When *L* is removed, the part *I* can be swung around so that the work can be inserted or removed. The strap clamp *M* holds the shell from turning.

The nose of the shell is first drilled $1\frac{1}{2}$ in. Then the bushing is removed, and the hole is reamed $2\frac{1}{2}$ in. The time for drilling and reaming is 6 min. per shell.

The third operation is rough-turning the outside of the shell from base to nose. This is done on heavy engine lathes with a double-track former and roller follower at the back connecting with and controlling the tool at the front of the machine. A plug with a

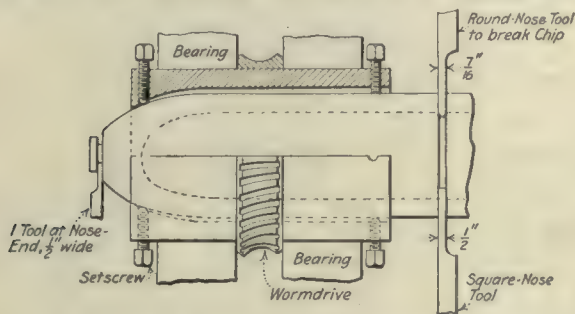


FIG. 2. CUTTING TO LENGTH

very slight taper is driven into the reamed hole in the nose of the shell. This plug is provided with a female center to fit the tail center of the lathe. Two methods are used for driving and centering the base end of the shell. A heavy three-lobed cam with three rollers, as shown in Fig. 4, is entered in the rough-forged hole in the base of the shell. The greater the cutting stress the farther the rollers are driven up the cam lobes and the tighter they grip the shell.

The other method of drive is by four-jawed chucks provided with a simple but efficient centering device. The tapered plug *A*, Fig. 4, is securely fastened to the face of the chuck. It has four slots so that the jaws can enter it part way, as shown. With the jaws removed from the chuck this plug is turned slightly tapered to a diameter that will permit the base end of the shell to enter to about the point *B*, Fig. 4. When in operation the tail spindle of the lathe is used to force the base end of the shell to a seat on the centering plug *A*. The chuck jaws are then tightened in the hole, and the work is ready to turn. A single cut averaging $\frac{1}{2}$ in. in depth is taken on the body, reducing it to 12.1 in. in diameter. Two cuts are required on the nose. The speed is 16 r.p.m., and the production is about one shell in 1 hr. 40 min.

The fourth operation is boring, which is done on heavy lathes with a double-track former *A* at the back to guide the boring bar *B*, as shown in Fig. 5. The work is held in a heavy pot chuck, split and hinged longitudinally. The rear end of this chuck screws on

the spindle nose, while the front end runs in a steadyrest. The nose of the rough-turned shell is centered at the back end of the chuck by forcing it to a seat in the machined conical inner end of the chuck. At the forward end of the chuck, outside the steadyrest and easily accessible, are four equally spaced hollow setscrews *C*, which are used to center and drive the work. The

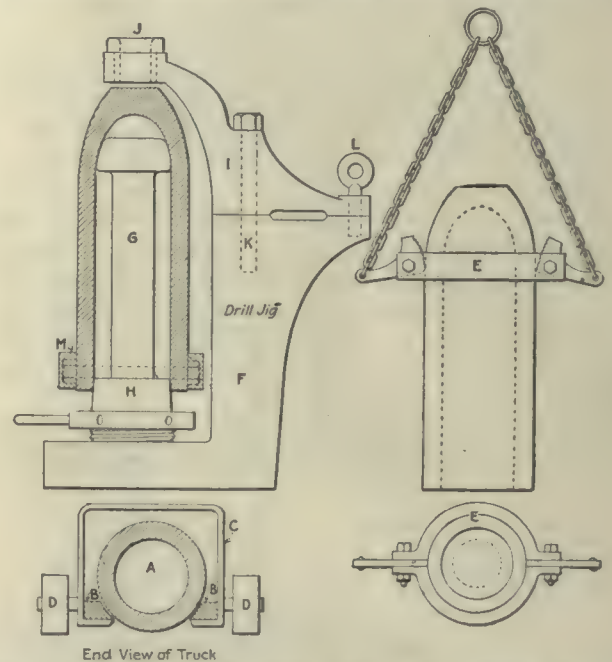


FIG. 3. SHELL TRUCK, DRILL JIG AND LIFTING CLAMP

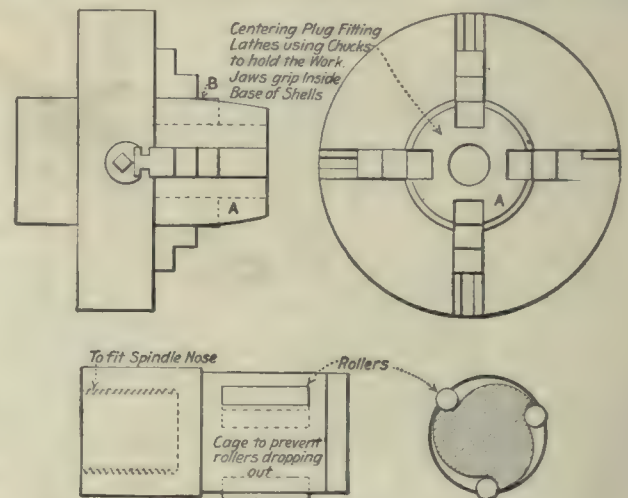


FIG. 4. DRIVING AND CENTERING DEVICES FOR ROUGH-TURNING

front end of the chuck is bored; and the operator of the lathe uses a feeler between it and the work when tightening the setscrews, to make sure that the work is concentric with the chuck.

The boring bar is about 4 in. in diameter—that is to say, as heavy as it can be made and still clear the opposite side of the hole when at the small end of the bore. The forward end is tapered on the side opposite the cutter, so that it will clear the conical end of the hole. For boring, the speed is about 30 r.p.m. One to two cuts are required to finish the inside to $7\frac{1}{4}$ in. in diameter, $35\frac{1}{2}$ in. deep. The production time is about the same as for rough-boring—one shell in 1 hr. 40 min.

The fifth operation, facing and threading the nose end of the shell for the socket, is done on heavy engine lathes. The work is held in a pot chuck with the nose of the shell projecting therefrom. The carriage of the lathe carries a square turret, as shown in Fig. 6. The hole in the nose is supported on the center held in No. 1 station while the setscrews in the pot chuck are adjusted.

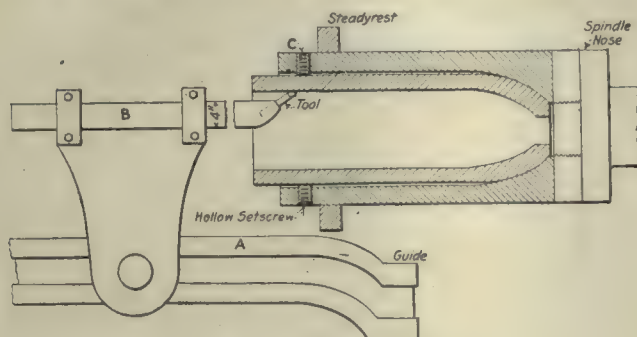


FIG. 5. BORING THE SHELL

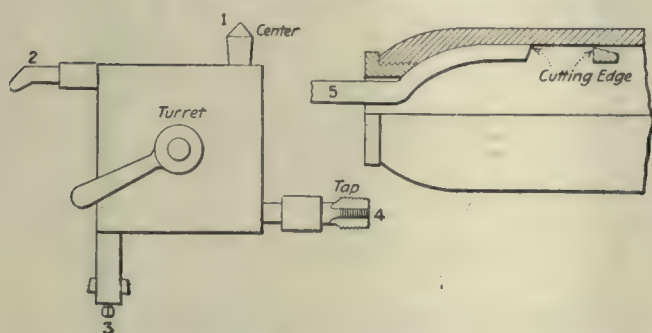


FIG. 6. THREADING NOSE AND INSERTING FUSE SOCKET

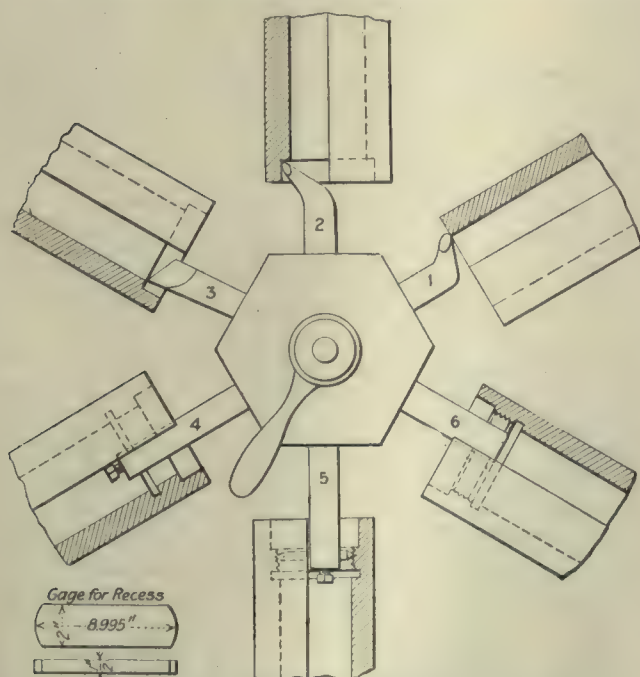


FIG. 7. THREADING THE BASE FOR ADAPTER

The nose is faced and the hole trued up with the tool in No. 2 station. The double cutter in No. 3 station brings the hole to tapping size, and the tap in No. 4 station taps the nose. The socket is then smeared with Pettman cement and screwed in with the aid of an alligator wrench with a long piece of pipe for a handle.

After the socket is screwed in, the tap is removed from No. 4 station, and the forming tool No. 5 is secured in its place. With this the inner end of the socket is brought to the same curve as the inside of the shell nose. Owing to the frailty of this slender tool there are apt to be chatter marks on the inside of the shell. They are subsequently removed by small emery wheels mounted on spindles driven by flexible shafts. The output on facing and threading the nose, screwing in fuse sockets and form-turning the inside end of the socket is about one shell in 30 min.

The sixth operation is threading the base for the adapter. This work is done in an engine lathe equipped with a hexagonal turret on the carriage, as shown in Fig. 7. The work is chucked with the nose end in a pot chuck about one-half the length of the shell. The rear end of the shell is run in a steadyrest. The base end of the shell is faced off with the tool in the first station

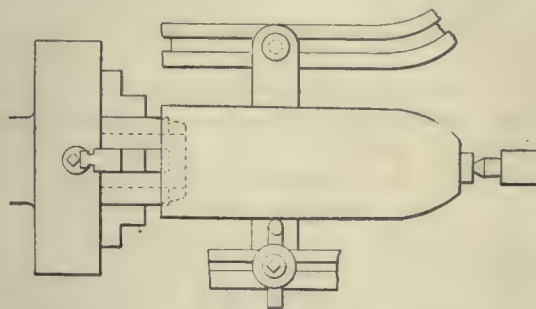


FIG. 8. FINISH-TURNING

of the turret. A similar tool is used to rough out the recess, which is finished with the tool shown in the third turret station. Then, with the tool as shown, in the fourth station, the clearance check is cut at the extreme end of the threaded part. This tool is followed by the single-point threading tool in station 5, and the thread is chased. Three cuts over the threaded part prepare it for chasing with the tool in the sixth station. This chasing tool is of the ordinary kind, with three threads of the Whitworth form. The time on this operation is 1 hr. 15 min. per shell.

The seventh operation, finish-turning, shown in Fig. 8, is done on engine lathes. Some of them are equipped with a single carriage that operates the whole length of the shell. Others are special lathes with two carriages, the tool in one carriage operating on the nose at the same time that the tool in the other carriage is operating on the body of the shell. Both types of lathes are provided with a double-track former at the back. The drive of the shell is by means of the jaw chuck and centering cone used in the rough-turning operation. The nose of the shell has a threaded plug screwed into the fuse bushing. The ratio of production of the one- and two-carriage lathes is as 5 to 6. The body of the shell is turned 11.960 in. At the base end, just below the driving band in the finished shell, a check is turned 11.855 in. in diameter. The average time for this operation is 1 hr. 40 min. per shell.

The eighth operation is to groove and undercut the driving-band groove preparatory to waving. No special fixture is provided for this work; a heavy engine lathe with turret tool post is used. The base of the shell is held in and driven by a shallow cup chuck, Fig. 9, with four heavy setscrews for centering the base end

of the shell. The nose of the shell has a threaded plug with a female center that runs on the tail center. The turret tool post has a formed tool with eight projections for forming the grooves and two side tools for undercutting. The time for this operation is about 30 min. The grooves are 11.260 in. at the bottom and 11.350 in. at the top.

The ninth operation is waving. The same type of lathe and the same set-up are used as in the previous

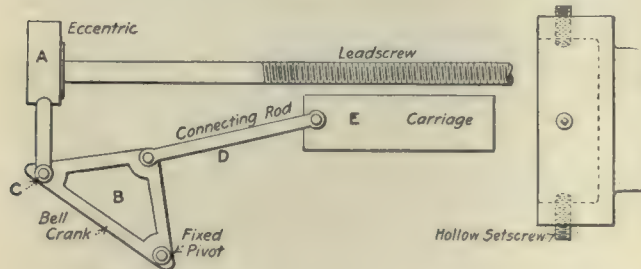


FIG. 10. WAVING ATTACHMENT FIG. 9. CUP CHUCK

operation. The wave tool is mounted in a turret tool post. The method of imparting the reciprocating motion to the tool is, however, slightly different from those already described in connection with the manufacture of smaller shells. Mounted on the lead screw of the lathe is an eccentric A, Fig. 10. The eccentric rod connects with the bell crank B at the point C. To function with exactness the eccentric should be spherical, and the connection at C should be a ball and socket joint. However, the mechanism works well without these refinements, if the joints are left slightly slack. The connecting-rod D transmits motion to the carriage E. The waving operation takes about 10 min.

The tenth operation is washing. Various methods of handling this work are in use. In one shop the shells are dropped over a perforated pipe, a sheet-metal cover is placed over the shell, and hot water under pressure is turned into the perforated pipe. This washes all the loose particles of steel and dirt from both outside and inside the shell, which is then plunged into cold water so that it can be handled.

A rotary washing machine that works satisfactorily is shown diagrammatically in Fig. 11. At A is a clamp used for lifting shells into and out of this washing machine. The part C is about 160 deg. in length. In it the part D slides. A clamp at E secures D in C. When at its extreme outward position and clamped by the lever E, the device embraces the shell body so that it cannot fall out when lifted by the eye-bolt F.

After being washed in hot and cold water, the shells are placed under a cold blast of air to dry. When dry, small defects, such as chatter marks, are corrected. A flexible shaft grinder is a useful tool for this work. Preliminary inspection follows but need not be detailed here.

Having passed the preliminary inspection, the shells are varnished. This is done with an ordinary hand spray, Fig. 12, with a nozzle long enough to reach from the base to the nose of the shells, which are laid on their sides on a bench of convenient height. One man holds an electric lamp at the nose end of the shell while the other man, at the base end, sprays the varnish on the inside of the shell. Varnishing occupies about 2 min. An eye-bolt is then screwed into the base, and the shell is dropped nose down into a cast-iron seat B. These

seats are arranged in rows on the floor. A portable electric oven, shown in Fig. 12, is then placed over the top of each shell, and the varnish is baked for 2 hr.

The adapters for the base are usually brush-varnished, as they are easy to get at with a brush. They are baked in an electric oven built for the purpose.

MAKING THE ADAPTER FOR THE SHELL BASE

It would perhaps be as well to digress here and take up the making of the adapter. The adapter forging is shown at A, Fig. 13. The first operation is rough-turning and facing the flange. The forging is gripped

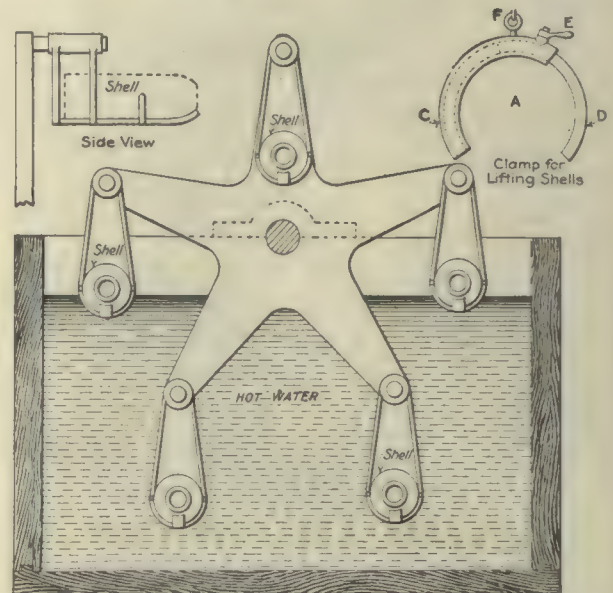


FIG. 11. WASHING MACHINE AND LIFTING CLAMP

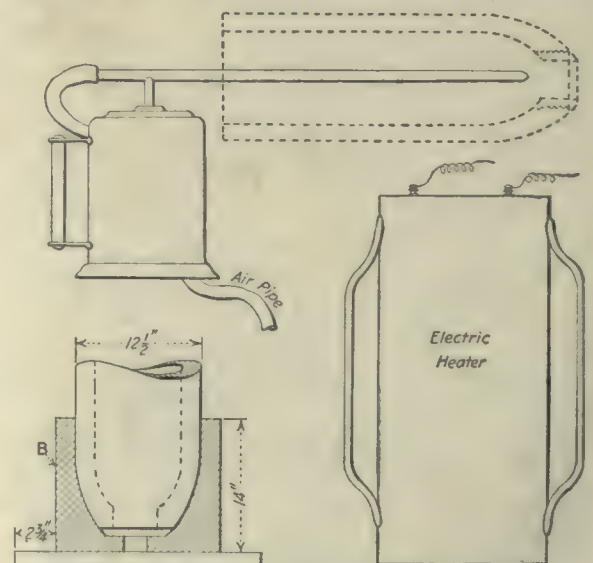


FIG. 12. VARNISH SPRAYER, SEAT AND ELECTRIC HEATER

by the smaller diameter in a four-jaw chuck of an engine lathe. The flange is reduced to $9\frac{3}{8}$ in. in diameter and the face of the flange cleaned up. A centering tool in the tail spindle is then run in, and the operation is complete; elapsed time, 15 min.

The work next goes to the drilling machine, where two $\frac{3}{4}$ -in. holes B, Fig. 13, are drilled $\frac{7}{8}$ in. deep in the flange. They are $2\frac{1}{2}$ in. from the center and 180 deg. apart on the circle. A simple jig is used to locate

the work from the center. About 5 min. is sufficient time for drilling the two holes. The adapter is then located in another jig, and both ends are properly centered.

The adapters are rough-turned between centers, as shown at *C*, Fig. 13. The driver *D* screws on the spindle nose and has two $\frac{3}{4}$ -in. pins $2\frac{1}{2}$ in. off center. These enter the holes in the flange of the adapter and

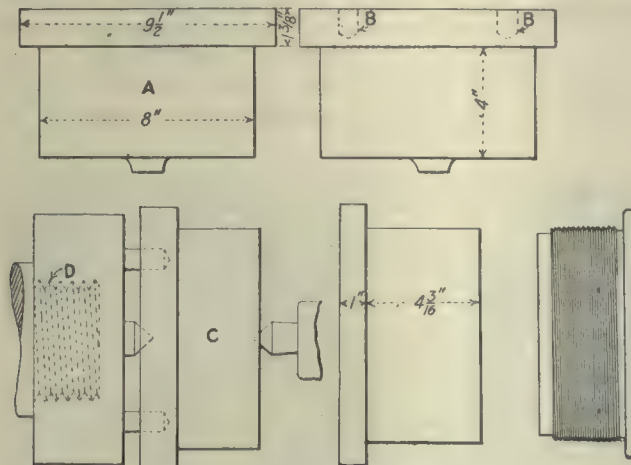


FIG. 13. THE ADAPTER

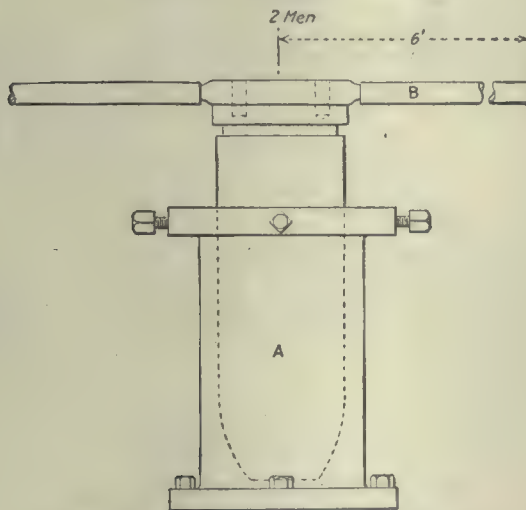


FIG. 14. INSERTING THE ADAPTER

drive it. The body is reduced to $7\frac{3}{4}$ in. in diameter and the flange to 1-in. thickness; time, about 30 min. each.

The adapters are then turned for threading, as shown in Fig. 13. They are held between centers and driven by pins precisely as in the previous operation. The flange is finished to 8.995 in., the threaded part to 7.696 in. and the pilot between 7.44 and 7.461 in. The recess between the flange and the thread is 7.460 in. in diameter. The time for this operation is about 25 min.

In some plants it has been found advisable to rough-thread the adapters in one operation and then pass them to another lathe for finishing. Formed chasers, such as those made by Pratt & Whitney or the Landis Machine Co., are used for both rough and finished threading. The work is held between centers and driven by the pins, as in the previous operations. Rough-threading can be done at the rate of about one adapter in 20 min. Finish-threading with practically the same equipment takes from 12 to 15 min. per adapter.

Returning to the shell, the fourteenth operation is fitting the adapter. The shells are held in heavy cast-iron stands, as at *A*, Fig. 14, which are bolted to the floor. Heavy pin wrenches *B*, with pipe extension handles 6 ft. long, are used to screw the adapters in and out. A facing tool built like a valve-seat facing tool is used when necessary to smooth the seat in the shell. Hand scrapers are also employed to obtain a fit

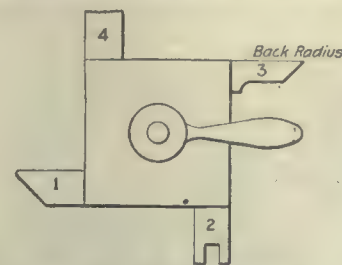


FIG. 15. BAND-TURNING TOOLS

between the shell and the adapter. The time for fitting an adapter is about 20 min. It is screwed tight into the shell with the pin wrench by two men, one on the end of each 6-ft. handle. The base of the shell and the adapter are faced off in the engine lathe. The shell is held in and driven

by a pot chuck. The outer end of the shell just above the driving-band groove is run in a steadyrest. The time for this, the fifteenth operation, is about 20 min.

APPLYING AND COMPRESSING THE COPPER DRIVING BAND

The copper bands are $12\frac{1}{8}$ in. in outside diameter, $11\frac{3}{8}$ in. in inside diameter and $2\frac{1}{8}$ in. wide. The operation of banding is similar to that described in connection with the 3.3- and 4.5-in. high-explosive shells, except that the bands are heated to a red heat. The press has six 10-in. hydraulic cylinders working at a pressure of 3,500 lb. per sq.in. A loose ring of steel is located below the dies. An eye-bolt is screwed into the fuse hole in the nose of the shell; the shell is raised by an air hoist and located over the dies. The hot band is dropped on the loose steel ring, which locates it to the proper height in the dies. The shell is then lowered into the two rings till its base rests on the bottom of the press. The band is given five squeezes. A squad of laborers handle the shells into and out of the banding department. Of the banding squad one man operates the air hoist, one tends the furnace and places the bands in the press, two handle the shell and turn it in the dies, and one man operates the controlling levers of the hydraulic press. The time for banding is about 5 min. for the complete time from floor to floor.

Band turning is done on a lathe without back gear. The shell is held in a short cup chuck, Fig. 9, and has a threaded plug in the nose. A turret tool post is used with four tools, as shown in Fig. 15. The band is roughed all over with the tool shown in station 1, the grooves are cut with the gang tool in station 2, the back taper is made with the tool in station 3, and the serrations with the tool in station 4. The time on this operation is about 15 min. The use of separate tools for band turning results in longer life for the various tools.

The shells are next weighed and then go to final inspection, boxing and shipping. The boxes hold one shell each. They are made of $1\frac{3}{8}$ -in. yellow pine well battened inside and out and have steel box strapping around the ends and center. They are stenciled: "1 12-in. H. E. Mark IV Lot No. . . . Net 880 gross 780 lb. Size 44x19x19 in."

A Brazilian Railroad Shop

SPECIAL CORRESPONDENCE

The Campinas shops of the Companhia Mogyana are designed to be used for repairing annually 80 locomotives, 60 passenger and 600 freight cars, to construct the necessary rolling material and to execute various repair work. All the buildings are located parallel to the main



FIG. 1. MODERN BRAZILIAN RAILROAD SHOP

line of the Paulista Co. Seven kilometers ($4\frac{1}{3}$ mi.) of tracks cross the shop yard, penetrating approximately $\frac{5}{8}$ mi. between the buildings. One line of the Paulista Co. passes longitudinally through the grounds between the two sections of buildings, thus facilitating the handling of heavy material. The steam generators in the first two compartments consist of three locomotive-type boilers with a capacity of 120 hp. each, which were constructed in the Campinas shops. At one side of the boiler room an induction-draft apparatus of the Buffalo Forge Co. has been installed. It occupies a very small space and maintains the fire as required by the consumption of steam. This regulation is secured by means of a graduated valve that controls the draft to conform with the variations of boiler pressure. The electrical units were built by the General Electric Co. Each of the first two consists of a tandem compound "Ideal" engine of 240 hp. direct connected to a direct-current 125-kw. 250-volt generator, and the third has a 100-hp. engine and a 50-kw. dynamo of the same types as those in the first two groups. This machinery is set on a large concrete foundation. All the steam piping is insulated by asbestos lagging covered by canvas.

The two compressors, made by the Christensen Engineering Co., of Milwaukee, Wis., have a total capacity of 425 cu.ft. of free air per minute, compressed to 100 lb. pressure.

The building was designed and built with a steel frame of modern type, having a height of 38 ft. 10 in. and planned to have the service of an electric traveling crane, with a 98½-ft. track running at a height of 30 ft. along a track 262½ ft. long.

The entire structure is of steel and carries a load of 1,420 lb. per sq.in. with a maximum load on the crane. It was built at the bridge works of Flender, of Benrath, Germany. The electric crane was constructed by Ludwig Stuckenholtz, and the electrical equipment has been provided by the Schuckert Works, both German concerns. The cranes are so arranged as to divide the load of 50 tons equally between two cars. If desirable, an auxiliary crane may be installed with a capacity of 3 tons. The span is 42½ ft. from center to center of tracks, with a clear height 26½ ft. above the floor of the shops. The speed is 6½ ft. per min. under full load for the main cranes and 18 ft. for the auxiliary cranes. The cross-travel is 32 ft. per min. and the longitudinal motion of the crane 125 ft. per min. When lifting the largest locomotives on the company's lines, the crane consumes about 36 hp., while the side movement of the suspended load takes about 8 hp. There is also a 25-ft. electrically operated turntable.

It receives the locomotives at the entrance to the shop and places them in a position where they can be conveniently handled by the crane, which lifts them 13 ft. above the ground and carries them easily to their proper destination without any further rehandling.



FIG. 2. ANOTHER VIEW OF BRAZILIAN RAILROAD SHOP

On the right, adjacent to the shop just mentioned, is a repair shop with an area of 5,920 sq.ft. It also has an electric traveling crane, provided with three motors and having a capacity of 5 tons. This crane runs 10 ft. above the ground, being operated by means of suspended chords.

A locomotive to be repaired is brought into the assembling shop on a turntable, leaving behind the track cleaner and the cylinders of the vacuum brake. After being hooked to the big crane, the locomotive is raised and transported to the siding intended. It is stripped and again raised, leaving the wheels and the truck on the track of the siding, which reaches up to the benches of the fitters in the fitting shop situated only a few yards away. All this work, which in the old shop represented two or three days' time, is now done in about an hour in the new building and with half the number of men.

When the wheels and trucks arrive at the fitters' shop, the slings are unhooked, the trucks taken to pieces, the

to the fitters' shop and has for its special use a third electric turning crane with two motors of 2-ton capacity.

Between each two sidings there is a line that traverses the fitters' shop. The wheels are then sent to the turning section with great dispatch, the shop railway running the whole length and being accessible by small turntables from the tracks that cross it. The pieces taken from the locomotives are put on the trucks which, by means of the turntables, can be easily removed to the machines for which they are intended, all being reached by means of tracks and turntables.

The machines in the section served by the small jib crane are provided with individual motors, the upper part of the shop being left free for the crane. The other apparatus is grouped at frequent intervals, each having its own motor. The machines driven individually are:

	Hp.
1 lathe for wheels, Niles-Bement, with capacity to turn two pairs of wheels per day of work, motor.....	15
5 lathes for wheels, Craven Bros., with motors of 3 hp. each.....	15
2 lathes for wheels, Sharp Stewart, with motors of 3 hp. each.....	6
1 lathe for wheels, London, motor.....	3
1 large lathe for heavy work, motor.....	5
1 hydraulic press for wheel axles, motor.....	3
Total	47

The machines in groups are provided with motors of about two-thirds the total horsepower of the group.

Group No. 1		Hp.
5 boring machines at 1 hp.....		5.00
3 planing and filing machines at 2 hp.....		6.00
1 vertical planer at 0.5 hp.....		0.50
1 machine for turning brass for cars at 0.25 hp.....		0.25
Maximum load		11.75
Motor employed		7.50
Group No. 2		
Two 24-in. lathes at 2.5 hp.....		5.00
Two 22-in. lathes at 2 hp.....		4.00
One 18-in. lathe at 1.5 hp.....		1.50
One 15-in. lathe at 1.2 hp.....		1.20
Maximum load		11.70
Motor employed		7.50
Group No. 3		
3 medium lathes at 1.5 hp.....		4.50
12 small lathes at 1 hp.....		12.00
2 planers at 3 hp.....		6.00
1 boring machine at 1 hp.....		1.00
Maximum load		23.50
Motor employed		15.00
Group No. 4		
6 medium lathes at 1.5 hp.....		9.00
3 small shaping machines at 0.5 hp.....		1.50
2 screw machines at 0.25 hp.....		0.50
Maximum load		11.00
Motor employed		7.50
Group No. 5		
1 straight planer at 3 hp.....		3.00
1 planing and filing machine at 2 hp.....		2.00
1 polisher for quadrants at 3 hp.....		3.00
1 polisher for guides at 2.5 hp.....		2.50
1 machine		1.00
Maximum load		11.50
Motor employed		7.50
Total Capacity of Motors		
13 individual motors		50.00
5 motors in groups		45.00
18 motors with a total of.....		95.00

These motors drive a countershaft or a jackshaft. They are made by the General Electric Co., of Schenectady, N. Y.

The power allowed for running each machine and each group is the result of very careful experiments conducted at the Campinas shops before definite installations were made. Today, with the employment of high-speed steels, the motors almost always run at an overload.

Just at the side of the assembling shop and in continuation of the fitters' shop is the principal part of the boiler shops, served by an electric crane with three motors

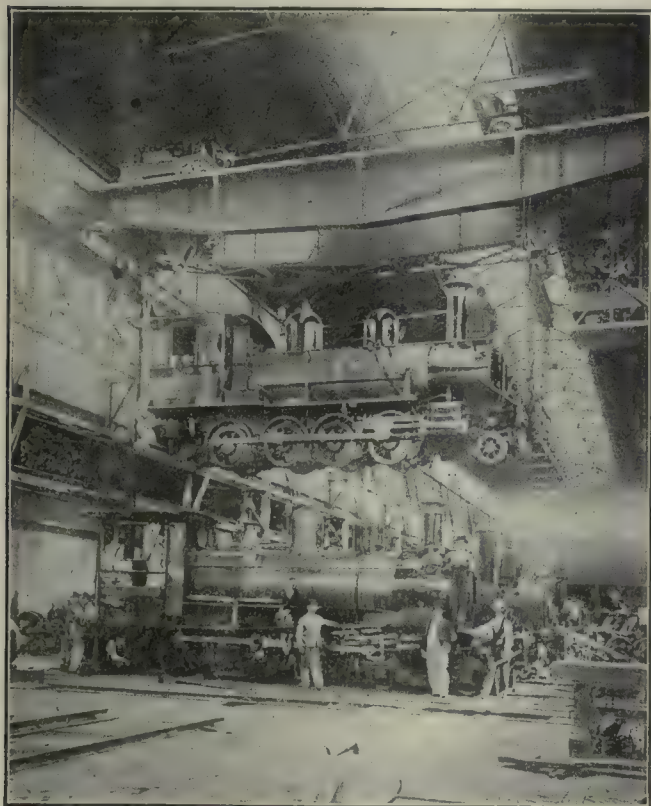


FIG. 3. LARGE CRANES IN A BRAZILIAN RAILROAD SHOP

cases removed, and the wheels are delivered to the 5-ton crane. In the same way, when the locomotive is finished and all is ready, the wheels are in a few minutes run under the machine, which is held by the crane.

The benches of the fitters stretch along the whole side of the shop and are well lighted by means of large windows in cast-iron frames. The compressed-air line is suspended along the columns, hose being within reach of the operators, who use it constantly.

As the pieces are taken from the machines, they are methodically placed in bins constructed for the purpose and located on the side opposite the fitters' shop. This contains 80 bench vises for 60 fitters and 20 apprentices, and various small tools comprise the utensils of this part of the shop.

This fitters' shop for locomotives under repair has an area of nearly 500 sq.ft. The machine shop, on the left wing and in the back part of the building, has a total area of 16,000 sq.ft.

The section for wheel lathes and other machines handling the heavier parts of the locomotives is adjacent

and of 10 tons' capacity, in all respects similar to the one of 5 tons' capacity already described. Both run on the same rails and work together.

The transportation of boilers to the boiler house is carried out with the least possible manual labor, with the assistance of the 50-ton crane and the lines that run across the assembling shop and enter the boiler shop under the 5- and 10-ton cranes, which on such occasions work together.

The big crane, raising the boiler from the truck of the locomotive, transports it to one of the lines mentioned, where two trolleys prepared for the purpose receive it and, barely 30 ft. away, deliver it to the smaller cranes, which in turn bring it to the desired place. A characteristic feature of this shop is the great progress shown in the application of pneumatic tools. Their advantages are being appreciated more each year. The boiler-shop force of the Mogyana Co. consists of only five boiler makers, with their helpers. This is a small number for a shop with a large output, where the boilers are continually modified and reconstructed; where whole furnaces, plates, pipes and accessories damaged by wear are being replaced, besides a large number of bridges constructed for the line, either open to traffic or under construction. The extensive use of pneumatic machines by the operators and apprentices aids in the major part of the work. The pneumatic installation consists of the following machines and tools:

- 10 boring machines of various sizes varying from $\frac{1}{8}$ in. to 2 in.
- 3 threading machines with reversing action.
- 10 hammers of various sizes for cutting, or chiseling, and for calking.
- 4 riveters with 12 tools.
- 1 rivet header.
- 2 pneumatic portable forges for rivets.

The boring machines can be employed in innumerable ways as small motors, one interesting application being the turning apparatus for boring cylinders of the locomotives and turning the tires of the wheels. The results obtained are very satisfactory both as to the economy and output. The boiler shop also contains the following apparatus:

- 1 shears and punch with knives 25 in. long, with passage for plates up to 24 in. wide, moved individually by a motor of 7.5 hp.
- 1 roller for bending plates 8 in. long, moved by an individual motor of 7 hp.; this motor is provided with a rheostat for reversing.
- 1 roller 4 in. long, worked by hand.
- 2 presses for straightening beams, rails, angle iron, etc.
- 2 forges for plates.
- 2 ordinary forges.
- 2 cranes of 1.5 tons' capacity for the service of the forges.
- 8 ordinary portable forges.

The first two machines mentioned are installed in the tracksmiths' shop, a part of the boiler shop, where the points and crossings of the tracks are made. The distance between these two shops, only 75 ft., is covered by the line which, crossing the mechanics' shop, also puts these shops in easy communication with the blacksmiths' shop, where it ends. The shop is equipped and has ample space for its heavy and rough work.

The forges, 30 in number, are placed to meet the exigencies of the service for which they are intended, the chimneys being arranged with the greatest care to avoid vitiating the air by spreading the smoke in the shop. Exits along the whole extent of the roof facilitate ventilation and give egress to smoke that has not escaped by the proper way.

The air for the forges is provided by a Root blower driven by a 10-hp. motor. The conduits are of cast iron, in a closed circuit, which supplies the air for the forges.

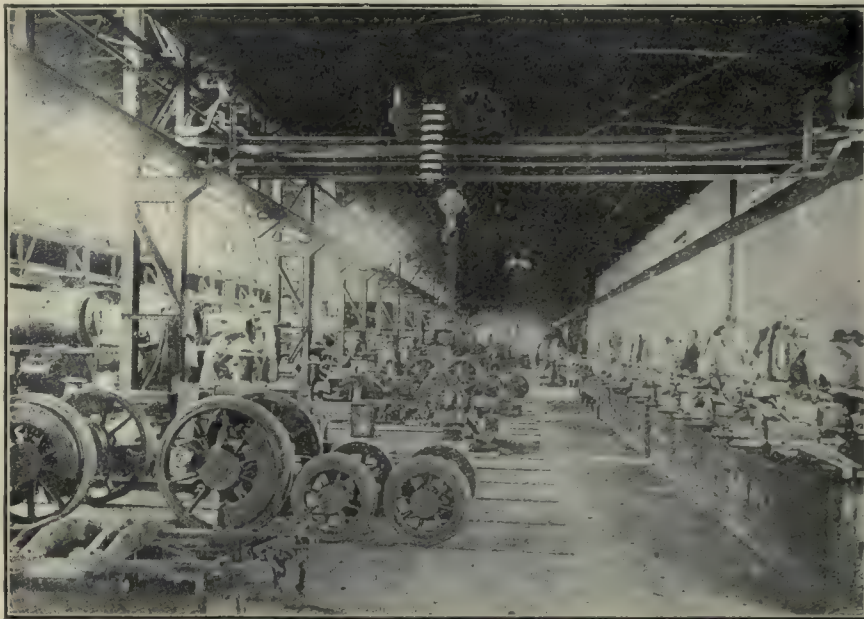


FIG. 4. VIEW IN FITTERS' SHOP

The ventilator installation is in duplicate, so as to have one always in reserve. The two ventilators are situated below the floor of the shop in brick casings covered with a strong top. A furnace for tempering springs and one for heavy work complete the fires of the shop.

THE FORGE SHOP

The forge shop has also two large steam hammers, with 12x18-in. cylinders, and an electro-pneumatic hammer for light work. This small apparatus, made in England by Peter Pilkington, which has an air compressor working the hammer, is driven by a 5-hp. electric motor. A valve worked by foot lets the compressed air escape at the will of the blacksmith, who thus can regulate the strength of the blows of the hammer as required for his work.

Four jib cranes give good service to the hammers, which are supplied with the necessary steam from an old locomotive boiler. Presses, stamps, cylinders for rolling spiral springs and various utensils for each kind of work are at the disposal of the shop. Each one of these shops has a space of 922 sq.ft. per locomotive built.

The shops for tracksmiths, tools, replaced tires and store of spare parts occupy the left part of the building, opposite the previous shops, and have a total area of 13,000 sq.ft., distributed as follows:

	Sq.Ft.
Tracksmiths and tinsmiths.....	5,260
Tools	900
Replaced tires	1,740
Store of spares.....	5,600
Total	13,500

In the tracksmiths' and tinner's shop, besides the shears and roller for plates already mentioned, there is a machine for making screws and rivets up to $1\frac{1}{4}$ in., a furnace, sand-blast apparatus and the necessary forges. In the tool crib all the tools of the shops are kept on shelves. There are also grindstones, emery wheels and other apparatus for putting them in condition.

DISTRIBUTION OF SHOP AREA

The tire shop has two furnaces for heating the tires and a tank for cooling, all three being served by a jib crane driven by an electric motor of 3 hp. A track and turntables provide for the easy transportation of the tires from the storehouse to the lathe that turns them. These also handle them to the furnaces, where they are put on the wheels, and finally to the wheel lathes or outside, as the case may be.

The following is the distribution of area of the various shops in percentage:

	Sq. Ft.	Per Cent.
Fitting shop	12,340	19.0
Adjusters' shop	5,900	9.1
Mechanics' shop	16,300	25.2
Boiler makers and tracksmiths	16,200	25.0
Blacksmiths	11,450	17.6
Replaced tires	1,750	2.7
Tools	900	1.4
Total	64,840	100.0

DETAILS OF THE FOUNDRY

The foundry is in two sections and has a capacity of producing 500 tons of iron and 80 tons of brass per year. It is located in its own building, independent of the others. This is constructed of brick, covered with French tile, and has an area of 5,600 sq. ft.

Along the larger section of the building runs a swing crane of 5 tons' capacity, for moving the ladles of molten iron for the heavy molds and large pieces made in this shop. The foundry contains:

- 4 furnaces for brass, two being for crucibles of 265 lb. and two for 220 lb.
- 2 Roots blowers.
- 1 sand mill.
- 1 grinder for dressing casting.
- 1 electric motor of 25 hp., which drives the various machines.

At the side of the foundry is the pattern makers' shop with all equipment required. Following is the store-room for models, where the latter are carefully arranged and numbered, so that they may be found easily when wanted.

The roundhouse is situated behind the shops, its center being in the axis of the principal building. When completed, it will represent a complete circle with a diameter of 292 ft., divided into 25 sections. All will be provided with cleaning pits for the machines and tenders about 50 ft. long; two of the sections will be reserved for entrances. At present only half of the roundhouse, with capacity for 26 locomotives, is completed, this being the average number in Campinas during the night at the period of least traffic.

The total area covered by the various buildings of the shops and their annexes is divided among them in the following proportion:

	Sq. Ft.	Per Cent.
Section for locomotives	70,530	36.3
Section for car and wagons	75,680	38.9
Power house	4,645	2.4
Foundry	5,900	2.9
Office and counting house	16,875	8.7
Roundhouse	20,960	10.8
Total	194,590	100.0

Sectional Vise of Special Design for High Work

BY MARTIN H. BALL

In Fig. 1 is shown a vise made in sections. It was designed principally for use on millers, to hold pieces too large to be held in the usual vise, but of such form that their size hindered their being held in an ordinary vise.

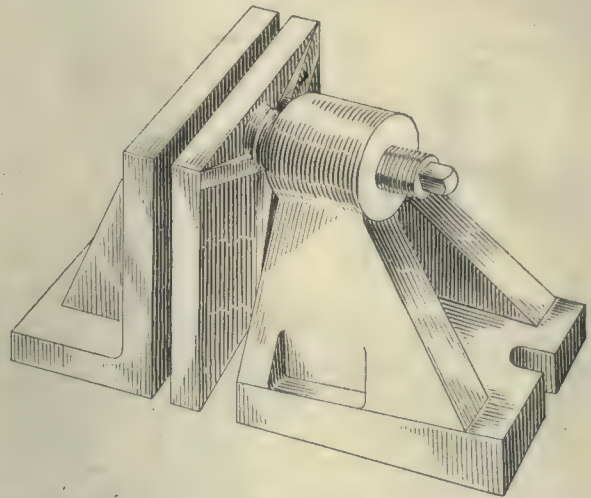


FIG. 1. VISE MADE IN SECTIONS TO BE ESPECIALLY ADAPTED FOR HIGH WORK

There were too few pieces to warrant the expenditure for a special fixture.

The stationary jaw is kept in alignment with the table by means of a key fitted to its base and to the table. The locating of the work is done entirely with this jaw, as it would be in using an angle plate. The stand, which contains the nut and screw, and the movable jaw serve

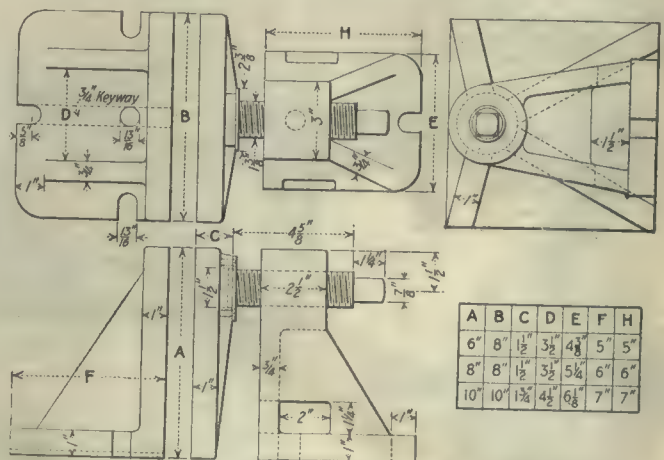


FIG. 2. DETAILS AND DIMENSIONS OF SECTIONAL VISE PARTS

only as a means to bind the work to the stationary jaw. The movable jaw can be set at an angle, or blocking or wedges can be introduced between the work and the movable jaw to allow its face to conform to the bearing presented to it by the work. In Fig. 2 are given the details of the various sections and the necessary dimensions to permit duplication.

A vise of this type has been found extremely handy for holding a number of pieces of thin rolled flat steel, as was discovered in putting through a large amount of this work in planing gages.

Jigs Used on Machine Tools

By ROBERT MAWSON

SYNOPSIS—Some jigs and fixtures employed in the manufacture of elements used on vertical millers are shown and production data are presented.

In this article are illustrated some further tools used by the Becker Milling Machine Co., Hyde Park, Mass., in the production of its line of vertical millers.

The output effected by these jigs has proved satisfactory both in the quality of the work and in the time required.

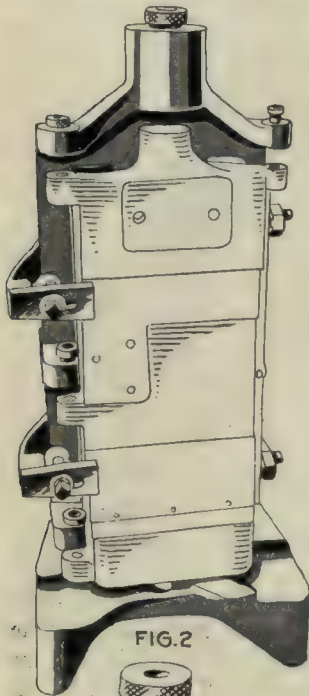


FIG. 2

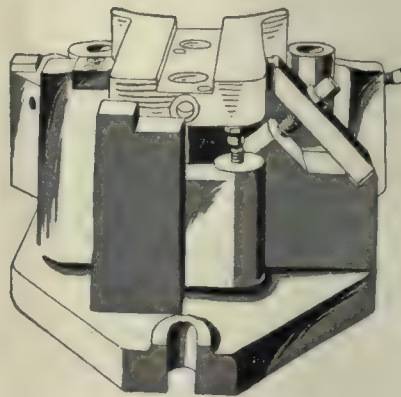


FIG. 4

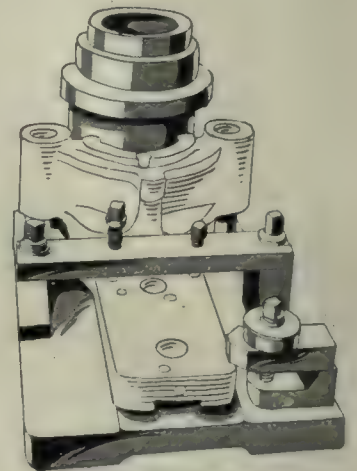


FIG. 5

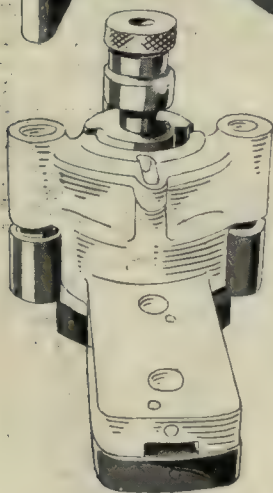


FIG. 6

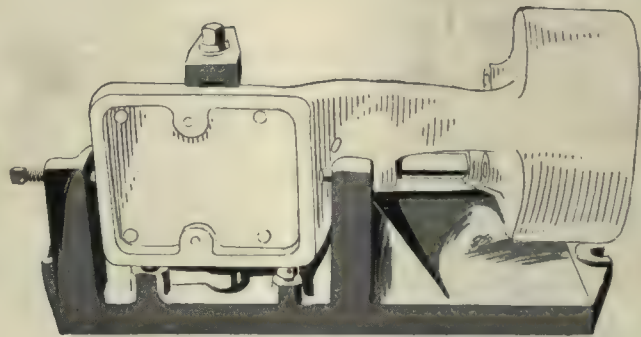


FIG. 8

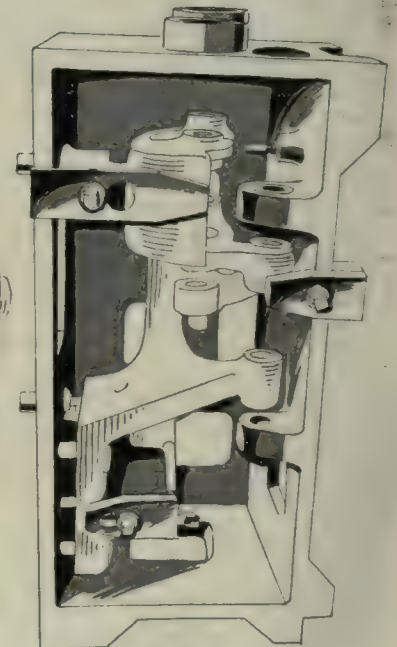


FIG. 9

JIGS USED IN MANUFACTURING MACHINE TOOLS

FIGS. 2 AND 2-A

Operation—Drilling carriage, Fig. 1. The milled casting is placed in the jig, being located on finished surfaces.

Holes Machined—One 1 3/4-in. spot drilled and reamed; one 1 1/2-in. drilled; two 1 1/8-in. drilled; one 1 1/4-in. drilled; one 7/16-in. drilled, afterward being reamed to 3/4 in.; one 5/16-in. drilled; one 3/8-in. drilled for 7/8 in.; 14 tap, one 7/8-in. drilled and one 1 1/8-in. drilled.

FIGS. 4 AND 4-A

Operation—Milling auxiliary bearing, Fig. 3. The rough casting is placed on height pins and forced against a steel locating plate with a strap.

Surface Machined—Base, using a 4-in. cutter operating at 170 r.p.m. with a feed of 0.06 in. per revolution.

FIGS. 5 AND 5-A

Operation—Boring auxiliary bearing, Fig. 3. The casting is located on pins that fit into holes which have previously been machined.

FIGS. 6 AND 6-A

Operation—Babbitting auxiliary bearing, Fig. 3. The casting is located on two pins that fit into previously machined holes and against a milled shoulder on the center stud.

FIGS. 8 AND 8-A

Operation—Milling feed bracket, Fig. 7. The casting is placed on poppet screws that are set to hold the piece at the correct height. A bar is placed through a reamed hole to bring the piece in correct alignment. Straps are then tightened on the casting to hold it in position.

Surface Machined—Base, using an 8-in. cutter operating at 38 r.p.m. with a feed of 0.13 in. per revolution.

FIGS. 9 AND 9-A

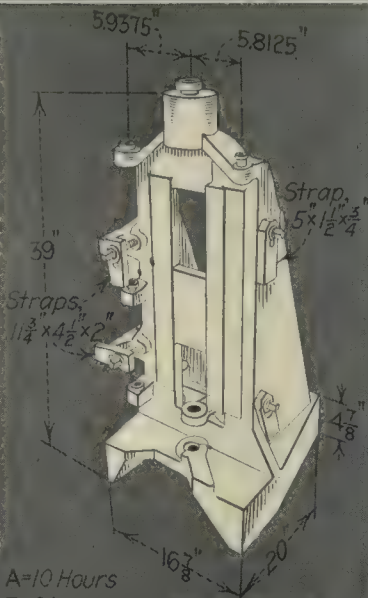
Operation—Drilling feed bracket, Fig. 7. The rough casting is placed on height pins and held in position with straps as shown.

Holes Machined—Four 5/16-in. drilled; two 3/8-in. drilled; two 1 1/4-in. reamed; two 1-in. reamed and two 1 3/8-in. reamed.



CARRIAGE

FIG 1



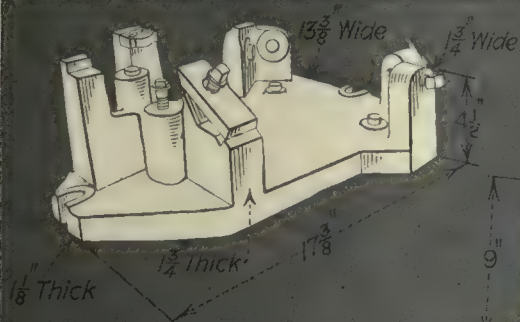
A=10 Hours
B=20 Hours

FIG 2-A



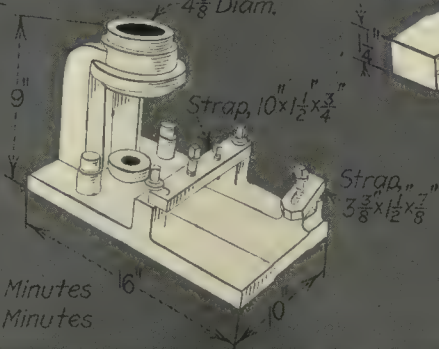
AUXILIARY BEARING

FIG 3



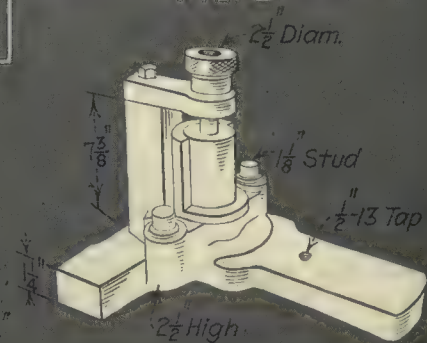
A=1 Hour
B=1/2 Hour

FIG 4-A



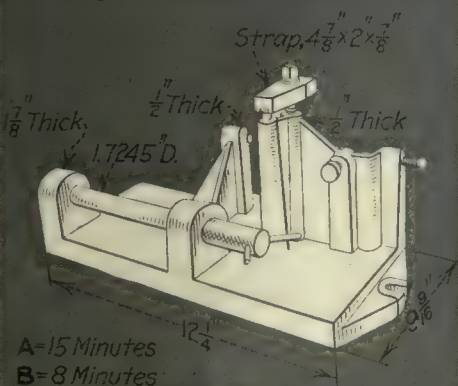
A=30 Minutes
B=20 Minutes

FIG 5-A



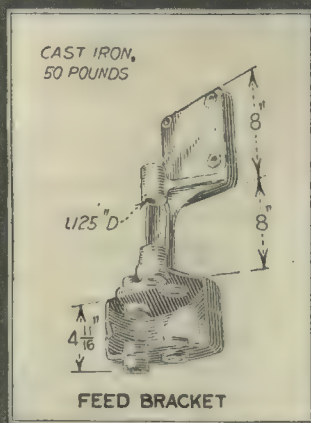
TIME OF OPERATION.
6 MINUTES

FIG 6-A



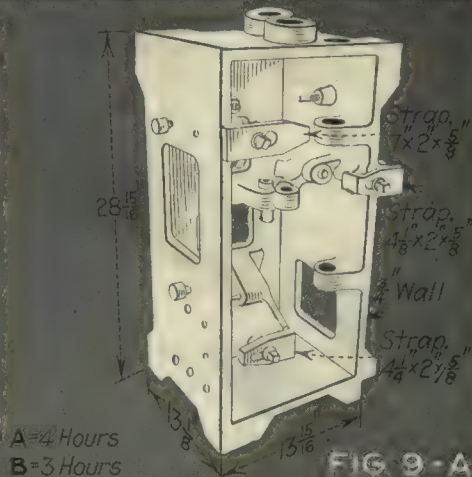
A=15 Minutes
B=8 Minutes

FIG 8-A



FEED BRACKET

FIG 7



A=4 Hours
B=3 Hours

FIG 9-A

A=TIME REQUIRED FOR OPERATION WHEN
NO SPECIAL TOOLS WERE USED

B=TIME REQUIRED FOR OPERATION WHEN
TOOL DESCRIBED IS USED

ALL BUSHINGS USED FOR GUIDING TOOLS ARE BLACKENED. ALL JIG AND FIXTURE BODIES ARE CAST IRON, STRAPS AND FASTENINGS, MACHINERY STEEL; GUIDE BUSHINGS ARE TOOL STEEL, HARDENED AND GROUND

A Few Jigs of Universal Character

By A. E. DEKUZELEWSKI

The increased demand for machine tools, especially lathes, has changed conditions in the tool-manufacturing plant in regard to tool and jig equipment. In some plants, where no jigs at all were used for years and the work was done by laying out, one now can notice how elaborate labor-saving appliances are being built and used.

Among the jigs built recently at the plant of the R. K. LeBlond Machine Tool Co., there are a few that

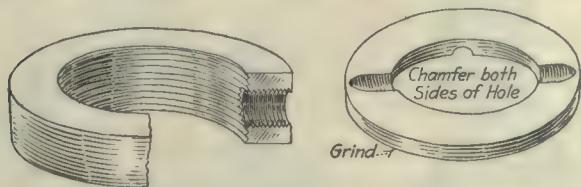


FIG. 1

FIG. 4

Fig. 1—Collar to be drilled. Fig. 4—Thrust collar with milled oil grooves

particularly command attention because of the fact that they are used on jobs hardly ever jigged before in a similar way.

It has been a source of constant argument among designers of jigs whether it was possible to construct a universal jig to perform machining operations on a number of details of the same shape, the sizes being different. As a rule the answer was negative—a universal jig was too much of an intricate mechanism to insure accuracy, and as a rule would be too expensive and difficult to adjust. While this is true in most cases, there are certain operations where the contrary can be proved. I will show this by describing a few jigs that were designed and built recently.

A JIG FOR DRILLING COLLARS

About fifty different sizes of collars, made of cast iron, as shown in Fig. 1, were to be drilled. The outside diameter, inside thread and width are variable. Holes were drilled and tapped for the setscrew as well as two holes for the spanner wrench (placed at an angle of 120 deg. from the setscrew hole and not shown on drawing) which remain the same.

For performing the drilling and tapping operations the jig shown in Fig. 2 was used. The jig consists of a standard 10-in. universal chuck mounted suitably on a solid angle plate so that it can revolve. The band *A* locks the chuck in one of the three positions corresponding to the holes to be drilled in the collar. The jaws of the chuck project but a fraction of an inch over the face of the chuck and have three recesses.

Block *B*, which is bored to receive the drill bushing, fits into one of these recesses. Then by fastening the block with the bushing into the next recess the jig will take a collar of a larger diameter. Back of the collar to be drilled is a spider with three arms which has a motion on the center line of the chuck and is adjusted by means of a screw from the back of the jig. This spider regulates the distance between the drilled hole and the face of the collar by changing the drill bushing, which is removable. It is also possible to drill holes of different sizes.

This jig has been giving satisfaction and takes care of large quantities of about fifty different sizes of collars, some as large as 6 in. in outside diameter, and leaves little opportunity for improvement.

GEAR-BLANK DRILLING JIG

The jig for drilling the gear blank is shown in Fig. 3. These blanks come in different sizes from 5 in. up to 10 in. in outside diameter, about twelve different sizes in all. The jig consists of a universal three-jawed scroll chuck mounted on a heavy base plate *A*. The jig plate proper *B* swings on the center of the right-hand supporting column in order to facilitate the loading of the gear blank. The swinging of a jig plate, containing a drill bushing, is as a matter of fact an objectionable feature. This has been overcome by arranging the screw *C* to fit into a conical recess when the jig plate is in the right relation to the center of the chuck. The design is made to lock the chuck $\frac{1}{8}$ in. away from center, the result being that the conical end would invariably drive it back home.

It will be noticed that the jig plate has six bushings, to accommodate both small and large blanks.

A FIXTURE FOR MILLING OIL GROOVE IN THRUST COLLARS

The last example shown is a fixture for milling oil grooves in thrust collars. The thrust collars, Fig. 4, come in various sizes from $1\frac{3}{4}$ up to 6 in. in outside diameter. Each collar has two grooves on each side, which are not supposed to run out but stop about $\frac{1}{16}$ in.

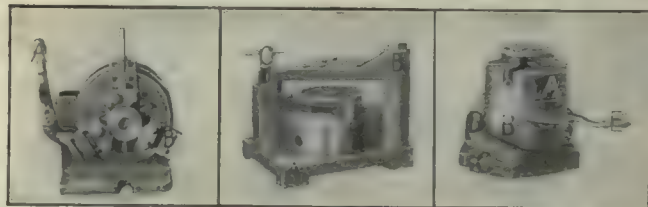


FIG. 2

FIG. 3

FIG. 4

Fig. 2—Jig used for the collars. Fig. 3—Jig for gear blanks. Fig. 4—Universal three-jawed chuck

from the outside edge. The depth of the grooves should also be maintained closely because of the small width of the collar. In order to avoid the raising and lowering of the milling-machine table the bottom of the groove runs at an angle to the face.

A universal three-jawed chuck, Fig. 5, is mounted on a base *B* which can be adjusted to any angle smaller than 20 deg. in relation to the base plate *C* which is fastened to the milling-machine table. At *D* is shown the end of a groove which forms the part of a circle; a screw fitted in this groove securely clamps the upper base with the chuck at any desired angle; the handle *E* locks the chuck in four positions. The thrust collar shown is being held by the inside, which is not always the case; the small collars are being held by the outside, the jaws being reversible. After the collar is chucked, the table is advanced and the milling cutter passes the first half of the collar and cuts into the second up to a stop. The table is then run back and, indexing around 180 deg., is started again.

By using this method the groove is machined without raising or lowering the table.

Storekeeping in the Remington Typewriter Plants

By L. P. ALFORD

SYNOPSIS—The principles, a little of the philosophy, and some of the rules of the storekeeping system now in use in the plants of the Remington Typewriter Co. These methods have been put into force during the installation of scientific management, and with the counsel and advice of H. L. Gantt.

The article beginning on p. 457 briefly sketched the results of the installation of scientific management in the four principal plants of the Remington Typewriter Co. and outlined the attitude of the management of the company toward the employees. In order to show the reasons for some of the work that has been done and

ORDER NO.		SYMBOL	
		S	
DESCRIPTION			
LOCATION A		S	
REQ. NO.	DATE DUE		AMT. ORDERED
AS-4		ORDER TAG	

FIG. 1. FORM OF ORDER TAG

the principles that govern the important features of the system as now installed and in use, this article and two others that will follow will take up storekeeping, time-keeping, labor and production control, and task-and-bonus work. This one will be devoted to storekeeping, and, as outlined in the previously mentioned article, but few details will be shown. On the contrary, the practical reasons for and principles of storekeeping will be given.

THE PRIME FUNCTIONS OF STOREKEEPING

Mr. Gantt puts the four prime functions of storekeeping as follows:

1. To have on hand, when wanted, all material needed.
2. To see that all material not needed is disposed of.
3. To safeguard all materials not issued to some special order.
4. To keep in the manufacturing office an exact balance of material on hand and on order.

These functions are so plainly stated that when read they almost seem obvious; for that very reason there is a danger that the practical truths behind them may not be seen by the reader. To understand what carrying out these functions means in the Remington plants (or might mean in any machine-building plant), one must appreciate the losses, wastes and delays that they prevent. Many important things are accomplished if the storekeeping system functions as it should; that is, if it does what it is expected to do.

Each one of these storekeeping functions is founded on wisdom of the most practical sort. It used to be

common to speak of far-sighted, careful, planning men as "forehanded." The first storekeeping function is the function of forehandedness. If properly carried out, it eliminates the costly delays that come from a lack of materials, supplies and tools.

FIRST FUNCTION—TO HAVE WHAT IS WANTED WHEN IT IS WANTED

No one can quarrel with the plain statement that if work is to go forward in an orderly, expeditious manner, everything needed to do it must be on hand as soon as it is wanted. If work is to be started on a lot of castings at 7 a.m. on the fifteenth of the month, those castings must be on hand on that day and at that hour. If a machine must be shipped at noon on Saturday, and if it takes two days to set it up, the parts must be ready for the erecting man by noon on Thursday. If a lot of forgings are to be drilled on Wednesday, and if there is a $17/64$ -in. hole so located that an extension drill is needed for the job, that drill must be procured and be ready for use when Wednesday comes. If a lot of machines are to be boxed for foreign shipment during Tuesday afternoon in order to catch a freight shipment and be in New York City for a steamer sailing on Saturday of the same week, the packing boxes, tarred paper for their lining and slushing compounds for the bright parts must all be on hand and ready when the shipping-room crew starts at work after dinner on Tuesday. Such things are just homely truths.

The work of having all these things on hand and ready when wanted is the first function of the storekeeping department. If it is not performed in a proper manner, the jobs in the shop cannot be started when they should be for lack of material or tools or supplies; machines cannot be set up for shipment to meet promised date of delivery; and efforts will be made to get stuff in a hurry, taking executive time and force, piling up extra charges for telegrams and tracers, express instead of freight bills and through it all a feeling of confusion, helplessness and loss of control. There is a common, oft-repeated saying, "A bird in the hand is worth two in the bush." This can be paraphrased for the shop by saying, "When wanted, a carload of steel in the store-room is worth a dozen on the road; and a dozen castings in stock are worth a hundred in the other fellow's foundry."

The evil results of not having parts on hand when needed for assembling show up perhaps more monstrously than any others. What does a manager think of himself and his own methods if an important machine is held up in the erecting shop because some petty two- or three-cent pin or screw or washer or nut is not on hand. Such an incident ought to produce more hard thinking than it does. To picture the dire consequences that may flow from such little lacks, one has but to recall the tragedy in the old proverb which says, "For want of a nail the shoe was lost; for want of a shoe the horse was lost;" and then goes on to tell of the loss of the messenger, the battle and finally the nation.

The wisdom of this first function of storekeeping comes from the practical side of things. Plan your work so that you will have on hand when you want it all the material that you need.

SECOND FUNCTION—DISPOSAL OF UNNEEDED MATERIAL

If you have on hand any material that is not needed, the time to dispose of it is at once. In all probability it will never be worth any more than it is at the moment when you find out that you do not want it.

There is a thrifty Scotch saying to the effect, "Keep a thing seven years and you will find use for it." The length of time mentioned in this wise saw is pretty long—seven years. Storekeeping, like all other work, costs money. Storage is an expense. The principle of economy is to free the shop of every bit of material that is not needed, as soon as its condition is known. Machines and machine parts depreciate in value more rapidly from obsolescence than from anything else. It is a more bitter enemy of value than rust and corrosion. It may act swiftly—as overnight. So the only way to gain the greatest degree of economy is not to wait for the effect of inevitable obsolescence, but to dispose of all unneeded material at once. This practice gets all the value possible out of depreciating material and aids in keeping down to a minimum the expenses and perplexities of storekeeping and storage. So there is a wealth of practical wisdom in this second function of storekeeping.

THIRD AND FOURTH FUNCTIONS—SAFEGUARDING MATERIALS AND KEEPING STORE BALANCE

The third function is merely that of locking the barn before the horse is stolen or strays away. Such safeguarding is more necessary as a check on waste than to stop pilfering. Mr. Gantt believes that the money lost through wastage of material in a machine shop that has no proper storekeeping system is greater in dollars and cents than the waste from idleness on the part of the workmen.

"Knowledge is power" is a general truth. "Knowledge gives control" is a shop-management truth. To be forehanded, to have material on hand when it is wanted, it is necessary to know at all times what is on hand and order far enough in advance so that there will be no shortage. To do this, someone must always know what is on hand and must receive due warning when any particular kind of material or supply is running low. The way this is done is by keeping a balance-of-stores record. This is merely a running inventory which shows the additions to and withdrawals from stock and gives a balance after every transaction.

This detail of the system is merely substituting an orderly procedure for something that otherwise would have to be done in a haphazard, confused manner. Of course, it is possible to send somebody into the shop, to chase around and try to find out just how much of any particular kind of material is in storage and to hope against hope that the report will be somewhere near the truth. But this far too common method has no element of accuracy or certainty. It is therefore nothing but a bit of practical wisdom to establish and maintain records that give an exact account of all materials on hand and on order. The fourth function of storekeeping—keeping exact balance of stores—must be performed, if the first is to be properly carried out.

As a further help in appreciating the importance of the storekeeping functions a few of the rules and instructions from the Remington plants will be given. These are not complete and are not presented here with the thought that by following them a perfect system of storekeeping will be developed, but merely to help in understanding the principles and reasons that have gone before. In order that the four prime storekeeping functions may be satisfactorily performed, the storekeeper must be made the custodian of all material not actually issued to the shop on order and must strictly observe the following rules:

RULES OF THE STOREKEEPING SYSTEM

Rule 1—Separation of orders—order tags: All material received on one order must be kept by itself and must be tagged with an order tag properly filled out. Fig. 1 gives the form of order tag.

Rule 2—Bin label: Each bin or receptacle holding material must bear a bin label properly filled out. See Fig. 2 for the form.

Rule 3—Physical separation of "order point." By order point is meant the minimum amount of material that will satisfy all needs during the period required to order and procure, or manufacture, a new lot. As soon as all but this minimum amount has been used a new order must be issued. The new lot is physically separated from the other lots and is never touched until

SYMBOL S			
NAME			
ORDER POINT	AMT. TO ORDER	TIME FOR DELIVERY	UNIT
BIN LABEL			

FIG. 2. FORM OF LABEL FOR MATERIAL BINS

all the others are gone. The requirement that all of an old lot must be issued before any can be taken from a new lot insures that the older pieces will always be used up and provides means to correct the balance cards at the end of every order.

Rule 4—Receipt and issue slips: A receipt slip designed to suit the needs must be sent to the balance-of-stores clerk by the storekeeper for all material received. An issue slip, Fig. 3, must be received by the storekeeper and sent to the balance-of-stores clerk for all material issued. When the last of a lot is issued, the order tag is sent in with the stores-issue slip. The check thus afforded enables the balance-of-stores clerk to check his cards frequently and insures that the inventory furnished by them is substantially correct. In fact, experience has proved that inventories taken from such cards are more accurate than any physical inventory.

Rule 5—"Ordered" signal: When the order point is reached, the storekeeper must place a requisition for a new lot and display the ordered signal (usually a red card) on the bin. If the material is delivered on a schedule and not carried in quantity in stores, the storekeeper will place a requisition when the amount still due has reached the order point. If for any reason an order is placed before the order point is reached,

the storekeeper on notification will display the ordered signal.

The general instructions for carrying out the four functions are as follows:

First Function—Procuring materials: If the material is of such a nature as may be advantageously purchased in manufacturing quantity and kept in stores for use, the order should be placed when the order point is reached. If, however, the material cannot be advantageously stored, but is preferably delivered at a rate corresponding to the rate of consumption, a new order is placed when the amount still to be delivered has fallen to the order point as shown on the balance-of-stores cards.

Second Function—Disposing of materials: At the time of taking an inventory the balance cards for any material which has not been used since the last inventory must be thrown out and the disposal of the material passed upon by the proper executives. By this means obsolete and questionable material is held down to a minimum quantity. Once a year all of the inactive material is considered by some competent authority and either sent back to stores, scrapped or otherwise disposed of.

Third Function—Accounting for material: To carry out this function it is only necessary to observe carefully

material on which no more work is to be done and which is ready for assembling or shipment. This kind of material is called stock.

The storeroom itself is provided with interchangeable bins of different sizes and movable racks for holding the bins. So far as possible all special racks and all other appliances for storing material are made removable and in interchangeable units.

As the order point is the minimum amount of material that may be needed while a new supply is being provided, it is necessary definitely to separate this quantity physically from all other material of the same kind. The separation may be accomplished in a number of different ways, of which the following are a few:

The amount constituting the order point may be contained in a small box, bag or envelope of a proper and convenient size, placed in and left at the rear of the bin until the remainder of the material in that bin has been issued. The container—box, bag or envelope—should be marked or indicated by a red signal.

When heavy or bulky material is stacked, a red dividing board is often conveniently placed above the order point and thus becomes the physical representation of that point.

When drill rods and stores of a like nature are kept in special racks, the quantity representing the order point is often conveniently banded or tied together with a red tape. This serves to separate it from the rest of the material of its kind, and it is not disturbed until the remainder of the material has been issued.

It is not difficult to devise other methods to suit special demands. A preceding article, printed on page 309, on the toolroom system of the Smith Premier Works of the Remington Typewriter Co. shows some of the devices used in the toolroom to bring about this physical separation of the material constituting the order point from the rest of its kind. Similar methods are used in the four Remington factories for all classes of stores, including raw materials, supplies, semifinished and finished parts.

SUPPLY STATIONS FOR SMALL STORES AND CLASSES OF STORAGE

It is often necessary to issue small stores, such as nails, screws and the like, in very small lots. The cost of making out store-issue cards and the clerical work connected with the keeping of proper records in such cases may be more than the value of the small stores issued. It is desirable, therefore, to have means for issuing such stores without doing the clerical work needed to keep balances and records, as in the case of larger pieces and more important stores.

The way this is accomplished is to have in each department a small rack that holds a limited quantity of each of the various small stores usually called for in that department. The stores in this rack may be given to the workmen without writing store-issue cards, the racks being replenished from time to time by drawing stores from the storeroom on store-issue cards and charging them directly to the proper expense account of that department. This rack is under the charge of the general storekeeper, who sees that its use is restricted to the purpose for which it was established and that it is not allowed to become a general means of issuing stores.

STORES SYMBOL			CHARGE TO ORDER NO.		
S					
QUANTITY	UNIT	TOTAL WEIGHT	UNIT VALUE	TOTAL VALUE	
		LBS.			
DESCRIPTION					
STOREKEEPER			MONTH	DAY	YEAR
A S					191
PLEASE ISSUE ABOVE TO _____					
AT _____ M. ON _____ 191					
SIGNED BY MAN TO WHOM STORES ARE ISSUED _____					
ENTERED IN			STORES DESCRIBED ABOVE HAVE BEEN ISSUED		
STORES TAG	BALANCE ACCT.	D. V.	COST ACCT.		
SIGNED BY GEN. STOREKEEPER OR HIS REPRESENTATIVE _____					
ASS			STORES ISSUE		

FIG. 3. FORM OF MATERIAL-ISSUE SLIP

the rules regarding receipts, issues and checking by means of the returned-order tag.

Fourth Function—Knowledge of material available: To carry out this function properly it is only necessary to perform the third function carefully.

CLASSIFICATION OF MATERIAL STORES—STOREROOM INDICATION OF ORDER POINTS

Material kept in the storeroom is of three general kinds—stores; worked materials; finished parts or finished machines. These may be defined as follows:

Stores are purchased materials or material on which the shop has done no work. Worked material is material on which some work has been done, but which is as yet unfinished. Finished parts or finished machines are

Pattern Making for Draftsmen

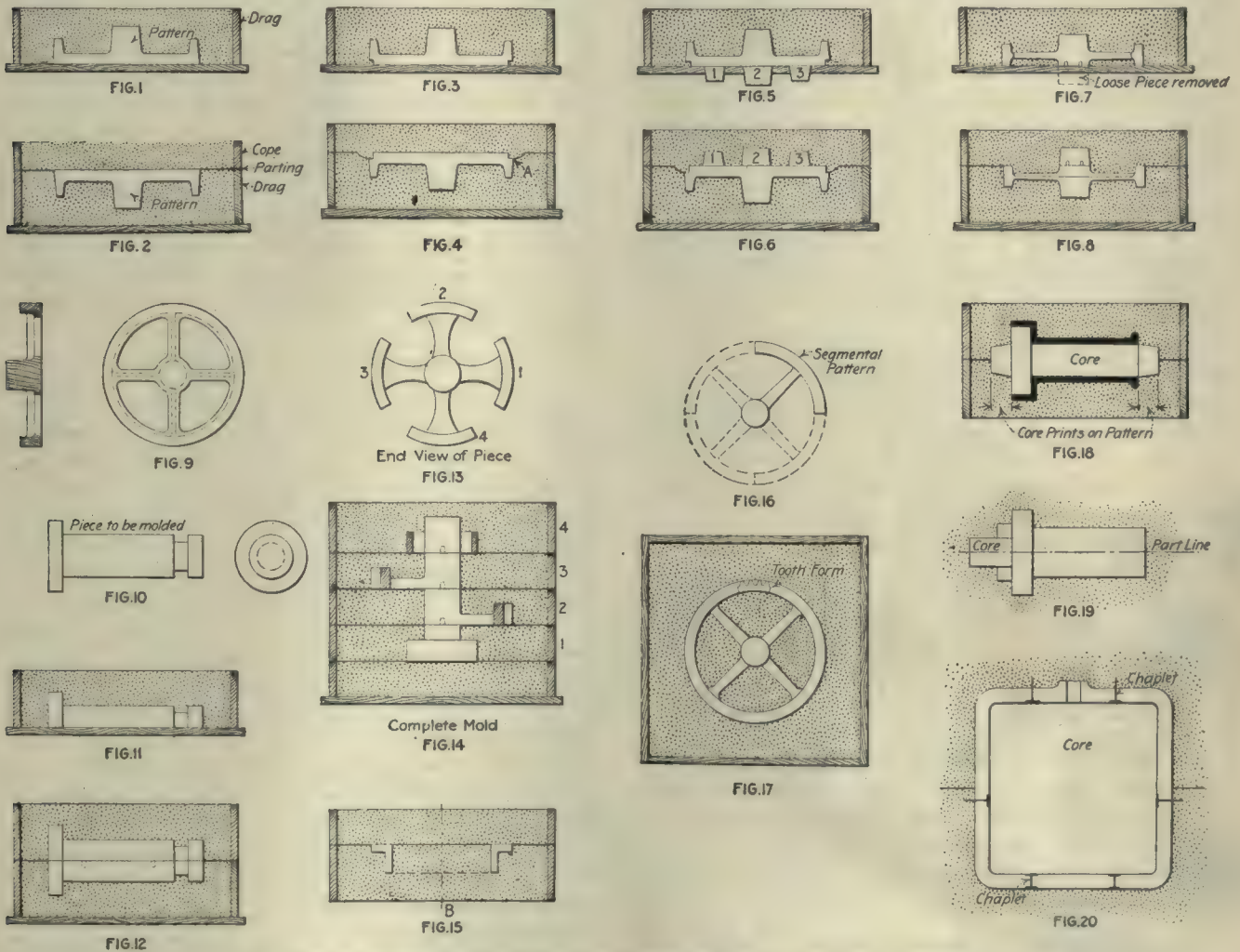
By A. SPALDING

SYNOPSIS—The intention of this article is not to prescribe hard and fast rules for pattern makers. The proper methods to be pursued can only be gained by actual pattern-making and foundry experience. The present purpose is to point out the general principles that, kept in mind, will be the means of avoiding complications.

Among the requirements an efficient draftsman should possess is a knowledge of the principles of pattern making, which, in turn, involves an understanding of the manner in which patterns are used and handled in the foundry.

at, if necessary, a sacrifice of metal. This may be done in the cases of iron and steel castings where, owing to the low metal cost, the addition of a few pounds of metal will be found a paying investment, compared with the extra expense which may otherwise be necessary in pattern making and molding. On the other hand in order to save metal, realize the desired lightness and facilitate machining, large quantities of castings may justify greater expense in pattern making and molding, for in such cases it is clearly seen that these points may then be of primary importance.

The foregoing remarks bring us to the conclusion that in order to design to the advantage of pattern shop,



EXAMPLES SHOWING THE BASIC PRINCIPLES OF PATTERN MAKING

Without such information a draftsman is certain to create unnecessary expense when his designs are reproduced in patterns and castings. On the other hand, an intelligent analysis of each piece to be cast, with due consideration for the number to be made, may result in a considerable saving in the cost of both pattern and molding.

The number of castings to be made from any given pattern plays an important part in the determination of the proper method to adopt. In other words, patterns made for a limited number of castings should favor a limitation of expense and simplification of the pattern

foundry and machine shop, the draftsman should have some idea of the quantity of pieces to be cast.

To begin with, it must be kept in mind that the pattern is used to form a mold in the sand or loam, and that this pattern must be so made that it can be removed without injury to the mold and leave a cavity which, on being filled with metal, will produce the desired form of casting.

To make clear the most common forms of molding we illustrate in Figs. 1 and 2 the simplest type of pattern and its application in the production of a mold. It will be noted that this pattern has no projections or bosses on

one side, thus eliminating the necessity for a two-piece pattern and permitting the molder to lay the pattern on the board and to fill in the drag or bottom half of the flask with sand, after which it is "rolled over" and the cope or top half of the flask is placed and filled with sand. The cope is then lifted off with its sand, thus exposing the pattern for rapping and drawing, after which the cope is replaced, leaving the impression of the pattern for the casting. No risers or vents are shown for pouring, as these are formed in the mold by the molder.

FUNCTIONS OF RAPPING

The rapping already spoken of is necessary in order to loosen the pattern in the mold so that it may be withdrawn without breaking away the sand. It can be seen that the more draft or taper on the pattern at right angles to the parting the less rapping will be necessary to draw. Excessive rapping is objectionable as it enlarges the mold and thus produces a casting with thick sections at right angles to the direction in which the rapping is done. This, of course, adds unnecessary weight, and in the event of machining will necessitate the removal of a greater amount of metal, thus proving the desirability of a draft. This case shows why a flat surface on the pattern is an advantage to the molder, for it permits him to ram the sand around the pattern without danger of tilting, and also facilitates parting the mold. This is subject to some modification, as shown in Figs. 3 and 4, where is illustrated a similar pattern showing a certain amount of undercut sand in the drag.

In an instance of this kind the molder cuts the part line down to *A* in order to remove the undercut sand and to permit the removal of the pattern from the mold, bringing out the point that the molder does not necessarily require a parting in one plane, although this is desirable as it eliminates some extra work in making the mold, which, however, need not be considered seriously.

Next in order is the pattern that requires what is called a match board, which is merely a molding board made especially for a certain pattern and having holes in which lugs or other projections on the pattern extend while the necessary part of the pattern is being molded in the drag. This case is illustrated in Figs. 5 and 6. While it is possible to avoid the use of a match board by making the bosses 1, 2, 3 loose and located on the pattern by dowels, this is often an objection when the pieces are small or numerous, and consequently likely to get lost. Moreover, loose pieces are often flimsy, where they have fillets or beveled edges. On the other hand, the reader may argue that the same procedure might be followed as illustrated in Fig. 4.

USES OF MATCH BOARDS

This is practical where the projections are so distributed as to afford a bearing for the pattern on the molding board, so that the pattern will not be tilted, thus distorting the mold when ramming the sand around the pattern. Even in such an event the pattern must be strong enough to prevent springing or breaking from ramming the sand, although this procedure involves extra work for the molder and is objectionable where large quantities of castings are to be made.

An example of loose pieces is shown by the wheel pattern in Fig. 7, where the hub extends beyond the rim, and the spokes are strong enough to stand the ramming

of the sand. It is assumed here that the arms are oval in section which, of course, necessitates dropping the part line to their center, as shown by the heavy line in Fig. 8. Here large quantities of castings might justify a split pattern, which will be explained later. A more simple pattern for the pattern maker and molder would be the one shown in Fig. 9.

Next comes the pattern that must be made in two pieces, or split, one-half of which is molded in the drag and the other half in the cope, as shown in Figs. 10, 11 and 12, which illustrate the piece to be molded and the first and second operations in molding. In order that the two parts of the pattern may match properly, the pattern maker provides dowels with which to accomplish this end. The two parts of the flask must also be furnished with proper means whereby the cope and drag may be properly registered after the pattern has been removed.

Patterns that cannot be parted in any direction to avoid undercut sand, which would be broken from the mold in removing the pattern, must be made in three or more pieces and molded in a multiple-part flask, the number of parts depending on the number of pieces into which it is necessary to divide the pattern. This class of molding requires special flasks to bring the partings at the proper point on the pattern and is to be avoided except where absolutely necessary, or when justified by the quantity of castings to be made, and where a material saving in machining operations may be effected. Figs. 13 and 14, which show a four-part flask, will serve to illustrate this case.

DISPENSING WITH THE PATTERN

Again, we have the sweep by which a mold may be made without a pattern, provided the piece is of uniform section. Circular pieces are most suitable for sweeps as the work can be done with less variation and greater ease than in other forms, since it affords the advantage of working from a fixed point, the center being possible. This case is illustrated in Fig. 15, where the sweep is merely a thin piece swung around the center *B* in the sand, thus sweeping a circular mold, after which the cope that has been rammed with sand and beveled is placed, completing the mold. This method is applicable only where a limited number of castings are required, as it involves greater skill and necessitates more work on the part of the molder, although it reduces the pattern work to a minimum. A modification of the sweep is sometimes used in molding gears with cast teeth. In this case a pattern may be used by which the hub, arms and rims are molded, after which a sweep with one or more teeth is stepped around the mold as the sand is rammed up, forming the tooth mold.

Some firms that make a business of casting special gears employ a machine which has the general appearance of a boring mill, by which the tooth form is stepped or indexed accurately around the periphery of the gear at the proper diameter, the molding being done on the table while the crossrail supports the tooth form. It is even possible to sweep the remainder of the gear, provided there are no spokes, in which event it is practicable to use a segmental pattern which molds one or more spokes and part of the rim and is then stepped around to the next space. This class of work is shown by Figs. 16 and 17.

Next is the part that requires care, owing to the cavities or undercut projections, which are impossible to mold

with loose-piece patterns. A core is a part of the mold that must be formed of sand, and it is usually reinforced with wires and rods and baked in a core oven to make it sufficiently strong to withstand handling and prevent erosion by the hot metal. Cores are made in so-called core boxes, the production of which is a part of the pattern maker's duty. The core box, usually made of pattern lumber is merely a box split for the removal of the core and has a cavity of a form that serves as a mold for the desired shape of core. In order to support the cores in the sand mold and locate them properly, so-called core prints are placed on the pattern, these being merely projections that form a cavity in the sand, by which the core is supported from the projections that match these cavities. The core prints are usually painted a distinguishing color so that the molder may be certain of their purpose and know that a core is required.

A mold with core in place is shown in Fig. 18. In Fig. 19 is shown a core used to mold undercut projections. A core for producing a cavity in a casting requires openings in the casting for the support of the core by projections which fit the cavities molded by the core prints, as already shown. Openings also are necessary for the removal of the core from the casting, the core being dug out of the casting.

For other reasons some parts are so designed that they cannot have openings so located that prints will afford means for sufficient support for the core to permit its accurate location. In these cases resort must be made to chaplets of varying form to suit the particular conditions to be met. Chaplets are metal pieces that are placed in the mold to support and locate the core and are necessarily cast into the casting when poured. However, they are of small section, and the heat of the molten metal forms a union making a satisfactory casting.

In Fig. 20 is illustrated the application of two forms of chaplets. By the use of loose pieces it is often possible to make one pattern serve for castings which, in general are similar, only varying in some detail. With this in mind it is often possible to avoid the expense of two complete patterns by so designing similar parts that one pattern, with the addition or the removal of certain elements, may serve for more than one casting. Small feet or other projections are to be avoided on comparatively heavy castings when they project a considerable distance, as there is greater danger of their being broken off in handling and machining, thus rendering an expensive casting useless. It is usually preferable, in case small projections of this nature are necessary, to make a separate casting to be attached after machining.

While the foregoing principles and suggestions are general practice, there are numerous exceptions and variations. For instance, a pattern may be of such thin section as to be impractical to split in the event of a small number of castings. Preliminary to molding the drag the molder must bed it in a pad of sand on the board. Where many castings are required, it may be necessary for the pattern maker to build up each half of such a pattern and fasten the two parts to a moulding board to secure strength, one half to be used for the drag and the other half for the cope.

The primary consideration for the draftsman is to design castings for the simplest possible form of molding and pattern making consistent with the other requirements.

It is generally desirable to avoid great variations in the thickness of sections in a casting, also to avoid thin high webs of sand in the mold, as they are likely to be broken in rapping and drawing the pattern. Standard sizes of fillets should be adhered to as closely as possible. Fillets for patterns are made of wood, leather, composition and metal. Reference to the local pattern shop for sizes carried in stock will avoid irregularities in this work. It is best to consult with the pattern-making and molding departments, if possible, when in doubt as to the advantageous possibilities of simplifying a casting. The draftsman should not feel that the necessity for such consultation is a reflection on his ability, for while he should have a general knowledge of the principles, there are so many ways and methods of treating different cases that it is oftentimes worse than useless to try to predetermine these subsequent operations.

Rolling a Steep Taper Thread

By F. E. Ross

The problem was to cut a coarse-pitch taper thread on the end of about 5,000 rods, $\frac{3}{8}$ in. in diameter, of iron, brass, cold-rolled steel, aluminum, etc. The threads were to screw into a porcelain knob, already made, which had threads varying considerably in size, pitch and taper.

This taper-thread business is one that has been camping on my trail for some time. It has bobbed up in a number of various forms, and in every case I have turned it down; but this time I decided to let it come on and do its worst.

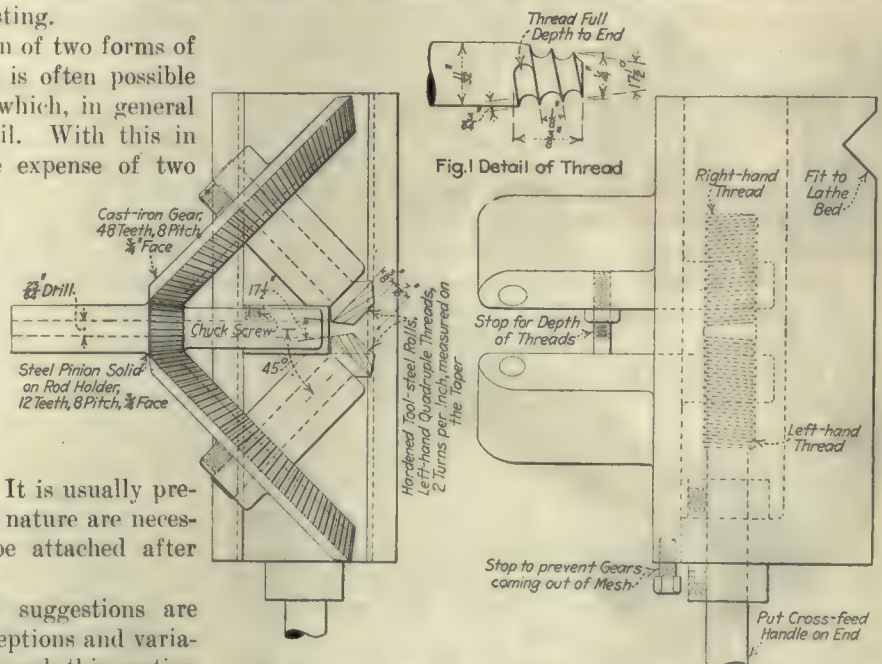


Fig. 2 Details of the Thread-Rolling Attachment

FIGS. 1 AND 2. THE THREAD AND DEVICE FOR ROLLING IT

After considerable experimenting the threading shown in Fig. 1 was found to be the only one that would give satisfaction in all cases. The thread is $\frac{3}{8}$ in. long and cut full depth to the very end. The taper is about $3\frac{3}{4}$ in. per ft., or an included angle of $17\frac{1}{2}$ deg. The pitch

is eight threads per inch, measured along the taper. The depth is $\frac{3}{64}$ in., with a large round in the bottom and practically a sharp thread at the top.

Previous to our taking the job two or three of our competitors had attempted to cut the threads with solid and split dies, but on account of the excessive taper every tooth in the die would take such large bites that the rods would almost invariably twist off. Furthermore, if

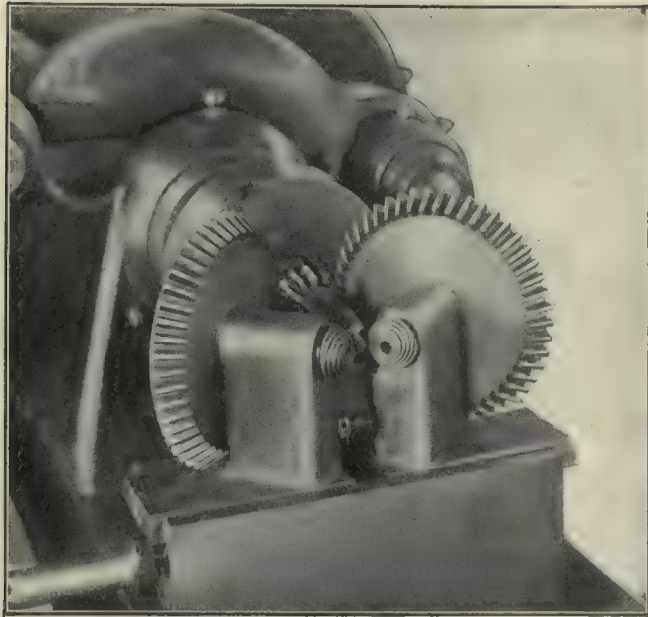


FIG. 3. ATTACHMENT WITH WORK IN PLACE

as to be almost negligible, the handling of the stock taking nearly all the time. The order was small and was done at odd times by a boy, so no attempt was made at a record production; but 200 an hour was easy.

The threads were all uniform in size, clean and slightly polished. Not much attention was given to the sizing of the blanks, so long as they were not too small. If they were a little large, the surplus stock would be

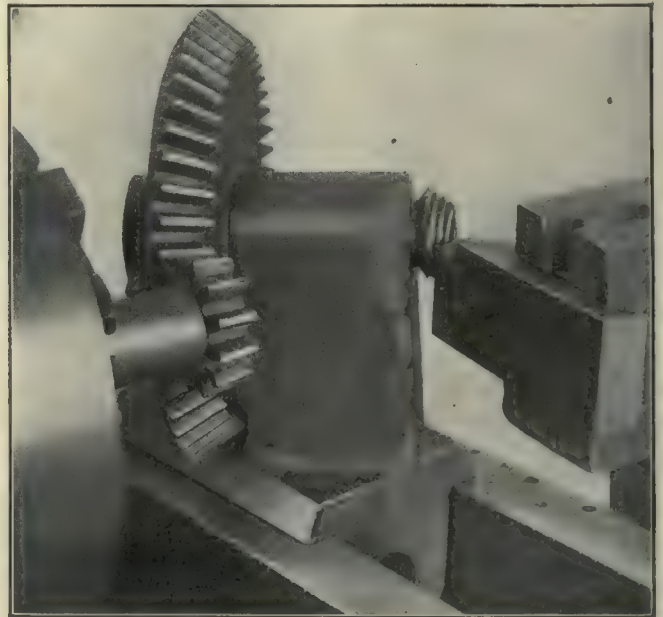


FIG. 4. THREADING THE ROLLS

with coaxing or juggling the die was run on the required distance, there would be a lump of metal left where each tooth stopped cutting. In fact, the only way seemed to be to cut the threads on an engine lathe, a slow, disagreeable job with such a coarse pitch and such small stock.

After giving the matter a little thought, we decided to roll the threads, using two conical rolls—one on each side of the blank—so that one would neutralize the thrust of the other and approximate as far as possible three cones rolling together. With this end in view the device illustrated in Figs. 2 and 3 was designed and made.

In making it nothing out of the ordinary was encountered until we came to cutting the taper quadruple thread on the tool-steel rolls. We had no taper attachment on any of the lathes in the shop, and it was entirely out of the question to set the tailstock over sufficiently. We easily overcame these difficulties by strapping to the lathe bed one of the slides with the roll and driving gear mounted on it. A 12-tooth pinion in the lathe chuck did the driving and gave the proper reduction. A four-toothed threading tool in the tool post and the lathe set for eight threads completed the arrangement, shown in Fig. 4. The lathe, of course, had to run reversed, but otherwise it was a straightaway job.

In assembling, it was only necessary to have the two rolls exactly register. The operation of the device was extremely simple. The rod, previously cut off and tapered at the end, was caught with the end projecting the required amount in a rod holder. The lathe was started, and the two rolls were forced into the rod until the slides were solidly up against the stop. The lathe was run at the fastest speed and the crossfeed handle turned as rapidly as possible. The actual rolling time was so small

squeezed out at the small end. In fact, the threads would roll to size without any tapering of the blank, but the first and second threads would be full of cracks, showing that the metal had been strained.

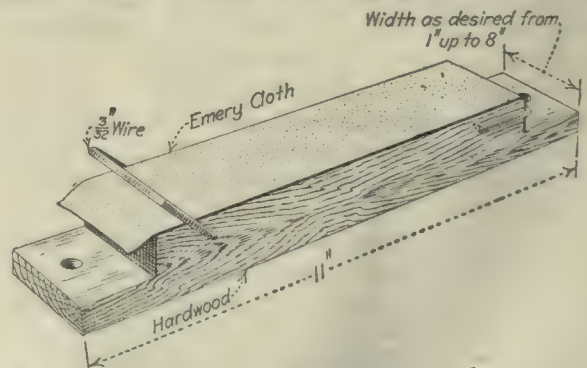
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Emery-Cloth Holder

By JOSEPH K. LONG

The accompanying illustration shows a handy method of holding emery cloth. The size will depend upon the work to be done, but it is simply a block of wood of about the dimensions given. In place of tacking the emery cloth to the block, it is fastened in place by a bent wire clamp.

The emery cloth should be about $1\frac{1}{2}$ in. longer than the top part of the block in order that the ends may be



BLOCK FOR HOLDING EMERY CLOTH

turned down and held in place. When the cloth is worn out, it is easy to remove it to put in a new piece.

Each end is extended $1\frac{1}{4}$ in. at the bottom, so it may be fastened to the work bench, if it is so desired.

Critical Speeds of Shafts

BY WILLIAM KNIGHT*

SYNOPSIS—A solution of the critical-speed problem that does not involve the layout of the deflection curve. The method is checked with three other accepted formulas by means of an example. The agreement is satisfactory.

The critical speed of a rotating shaft is generally calculated on the basis of the deflection produced by the static loads.

This method is not strictly correct because this critical speed is reached only when the centrifugal forces of the unbalanced masses on the shaft are large enough to counterbalance the elastic resisting forces of the shaft opposed to them. Under these conditions, instead of the deflection produced by the static loads, we should consider the deflection produced by the centrifugal force of the unbalanced masses. At the critical speed, the shaft is in indifferent equilibrium and any deflection curve could be assumed as being representative of the shape taken by the shaft at this stage of rotation, provided that the assumed deflection curve is well in accordance with the dimensions of the shaft and the way it is supported and loaded.

The more nearly the static deflection curve is similar to the actual deflection of the shaft at the critical speed, the more nearly correct is the method of determining the critical speed from the static deflection curve. Dr. Stodola in his book on "Steam Turbines" (second edition, page 135) and Dr. Loewenstein in "Centrifugal Pumps" (first edition, page 196) have treated this point in a clear and satisfactory way.

In general we might say that although the method of determining the critical speed of a shaft by making use of the static deflection curve is not strictly correct (except

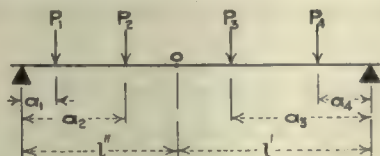


FIG. 1. DIAGRAM OF SHAFT LOADING

in the case of symmetrical shafts, symmetrically loaded with reference to the supports), in almost every case the results obtained are for every practical purpose close enough to the actual critical speed.

Professor Morley (*Engineering*, July 30, 1909), by assuming simple harmonic vibration throughout, concludes that the energy of a vibrating shaft is partly kinetic and partly strain energy. By equating the maximum strain energy to the maximum kinetic energy he derives the following formula for the lowest or fundamental critical speed:

$$N = \frac{30}{\pi} \sqrt{\frac{g \sum (P f)}{\sum (P f^2)}}$$

which, with the in.-lb.-sec. system, becomes:

$$N = 187.7 \sqrt{\frac{\sum (P f)}{\sum (P f^2)}} \quad (1)$$

where

N = Critical speed in revolutions per minute;

P = Static loads on the shaft in pounds;

f = Deflections at the loads in inches.

Formulas for obtaining the critical speed of a rotating shaft of uniform section under different conditions of loading and supporting have been published by Dr. S. Dunkerley (*Philosophical Transactions of the Royal Society*, June, 1894), by Professor Morley and by S. H. Weaver (*American Machinist*, Vol. 33, p. 61).

In all these formulas the critical speed is expressed as a function of the calculated deflection of the shaft under the influence of the static loads.

For shafts of variable section and with any distribution of loads, it is not easy to find in an analytical way the

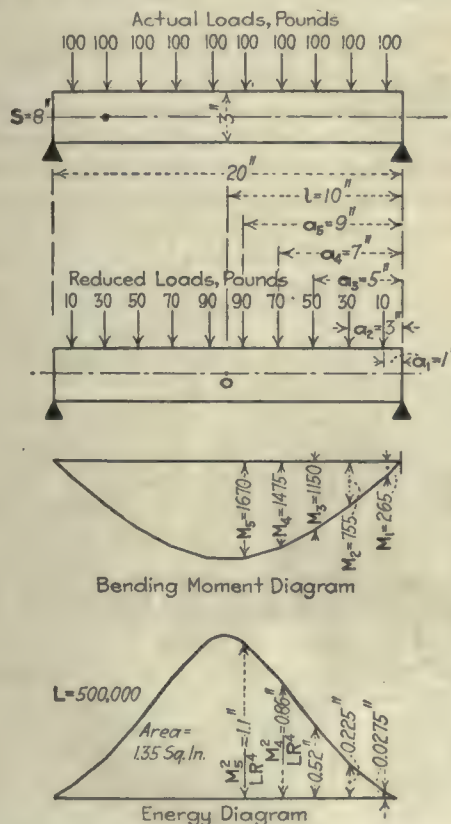


FIG. 2. ENERGY DIAGRAM FOR UNIFORM CONCENTRATED LOADS ON SHAFT OF UNIFORM SECTION

deflection, and in this case the problem must be solved graphically. Several methods have been given for determining the elastic curve assumed by a loaded shaft, and a very good illustration of one of them is given by A. Schein in the *American Machinist*, Vol. 37, p. 1027, and Vol. 38, p. 10. Having found the deflection of the shaft at any load, by applying formula (1) the critical speed can be obtained.

There are some cases in which the deflection of a shaft cannot easily be obtained and in these cases a method which did away with the layout of the deflection curve would be most desirable. In other cases also it could be used either as a direct means for obtaining the critical speed or as a check to the ordinary method.

*Engineering department, Crocker-Wheeler Co.

A fine solution of this problem is given by M. Delaporte (*Revue de Mécanique*, June, 1903). This method substitutes the calculation of the strain energy of a deflected shaft when statically loaded, to the calculation of the deflection curve.

Mr. Delaporte proves that if we have a shaft loaded with loads P_1, P_2, P_3, P_4 and a point O is chosen on the shaft such as to give a minimum value of (Fig. 1):

$$F = P_1 \left(\frac{a_1}{l_{11}} \right)^2 + P_2 \left(\frac{a_2}{l_{11}} \right)^2 + P_3 \left(\frac{a_3}{l_{11}} \right)^2 + P_4 \left(\frac{a_4}{l_{11}} \right)^2 \\ = \gamma P \left(\frac{a}{l} \right)^2 \quad (2)$$

the strain energy of the deflected shaft will be very nearly the same as if the loads:

$$P_1, P_2, P_3, P_4, \quad (3)$$

were substituted by the reduced loads:

$$P_1 \frac{a_1}{l}; P_2 \frac{a_2}{l}; P_3 \frac{a_3}{l}; P_4 \frac{a_4}{l} \quad (4)$$

The more nearly symmetrical the distribution of the loads, the more nearly equal is the energy of the elastic forces in both shafts. For all ordinary cases of distribution of loads on shafts of turbines and electrical rotors the difference is a negligible one.

If we call T the energy of the elastic forces on the shaft when the reduced loads (4) are considered as taking the place of the loads (3), the critical speed of the shaft loaded with the loads P_1, P_2, P_3, P_4 is given by:

$$N = 187.7 \sqrt{\frac{F}{2T}} \quad (5)$$

This is what Mr. Delaporte proves in his paper, and if we can calculate T we will have a new method of figuring the critical speed of a revolving shaft without first calculating the deflection curve.

It could be proved that in a deflected shaft, assuming that after the deflection has taken place every section perpendicular to the axis has remained a plane surface (quite a common assumption in elasticity), the total energy of the elastic forces in the shaft is:

$$T = \frac{2}{\pi E} \int \frac{M^2}{R^4} dl = \frac{1}{2E} \int \frac{M^2}{I} dl \quad (6)$$

where

E = Modulus of elasticity of the material of the shaft;

M = Bending moment at any point;

R = Radius at the same point where M is measured;

I = Moment of inertia of the section;

l = Length of the shaft.

This integration must be effected graphically, and substituting the value of T thus found in equation (5) the critical speed can be obtained without first laying out the deflection curve.

I will show as a practical illustration the simple case of a shaft of uniform section (Fig. 2) 3 in. in diameter and 20 in. long, supported at both ends and carrying ten concentrated loads of 100 lb. each, $S = 8$. Scale of drawing, 1 in. = 8.

First we find the point O where F —formula (2)—has a minimum value and we find that in this case the minimum value of F is obtained when the point O is taken at the center of the span.

We calculate the reduced loads $P \frac{a}{l}$ and substitute them for the actual loads P . With the reduced loads we lay

out the bending-moment diagram and find the value of the bending moment at each load.

Next we lay out the diagram for T . Starting from a horizontal base line, opposite to $M_1, M_2, M_3, \dots$, we plot in any convenient scale (in our case, $L = 500,000$) the values

$$\frac{M_1^2}{R^4}; \frac{M_2^2}{R^4}; \frac{M_3^2}{R^4}; \dots; \frac{M_{10}^2}{R^4}$$

where M and R are the bending moment and the radius at any particular section. In our case R is uniform throughout the length of the shaft.

Join the extremities of all the ordinates with a curve and, with a planimeter, measure the area A comprised

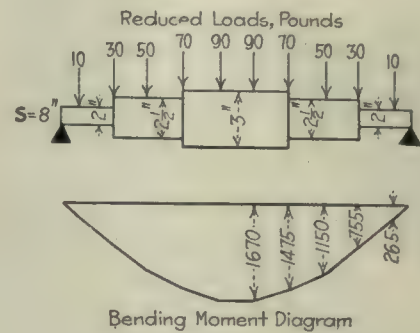


FIG. 3. ENERGY DIAGRAM FOR SHAFT OF VARIABLE SECTION

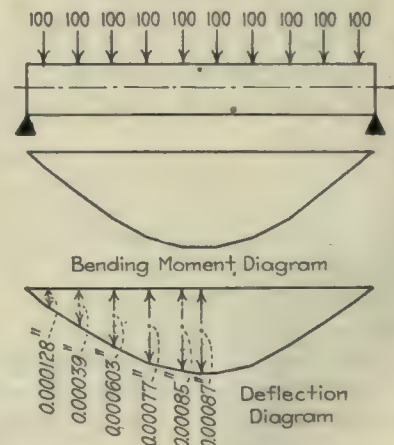


FIG. 4. DEFLECTION DIAGRAM FOR SHAFT OF FIG. 2

between the curve and the base line, in our case $A = 1.35$ sq.in. We will have:

$$\int \frac{M^2}{R^4} dl = 1.35 \times SL = 1.35 \times 8 \times 500,000 = 5,400,000$$

and taking the modulus of elasticity of the material of the shaft (assume steel) $E = 30,000,000$:

$$T = \frac{2}{\pi E} \int \frac{M^2}{R^4} dl = \frac{2 \times 5,400,000}{3.14 \times 30,000,000} = 0.114$$

The minimum value of F —formula (2)—referred to the point O is: $F = 330$.

Substituting in formula (5) the values of F and T just found we obtain the critical speed:

$$N = 187.7 \sqrt{\frac{330}{2 \times 0.114}} = 7,130 \text{ r.p.m.}$$

If the shaft instead of being of uniform section, as we have assumed, had been of variable section (see Fig. 3)

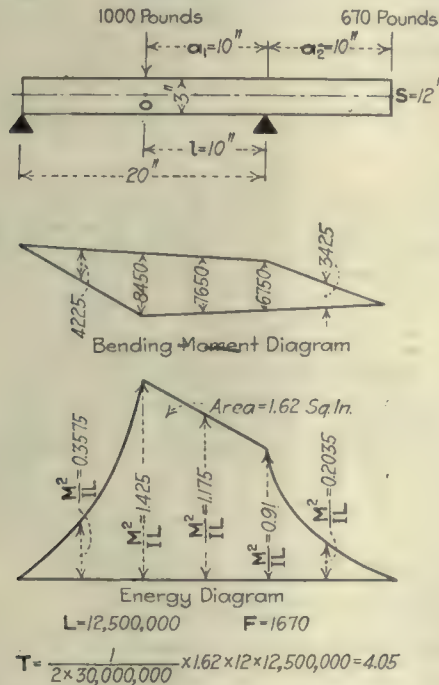


FIG. 5. ENERGY DIAGRAM FOR OVERHUNG LOADS

the bending-moment diagram would have remained the same and the T diagram would have changed as shown.

In order to check the results obtained, we will lay out the deflection diagram of this shaft, using the graphical method given by A. Schein (see Fig. 4) and figure the critical speed according to Morley—formula (1).

$$N = 187.7 \sqrt{\frac{\sum P f}{\sum P f^2}} = 187.7 \sqrt{\frac{0.5482}{0.000,369,2}} = 7,200 \text{ r.p.m.}$$

If instead we use the formula given by Dunkerley expressed in this more convenient form:

$$N = \frac{1}{\sqrt{\frac{1}{N_1^2} + \frac{1}{N_2^2} + \dots + \frac{1}{N_{10}^2}}} \quad (7)$$

where $N_1, N_2, N_3, \dots, N_{10}$ are the critical speeds of the shaft for each separate load, we have

$$N = 7,000 \text{ r.p.m.}$$

If we use the formula given by Weaver for a shaft subject to a uniformly distributed load we have:

$$N = 211.4 \sqrt{\frac{1}{f}} = 211.4 \sqrt{\frac{1}{0.000,87}} = 7,130 \text{ r.p.m.}$$

This shows a very good agreement of the new method that we have just outlined with the other well-known

methods of obtaining the critical speed from the static deflection curve.

In the same way the critical speed of a shaft carrying an overhung load can be calculated. Fig. 5 is the illustration of one simple case.

In using this method when laying out the bending moment diagram, always consider overhung loads as acting upward.

In this case the critical speed is found to be:

$$N = 2,690 \text{ r.p.m.}$$

As we have said before, this method cannot be expected to give accurate results if the distribution of the loads is unsymmetrical with reference to the supports. The case shown in Fig. 4 is a severe case of this nature which has been purposely chosen, in order to find the magnitude of the error.

Figuring the critical speed of this shaft by using Weaver's formula we obtain

$$N = 2,350 \text{ r.p.m.}$$

or about 12 per cent. difference.

SUGGESTION OF ANOTHER CRITICAL SPEED

Recent investigations on critical speed of shafts made by W. Kerr (*Engineering*, March, 1916) have given rise to a very interesting point.

According to Mr. Kerr, in a rotating shaft, at one time in the course of a revolution the force of gravity will act against the centrifugal force of an unbalanced mass while at another time it will act in the same direction and since the external forces on the shaft are counterbalanced by the elastic forces, a difference in deflection of the shaft will be found in the two cases. Therefore, the effect of gravity is of the nature of a forced vibration. According to Dr. Chree the period of natural frequency of a rotating shaft decreases with the increase of the speed. Then follows the possibility of having, at a particular speed, a rhythmically repeated disturbance equal in frequency to the reduced natural period of the shaft. This, and the fact that the inertia of the rotating masses raises the whirling speed and further reduces the natural frequency, will explain the possibility of having a new distinct critical speed when the effect of the gravitation is taken into consideration.

This new critical speed occurs at 0.71 of the ordinary critical speed and, although it is not so important as the one generally figured on, it is important enough if sufficient time is allowed to produce its effects and if heavy loads are carried on the shaft.

The point raised by Mr. Kerr gave rise to an extremely interesting discussion in which Dr. Stodola, Dr. Chree, Professor Morley, H. H. Jeffcott and others took part, and the conclusion was that although some were inclined to question the validity of the mathematical treatment of Mr. Kerr's theory, several cases of observed critical speeds at 0.71 of the calculated speed were reported by those who did not agree with Mr. Kerr's mathematics.



Metal Production in Japan shows a decided increase for the year 1915. Official figures now available show that the total value of the mineral output was \$87,711,075. This represents a gain of \$10,428,620 over 1914. The total value of metals produced amounted to \$17,811,405, or 57 per cent. above the previous year's figures. The increase in copper output was 7 per cent., and in value more than 37 per cent. over 1914. Antimony output increased 200 per cent., while the gain in value was 8,750 per cent.

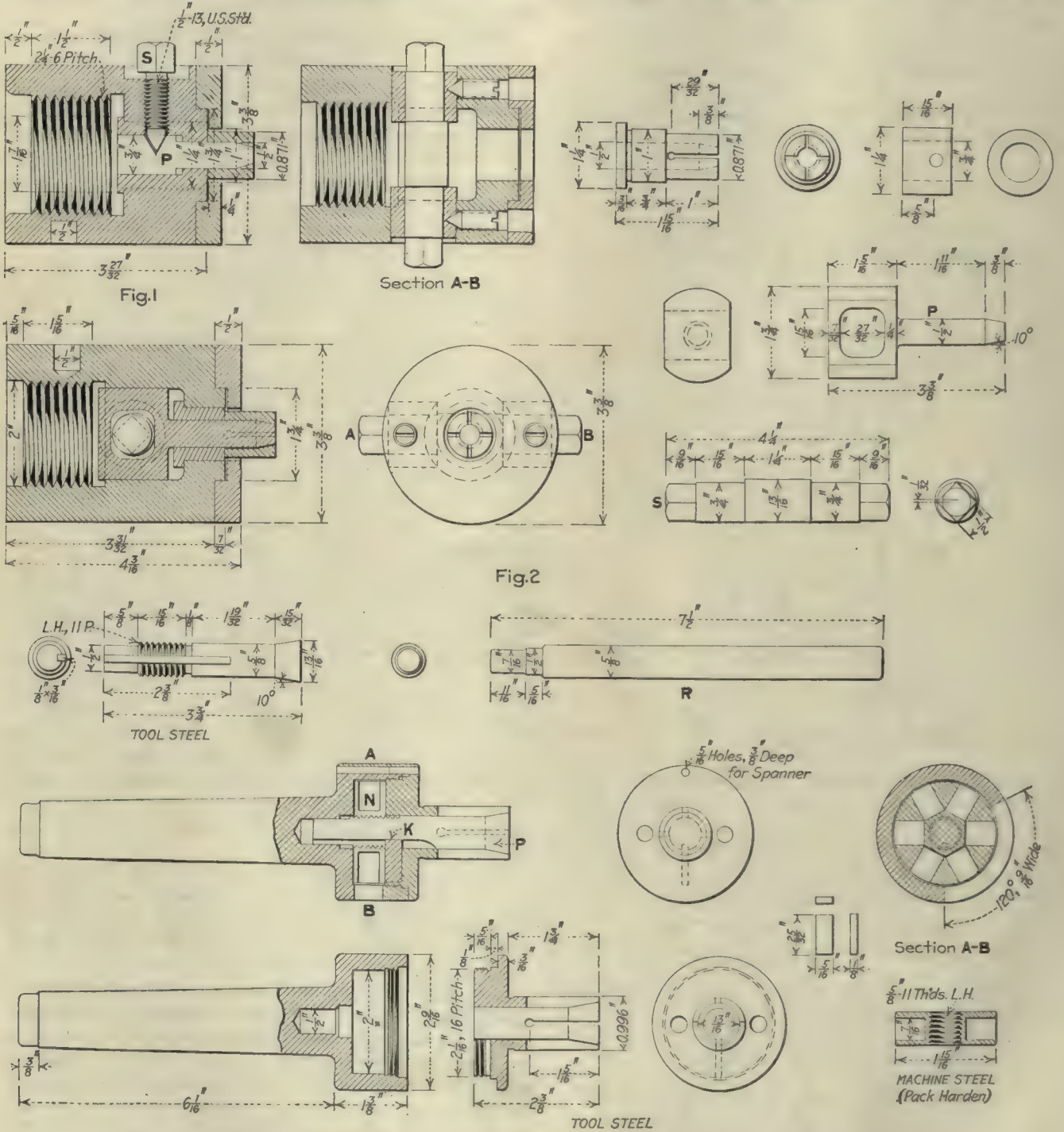
Expansion Arbors

By R. W. GREENE

Many styles of expansion arbors for use on lathes and milling machines have been developed to meet various needs, and it is probable that the three types illustrated herewith may prove useful to some of the readers.

The arbor shown in Fig. 2 is for use on a lathe and has proved very satisfactory and is better in principle than the one illustrated in Fig. 1. The plunger *P* is actuated by the eccentric shaft *S* and being well guided, allows no side strains on the part that expands.

The arbor shown in Fig. 3 is for use on a milling machine and is also very satisfactory. The plunger *P*



DETAILS OF SEVERAL TYPES OF EXPANSION ARBORS

The arbor shown in Fig. 1 is expanded by turning the pointed screw *S*, which in turn forces the plunger *P* into the taper hole. This type will answer for some purposes, but gives trouble, owing to the wearing and breaking of screw points and plungers. It is mechanically wrong, because the point of the screw can have a good bearing in the seat in the plunger in one position only.

is actuated by the nut *N*, which gives a direct pull and no side strain. The rod *R* is used to turn the nut and the plunger *P* is prevented from turning by the key *K*. An excellent feature embodied in all of these designs is that the parts that receive wear and are apt to break are easily replaced without in anyway affecting the body of the arbor.

Making Top and Bottom Rings for Time Fuses

BY FRED H. COLVIN

SYNOPSIS—The routing of the powder groove is one of the problems in the manufacture of this part of the fuse. Slight changes in cutter shapes affect results more than might be imagined. With incorrect shapes the chips clog in the groove and often break the cutter. This article describes three types of cutters and three kinds of machines used.

The top and bottom rings contain the mealed, slow-burning powder that forms the time element of the fuse, these rings being shown in detail in Figs. 1 and 2. As

them off after finishing as much as possible at one chucking.

Still another method saws them from the bar with a very thin circular milling cutter, and performs all the machining operations in external and internal spring chucks. The manufacturers who use this method claim it saves enough material to more than pay for any extra labor that may be necessary. It is one of the many cases where the hand screw machine has held its own against the automatic.

When the work is done on an automatic the rings are formed two at a time, as shown in Figs. 3 and 4. This

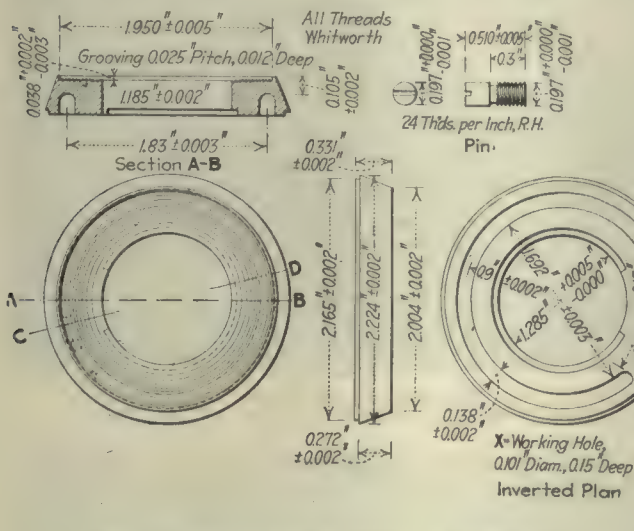


FIG. 1. DETAILS OF BOTTOM FUSE RINGS

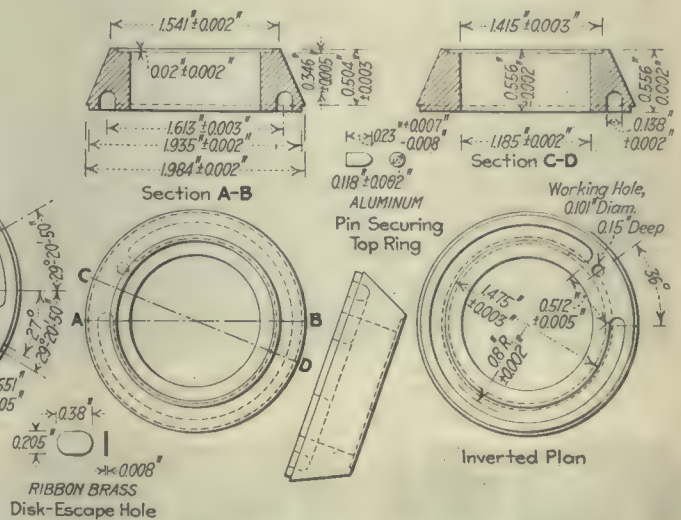


FIG. 2. DETAILS OF TOP FUSE RINGS

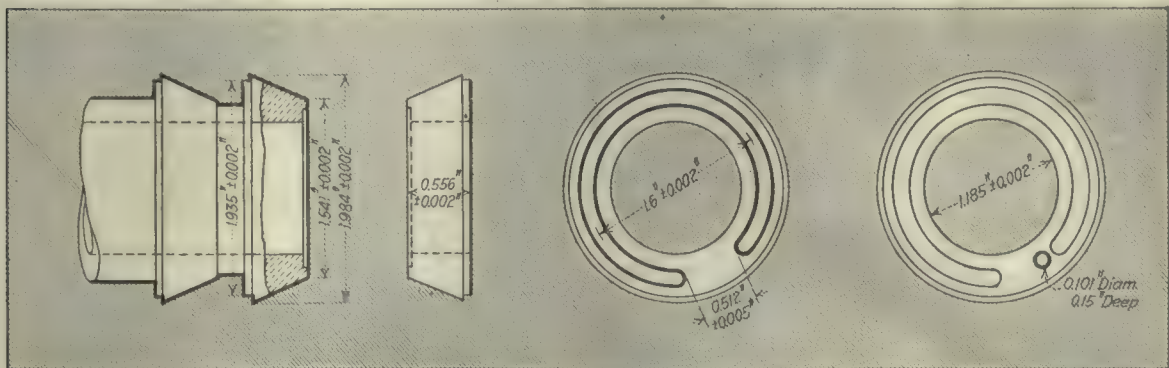


FIG. 3. SEQUENCE OF OPERATIONS

they are manufactured in the same way, they will be considered as one ring, dimensions for the tools and gages being given for both sizes.

The rings are made in various ways by different manufacturers. Some have tried stamping the rings from heavy sheet brass, which might in fact be almost called a forging process. One at least has tried forging the rings hot, with the powder grooves already in them, and has succeeded in making these within the required limit. The usual practice, however, seems to be to form them on the bar in an automatic screw machine and cut

is a roughing operation, so that close limits are not necessary, the rings being finished in a bench lathe, as shown in Fig. 5. Fig. 4 shows the double circular forming cutter, as well as the end of a formed bar. The rings are also bored and reamed, these tools being shown in the same figure. The circular serrating tool is shown, but in some places a flat tool has been substituted, as was shown in connection with the fuse body.

The rings then go to the bench lathe, shown in Fig. 5, where they are held on an expanding mandrel. The rings are faced off by the tool held in the small backrest,

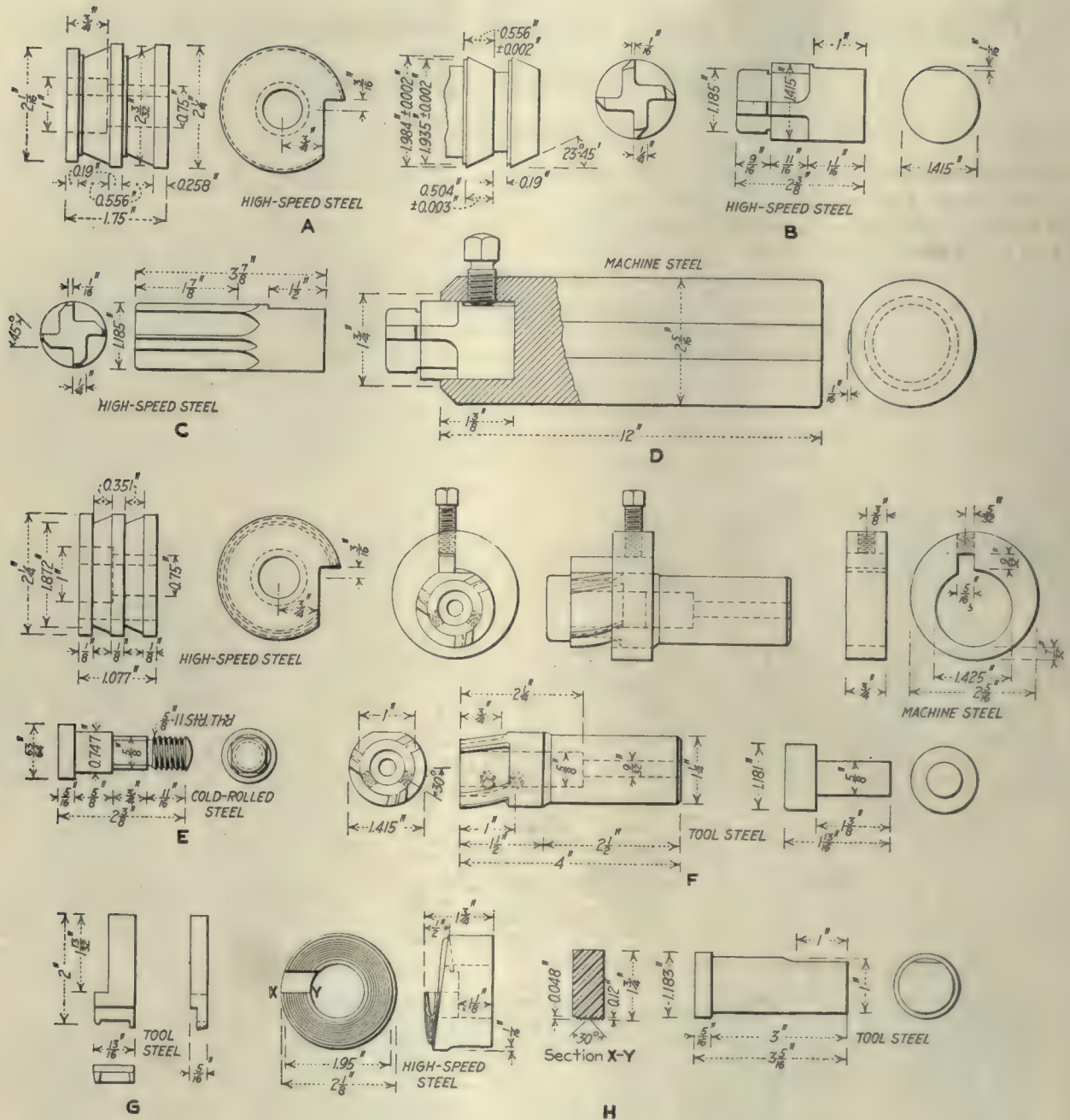


FIG. 4. CUTTERS USED IN FORMING OUTSIDE OF RINGS

A, form cutter; B, boring cutter; C, reamer; D, reamer holder; E, forming tool for bottom ring; F, boring and facing tool for top ring; G, facing tool for top and bottom ring; H, serrating tool for bottom ring

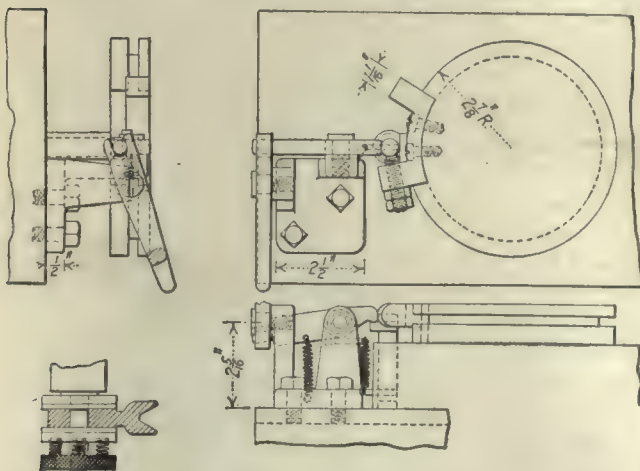


FIG. 7. DETAILS OF POWER-TABLE FEED

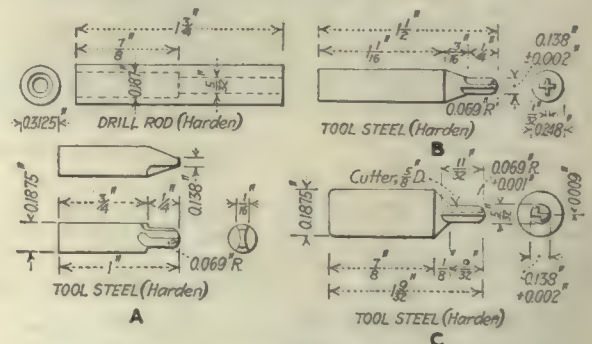


FIG. 8. THREE TYPES OF ROUTING TOOLS

which can be adjusted in and out by the screw shown, and the rings are then faced by the movement of the whole cross-slide in the usual way. The bevel is turned by the rest on the front of the cross-slide.

The gages are shown in position on the end of the lathe bed, these being go and not-go gages for height and diameter. The height gage was made in the shop, while the diameter gage is of the Johansson snap-gage variety.

cutter, cutter speed and work speed was found. In some cases difficulty was experienced by the chips welding fast in the groove. Fig. 6 shows a Leland-Gifford high-speed drilling machine with a special table rigged up for this

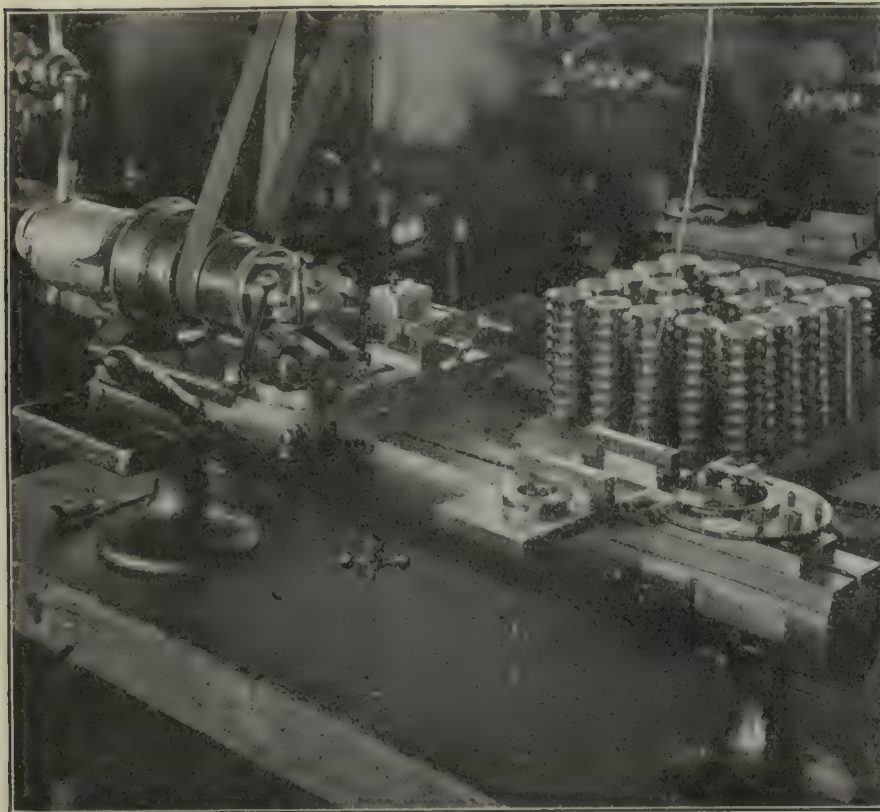


FIG. 5. SET-UP AND ARRANGEMENT FOR FACING AND BEVELING RINGS IN THE BENCH LATHE



FIG. 6. ROUTING POWDER GROOVE IN DRILLING MACHINE

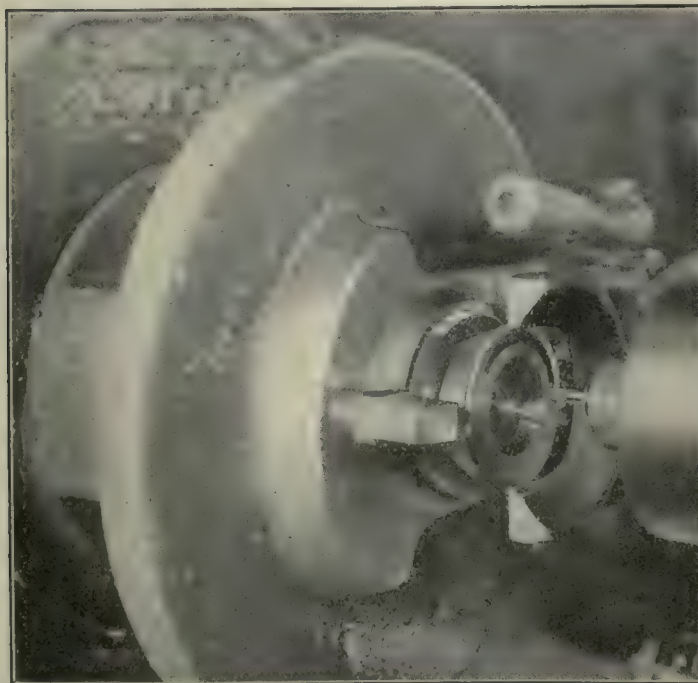


FIG. 9. ROUTING POWDER GROOVE ON GORTON HORIZONTAL MACHINE

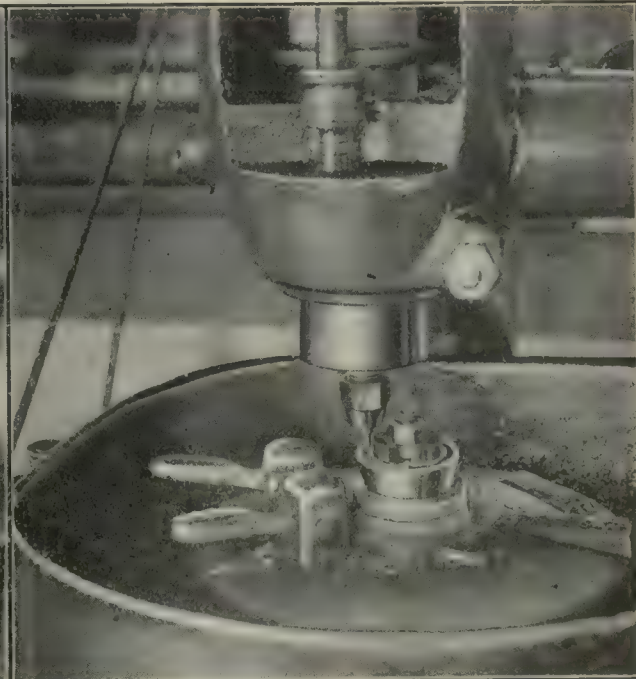


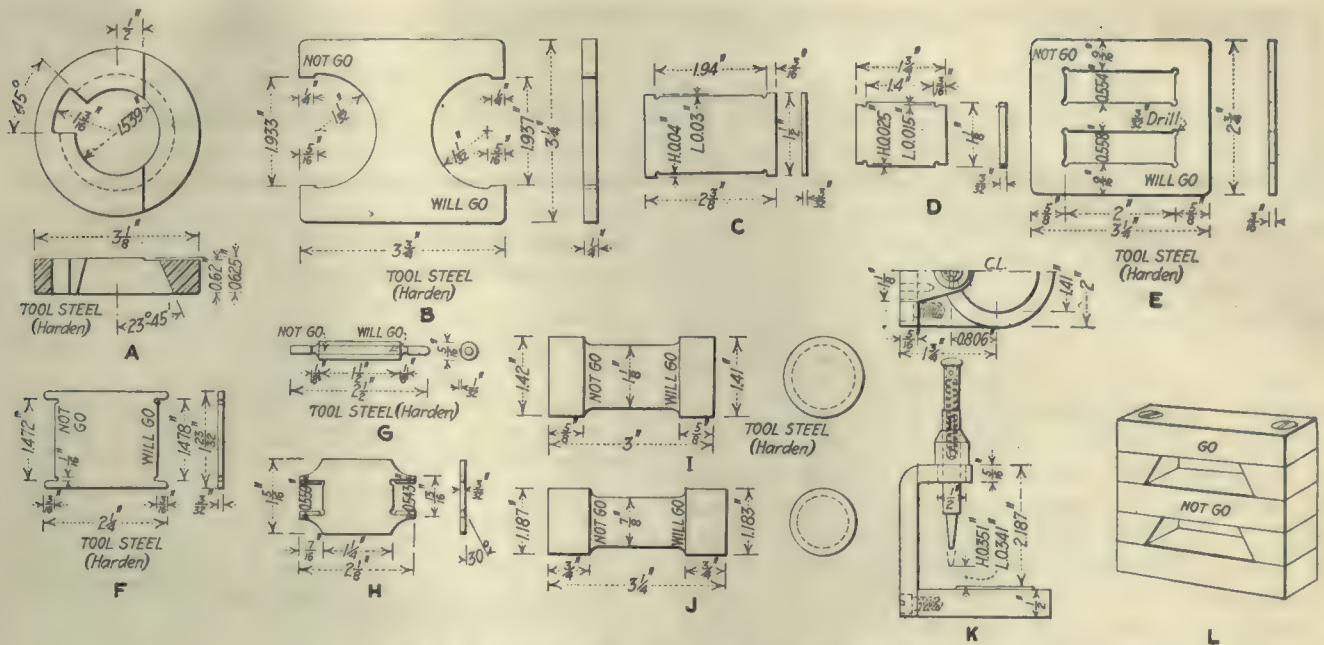
FIG. 10. ROUTING POWDER GROOVE ON GORTON VERTICAL MACHINE

One of the ring-holding boards is shown behind the lathe, and in detail in Fig. 13. These lathes are all run by girls.

Routing the powder groove had proved quite a problem in most shops until the right combination of shape of

work. This hand feed has now been converted into a power feed with automatic stop, as shown in Fig. 7.

Fig. 8 shows three types of tools used. The form shown in *B* has been found best suited for this work, and is made of the best drill-rod obtainable. The cutters



A, diameter of ring; B, diameter of lip; C, depth of lip; D, depth of recess in face of ring; E, thickness of ring before composition is pressed in; F, diameter of powder groove; G, width of powder groove; H, length of division piece, or space between end of groove; I, diameter of recess in face; J, diameter of bore; K, thickness from recess to bottom of groove; L, master gage for ring thickness

A foot treadle pulls this down whenever it is desired to release the ring.

At B, Fig. 11, is shown the new jig for drilling the work hole after the powder groove has been routed. This jig locates the ring by one fixed and one movable point fitting into opposite ends of the powder groove. The latch shown locks the two levers when they are in the proper position with the pins the correct distance apart and holds the ring under the plate carrying the drill machine while the hole is being drilled.

A VARIETY OF SPECIAL-PURPOSE GAGES FOR FUSE WORK

The different gages called for by the inspector are shown in Fig. 12. These only show the gages used before the rings have the powder grooves filled, another set of gages then being necessary as the ring and powder are both turned off in a bench lathe after the powder is pressed into the grooves. The gages require no explanation beyond that given in the captions to identify the respective applications.

Another form of gage, shown at *L*, Fig. 12, has been devised by some of the inspectors. This consists of flat blocks lapped to their proper dimensions and substantially held together by the screws shown. The different pieces are also doweled so as to be easily replaced in their proper positions. A gage of this kind can be readily corrected after it has worn beyond the allowed tolerance.

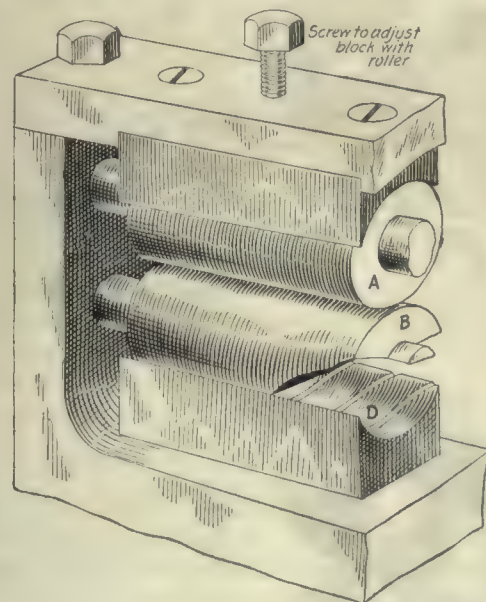
Fig. 13 shows details of the carrying racks used. These are similar for both the upper and lower rings, except for the difference in the length of the carrying pin, which is shown.

Fig. 14 shows the standard form of box that has been decided upon for shipping the rings from the factory to the loading plant. Each box contains 528 rings, these being arranged in four rows of 11 each, and 12 deep. They are separated by $\frac{1}{16}$ -in. cardboard of the dimensions shown.

Stiffening Sheet-Metal Rolls

BY AUGUSTUS UNSER

The simple and effective method of stiffening the rollers in a sheet-metal rolling machine here illustrated was devised after considerable trouble had been experienced in replacing new bearings and because of unsatisfactory production. Heavy sheet iron was required to be rolled on this machine, but in spite of its solid construction the rollers could not be kept from chatter-



ing, even after experiments had been made with extra-heavy shafts and bearings. After blocks *A* and *B* were inserted, as shown, the work was satisfactory and the machine runs smoothly without chatter. Graphite was inserted as shown at *D* to prevent the burning up of the rollers.

Nosing 4.5-In. British Shells

BY JOHN S. WATTS

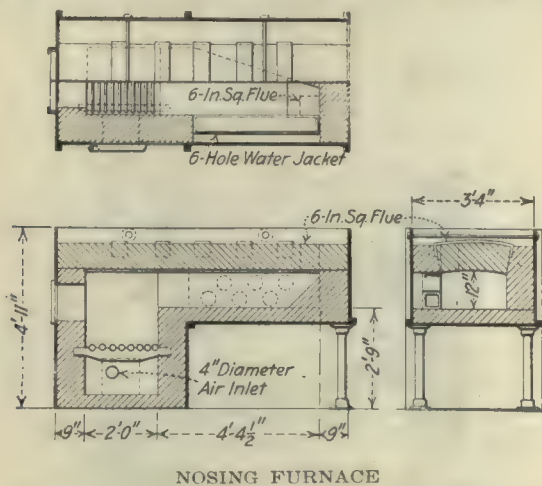
The following is a description of the outfit used by the writer for nosing the 4.5-in. high-explosive shell in a shop designed to have an output of 200 shells per day.

The shells, when ready for nosing, are turned to the finished diameter at the base for about $1\frac{3}{4}$ in. and fit in a horseshoe-shaped guide fastened to the table of the press. This guide is made of the right height to act also as a stop to prevent the shell from being pushed too far into the nosing die. The shell when heated is simply pushed against the guide. The open end of the shell is chamfered on the outside, this method requiring less pressure than the inside chamfering, to nose the shell.

The furnace for heating the shells is shown herewith, the design being an adaptation of a rivet-heating furnace used by the Eastern Car Co., of Canada. The fuel is Pennsylvania coke, and a fan gives the draft. It will be seen that a water jacket is built into one side of the furnace with holes to receive six shells, the shells being pushed through so as to protrude about $4\frac{1}{2}$ in. into the heating chamber.

The nosing press has a ram of 14-in. diameter, and the pressure is 1,200 lb. per square inch. The pump is belt driven, having three plungers $1\frac{3}{4}$ in. in diameter by 4-in. stroke running at 70 r.p.m. and delivering to an accumulator 5 in. in diameter by 7-ft. stroke. This pump and accumulator supply the banding press also. In order to get quick action on the press the comparatively large size of $1\frac{1}{2}$ -in. hydraulic piping is used throughout, and the press is practically as quick as a bulldozer.

We use a three-way operating valve, having connections for high and low pressure, the low pressure in our



case being the town water service, which gives us about 80 lb. per square inch, which is ample to raise the ram up to the point where the shell jams in the die, when the high pressure is turned on to complete the stroke.

With this arrangement one man noses 320 shells per day of 10 hr., and more could be done in that time if the operator was physically able to do more. In other words, the output is limited by the endurance of the workman.

This equipment is as low in first cost as any, is fast enough with two shifts per day to handle an output of 600 shells and if necessary could be increased by adding another man to assist the operator.

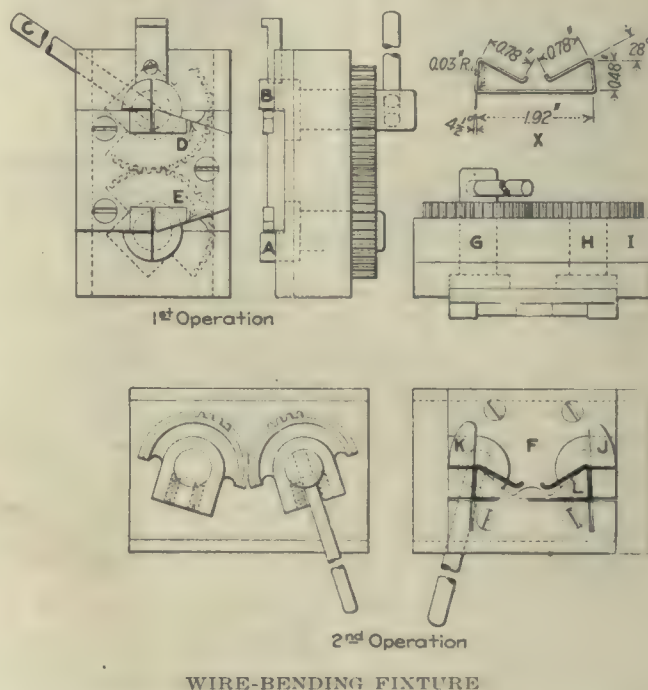
Wire-Bending Fixture

BY GEORGE P. BREITSCHMID

At *X* is shown a machine part made of 0.036-in. music wire. At first glance it would seem that at least four operations are required to make it. The tools shown, however, make this piece in two operations with a consequent lower labor cost, by employing what is known as the multiple-operation type of fixture.

The wipers *A* and *B* are connected by two segment spur gears and are actuated simultaneously by the handle *C*.

The surfaces at *D* and *E* are milled considerably past the right angle, for in bending music wire allowance must be made for the temper or spring back of the wire.



The fixtures of multiple-operation type are shown more to demonstrate the possibilities of this type of tool, as no doubt many of your readers have seen similar bending devices in prior contributions.

The second operating fixture, like the preceding one, is of the multiple-operation type. *F*, *G* and *H* are hardened tool steel. The part *I* is cast iron; *G* and *H* are connected by spur gears so that operation is simultaneous. The shape of the impresses *J* and *K*, and also of the bending plate *L* must be determined by trial. Allowance must be made as previously for the spring back of the music wire. This piece if made in large enough quantities could be profitably produced upon a 4-slide automatic wire-bending machine, but the method shown of connecting the impresses by gears greatly reduces the cost of production for the type of tool shown.

Slitting Belts

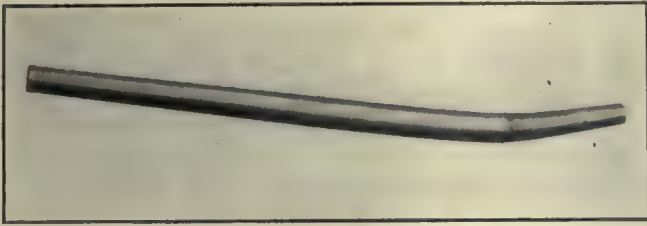
Having a number of heavy belts which were to be made narrower, Walter Scott points out that he accomplished the purpose quickly and accurately by slitting them on the circular saw just as you would a board.

Letters from Practical Men

What 30,000 R.p.m. Did to an Unbalanced Spindle

The illustration shows what happened when an attempt was made to use in an internal grinding head a longer spindle than the machine was designed for.

In this particular case the spindle that came with the machine was too short to grind a hole 5 in. long



THE BENT SPINDLE

in a ring gage. The spindle shown was made $6\frac{3}{4}$ in. long, with a taper $1\frac{1}{2}$ in. long on the small end. The diameter at the largest part was $\frac{5}{16}$ in., tapering to $\frac{1}{4}$ in. on the end to which the grinding wheel was attached.

The spindle was made tight in the taper hole in the grinding head and the machine started. As the machine gained speed, the end with the wheel on was seen to run out. Suddenly the spindle flew out of the head. When picked up, it was found bent, as shown.

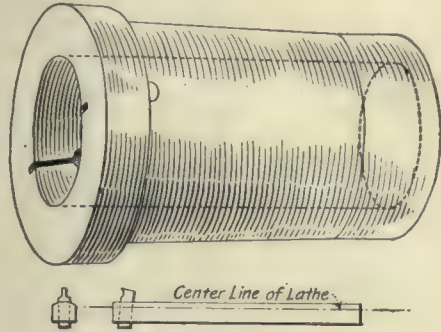
Bridgeport, Conn.

JAMES MCINTYRE.

Delicate Planing Job in the Bench Lathe

An excellent example of the adaptability of the toolroom bench lathe to precision work was demonstrated in planing the two keyways in the piece shown herewith. It was required that the part be splined to receive keys only 0.010 in. in width, also that they be 180 deg. apart. After the shaper had been tried in vain, in spite of the utmost care, the bench lathe was utilized and very good results obtained without any unusually difficult operation.

The part was held upon a plug arbor, which was turned for the job, and the division of the hole was obtained by means of the dividing holes on the cone pulley. The inclination of the cutting tool to the line of travel and



THE WORK AND SLOTTING TOOL

the work should be noticed, as this had an important bearing upon the successful working of the device. This cutting tool was necessarily so thin and weak that the slightest digging in of the tool would have resulted in its breaking off.

GUSTAVE A. REMACLE.

Newark, N. J.

Jigs for Drilling Bolts and Pins for Split Pin Holes

A number of interesting articles on drill jigs for cotter pin holes in bolts and pins have appeared in the *American Machinist* during the past year.

The adjustable jigs illustrated have been used successfully on this same class of work for a number of years. The greatest feature of these jigs has been that they do away with making individual drill jigs for each kind of bolt or pin as was formerly necessary.

Over 300 drill jigs were used for drilling all the varieties of pins and bolts used in a large western factory. Now a fixture such as the one shown is taking care of all the drilling of all sizes of pins and bolts manufactured. Where these kinds of pins and bolts are used a fixture of this kind may be easily appreciated.

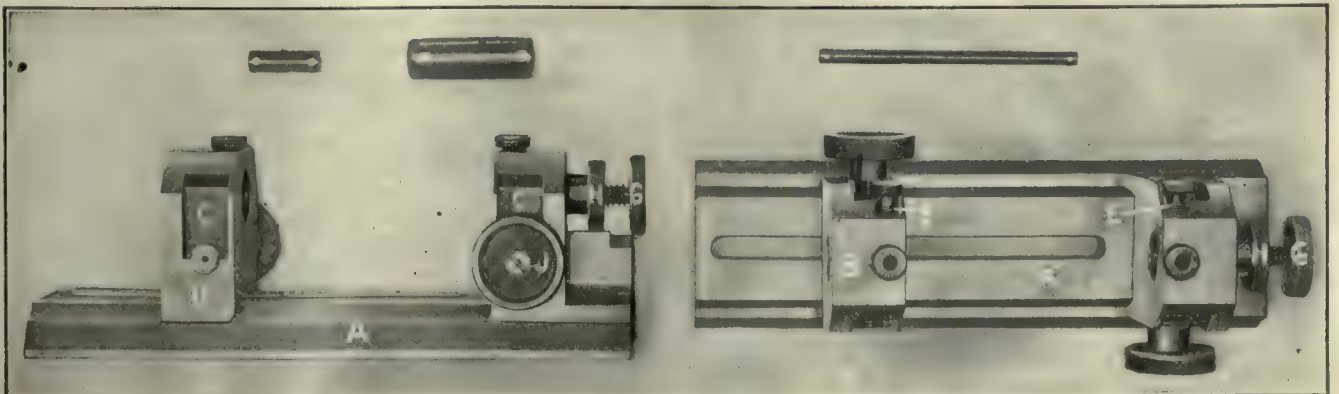


FIG. 1. TWO VIEWS OF ADJUSTABLE DRILLING JIG

These jigs can be adjusted for both diameter and length. The drill jig, Fig. 1, can be adjusted for diameters from $\frac{3}{8}$ to 1 in. by opening the clamping jaws *C*, Fig. 2, to the proper diameter with the screw *J*. These

G will prevent loosening of the screw during drilling operations. Plenty of chip room is given above and below the sliding jaw. No chip trouble is experienced and the work will come out of the jig easily. The chip plate

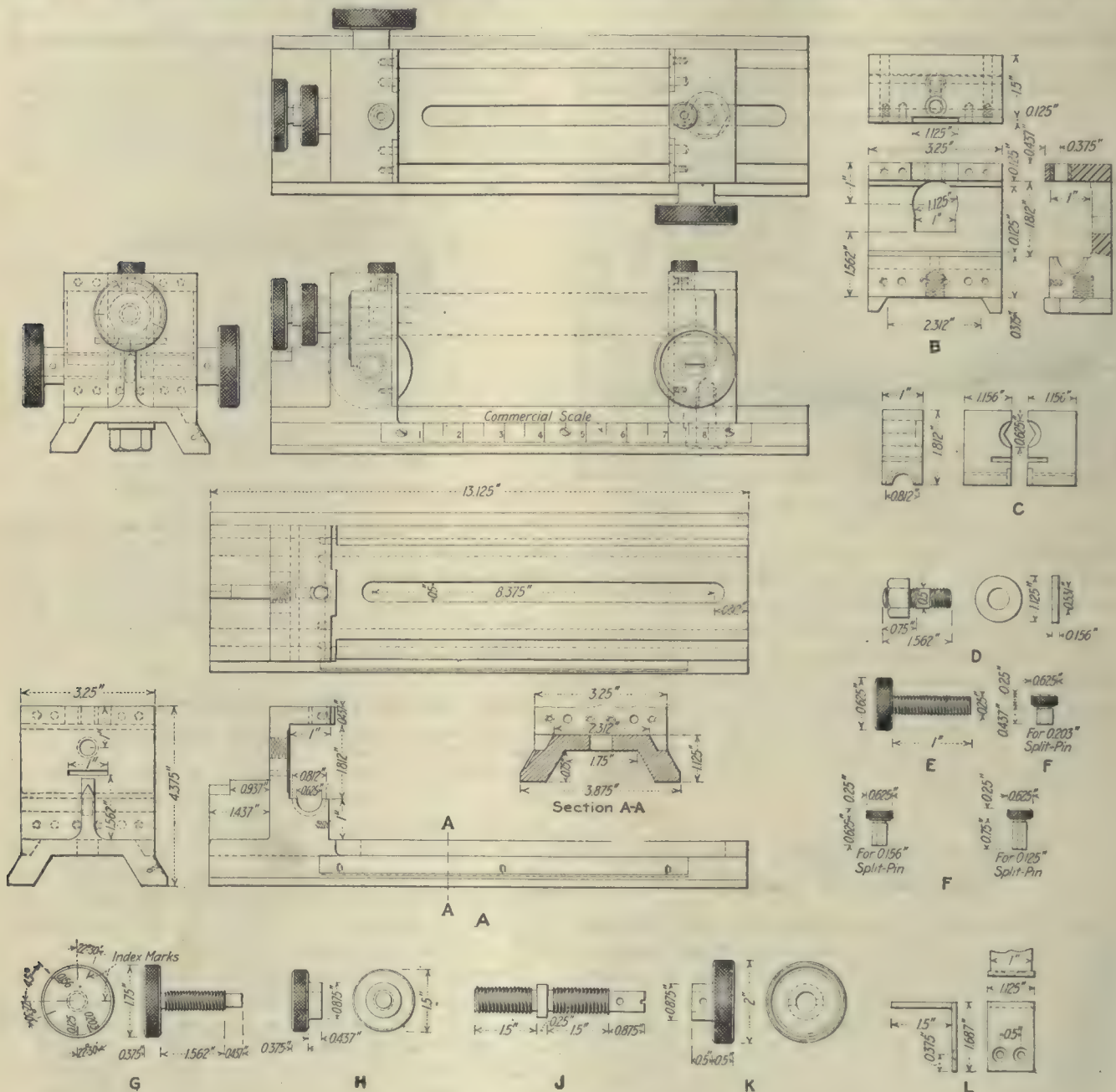


FIG. 2. DETAILS OF JIG CONSTRUCTION

jaws will center the work properly and hold it tightly while drilling. For lengths from 1 to 9 in., the sliding block *B* is moved the desired distance and locked to the base *A* by the locknut *D* in the slot in the base. A 9-in. scale, graduated in hundredths, is fastened on the side of the base to allow the operator to adjust the jig quickly for different lengths of work. The drill bushings *F*, for large or small holes, can be inserted quickly by loosening the lockscrews *E* in the base and sliding

block. To have the holes in the work properly spaced from each end of the jaws, a length-adjusting screw *G* is attached to the base *A*, and by moving the screw to established graduations as shown at the face of the screw a quick adjustment is made. The locknut *H* on the screw

L, fastened inside of the sliding block *B* and working in the slots of the clamping jaws *C*, prevents the chips from getting on the working parts of the drill jig.

When large amounts of pins as shown on Fig. 1 have to be drilled, a two-spindle drill head will help.

Davenport, Iowa.

WILLIAM BAUMBECK.

Self-Oiling Follow Rest

I have a great deal of lathe work to do which requires the follow rest. To assure that the jaws shall always be well lubricated, I have drilled a hole on the side of the follow rest away from the tool and fitted a small sight-feed oil cup.

J. GILLELAND.

Aldrich, Ala.

Discussion of Previous Question

The Advantages of Machinist Draftsmen

An answer to the question by Mr. Badge, on page 31, "Why do not more machinists become draftsmen?" might be found in the experiences of a number of draftsmen and of machinists who have become draftsmen.

In the first place it is not an easy matter, at least in England, for a man in the shops to obtain employment in the drawing office. The employer usually prefers to take a man with office experience or to select a youth and give him the training considered necessary.

In my own case it took two years of answering advertisements and writing to likely firms before I found a firm willing to give me a trial. Then I started with an "Irishman's rise"—a decrease in salary of about 30 per cent.—although I had spent considerable time in designing and building machines in an experimental department, was an experienced tool maker and had been with a firm that, having a pattern shop and foundry, gave every encouragement to the apprentice to learn all he could about these branches of the trade. A man with 12 months' office experience apparently stands a better chance for an office job than one who has had 6 years in a technical school, if he happens to have had all his practical experience in the shop.

No doubt, when the machinist once gets in, his shop experience stands him in good stead; but even then he will often find it necessary to move to two or three firms before obtaining the salary that he received while in the shop. Of course, the fact of his becoming a "rolling stone" is not necessarily a disadvantage, as he is certain to acquire a good deal of useful information.

The draftsman usually handles a greater variety of work than the machinist and has more opportunities of studying designs and methods than has the latter. Many machinists appear to envy the draftsman with his shorter hours and his "soft job," although perhaps they appreciate the fact that the "pencil pusher" must devote a large percentage of his so-called spare time to keeping in touch with his work. This feature may account for so few machinists attempting to take up drafting.

ALBERT F. GUYLER.

Nottingham, England.

The Art of Grinding

Referring to the article by F. B. Jacobs on page 165 of the *American Machinist*, on the subject of "The Art of Grinding," all grinding-wheel makers and all grinding-machine makers will welcome at any time college men or any educated man who desires to take up the question of reducing grinding and grinding-wheel usage to a science. Mr. Jacobs would be just as welcome as anyone.

But there are several things in this world that no one but those experienced can safely take up, no matter what their education may be. Surgeons today use certain instruments, certain knives, and they handle them in cer-

tain ways. A surgeon plunges a knife at a certain angle to avoid hitting vital parts, and surgery is pretty successful today and is called a science. But I do not think Mr. Jacobs would know what to order if he wished a knife for removing a member of the human body, and I do not think he would know how to use it when he received it. Further, I do not believe the surgeons could tell him on paper how to use it. I suspect he would have to have a good many trial knives and a good many hours of practice before he would hit it right. Before he got there, probably the police would have arrested him for murder.

There are lots of things in this world that must always remain an art. If some of us are so unfortunate that we cannot acquire that art, it is not very good taste for us to find fault because the artist does not know how to tell us what to do.

Trial wheels are necessary so long as there are different users, with different minds, with different machines, and different materials that affect the success of the wheel. While users of wheels remain the umpires as to what is the correct wheel, it will be necessary for the makers to submit trial wheels for the consideration of their customers. This is wholly right and will probably never be any different so long as the world stands.

Worcester, Mass.

C. H. NORTON.

It was indeed with profound delight that I read Mr. Jacobs' criticism, on page 165, of the grinding-wheel manufacturer's indifference to the necessity of reducing the art of grinding to an exact science. It seems absurd that in this age of efficiency we should not be enjoying a grinding-wheel millennium. Perhaps the fault of the past has been, as Mr. Jacobs hints, that the scientifically trained engineer has not focused his indomitable energies on this glaring phase of machine work. It is a strange coincidence that I, too, should have discovered, independently of Mr. Jacobs, that it will require a man of more than normal intelligence to distill grinding-wheel knowledge down to its very quintessence in a brief, cold formula. But I will let the honor of the discovery rest with Mr. Jacobs.

There is nothing very formidable about the array of simple facts that the scientifically trained engineer will find marshaled before his learned eye when the grinding-wheel field enters his range of vision.

To begin his boiling-down process all he will have to know offhand will be something as simple as this: If the work is to be ground wet or dry; if the machine that the wheel is going to be used on is frail or rigid; if it is of the so-called automatic type—surface, cylindrical, internal or universal; if it is bench stand, floor stand, or flexible shaft; if manganese, nickel, tungsten, cobalt, carbon, etc., predominate in the material to be ground; if the grinding is to be on soft rubber, glass, marble, horn, cork or leather; if the finish is to be rough or smooth; if the contact area of wheel and work is large or small; if the

work is heavy or light; if the surface speed of the work is 15 ft. per min., or 100; if the surface feet per minute of the wheel is 2,000 or 6,000.

These, of course, to the scientifically trained engineer will be but mere incidentals, and those of us who have been but poor dupes in the laggard growth of the grinding-wheel industry in the past twenty years will welcome with joy the smoothness with which the scientist proceeds to formulate his formula, often becoming positive of the exact weight of the machine in kilograms; the correct analysis of all parts of the material to be ground, together with the tensile strength and specific gravity; the mathematically calculated arc of contact; the absolute surface speed of the work; the micrometered diameter of the wheel, and its carefully measured speed.

These we know will be but trifles to him, simply to be jotted down as $\left(\frac{A}{B}\right)k^4 = g^{13}$.

The real interest to him will come in the making of the wheels themselves. These should at least claim from him a little more than passing attention. There is the purity of the abrasive to be looked into, and, naturally, no true scientist would sponsor a wheel that did not have his approved verdict as to the exactness of its physical characteristics in the preparation of the abrasive in the electric furnace. To select the most efficient shape of grain might possibly cause him a moment's hesitation. If his decision should be in favor of a crystalline grain, then a short debate on his part as to which facet to place uppermost in each grain might be important for an ideal wheel. A choice of the right combination of grains from the numberless combinations possible would be of ultra importance. This might require quite a lengthy formula, but of course it is within the scope of the trained mind that Mr. Jacobs mentions.

The bond to most wheel manufacturers has always been a thing to reckon with, but to such a scientist the thing is simplicity itself, keeping in mind that any altering cutting-strain can be taken care of geometrically. Obviously the amount of bond between each particle should be uniform, and each hand-picked particle inserted into its proper place with exact precision for, remember, that with an exact predetermined work speed and wheel speed, knowing the most efficient amount of work that each particle should do, it is necessary that in order to have the proper number of particles pass a given point per revolution of the wheel the particles should be most evenly spaced with absolute verification.

It would hardly be reasonable for one to doubt that the scientifically trained mind would find any trouble in the burning of the wheel. At best this is such a simple process that it could be determined with a footnote. As to whether or not the wheel should be made under the silicate, vlucanite, or elastic process might be determined as to whether or not the numerator of an equation were divisible by the cube root of the denominator. It is very easy to have things agree mathematically and mechanically.

Mr. Jacobs has struck a responsive chord in me in his suggestion that some scientifically trained engineer pause in his daily toil in other lines of endeavor to reduce the art of grinding to an exact science. Grinding has ceased to be a luxury and is now a necessity, and just such a superman is needed.

How convenient it will be before proceeding to grind, in this grinding millennium, to glance at a chart and ascertain most positively that the wheel that you desire is tabulated in a workmanlike manner. For example, having the aforementioned data represented by $\left(\frac{A}{B}\right)k^4 = g^{13}$, and wishing to know the proper wheel to use for grinding Lipowitz's Bismuth Alloy, you glance at the table and find, letting X equal the wheel and solving for X , that

$$\int_0^{\infty} \left(\frac{\sqrt{x^3 + a^4}}{a^3} + \frac{D}{\sqrt[3]{y^2 - D^5}} \right)^{-x} = X$$

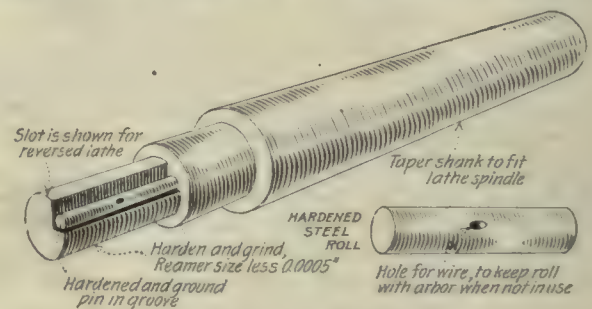
It will be such a pleasure for a customer to get the exact wheel he wants—just like having a prescription filled at a drug store.

ROBIN DUFF.

Worcester, Mass.

Roll-Grip Mandrel

Referring to Donald A. Hampson's "Arbor for Machining Rollers," page 244, the writer has seen used a large number of similar mandrels on small interchangeable automobile parts. These mandrels, known as "roll-grip mandrels," were made of tool steel with the grip end hardened, or of machine steel carbonized and hardened, then ground to the size of the reamed hole in the piece



ROLL-GRIP MANDREL

to be turned, less about 0.0005 in. The shape of the groove for the roll is preferable to that described by Mr. Hampson, as the roll can be laid on the groove more easily when putting on the work. The shank is tapered to fit the head spindle of the lathe, as work can be removed more quickly than when on centers. Do not forget the hole in the rollers for the tool cribman's sake.

Mineville, N. Y.

CHARLES F. HUNTER.

Young Men of Today--Criticism

From reading Mr. Brophy's article on page 269, it would seem that some inducement should be offered shop apprentices.

In most plants it is customary to give a boy a certain wage the first year, a small increase for the second year, and another for the third year. The amount is usually small, and a boy is expected to be able to pay his board, buy his clothes, and also purchase a fine lot of small tools, which in themselves are quite an expense. Most boys who learn a trade are of the poorer class, and their parents in a great many cases cannot afford to support them entirely, but need about all the boy gets, irrespective of the inducements held out by the manufacturer.

When a boy arrives at the age when he wishes to learn a trade, he should be placed in a position where it is up to him to make good. As an example, we will say that for the first period or year he receives \$1 a day; for the second year, \$1.25; and for the third year, \$1.50 a day. In most shops that is about the wage rate. No matter if one boy is far better than another, he receives the same pay as the other fellow gets, and no more.

Now suppose we put in a little efficiency clause in this contract, something like this: "If the apprentice shows good workmanship, strict attention to his work, speed and all the good points that go to make up efficiency, as a reward for this he will receive as a premium a wage increase equal to the amount that would ordinarily be given him in the next period mentioned in his contract. This amount is to continue unless, at the expiration of the period, he has shown ability satisfactory to the company, when he is to be given another increase that will equal that of the period next succeeding." This clause will inspire an apprentice and give him some encouragement.

In some shops after the first six months 10 per cent. of the wages is withheld by the company and given to the apprentice when he has finished his contract. This is a good idea, as it partly insures the company of his services to the end of his contract and also to some extent prevents a boy from getting a swelled head.

Inducements along the foregoing lines will tend to make more and better apprentices. A. E. HOLADAY,
Naugatuck, Conn.

In Mr. Brophy's article on page 269, descriptive of the young men of today, he says, "To sum up the situation, it almost seems that these young men are lacking in just ordinary commonsense," and asks, "Is it possible that too much book education is destroying the thinking power of our young men and preventing them from understanding life as it really is?" He speaks from the viewpoint of an employer who is seeking apprentices. The young man who is looking the future square in the face might present another view.

Many of your readers no doubt have heard the fable of the three blind men who went to see the elephant. One touched the elephant's leg and said, "The elephant is like unto a tree." Another, who touched its trunk, said, "You are wrong, the elephant is like unto a snake." Then the third, who had touched its tail, exclaimed, "You are both wrong; the elephant is like unto a rope." All were wrong, yet each was right from his individual point of view.

No doubt the young man with a reasonable amount of commonsense, who for the last few years, up to the time that the war in Europe created a demand for mechanics, has been obliged to take anything he could get at almost any pay, reasons that if he must work for such small pay he might better begin now than after spending three or four years learning a trade.

And the slow way in which an apprentice is advanced in some shops is very discouraging to those who are ambitious. They understand that, being nonproductive, they must work for small pay, but are often kept doing the same work after they can do just as much of it and that just as well as an old hand.

Eddie's experience was a fair example of this. He came to learn the machine trade in a shop where I was work-

ing. He was a bright young fellow, about 18, tall, clean cut and manly. We all liked Eddie just because we could not help it. He had been with us about two months, and the only machine tool he had been allowed to handle was a broom. One Monday we learned that he had taken a position in an office for \$1 less per week, as he wanted to learn something.

There are some of us who think Eddie used pretty good sense.

W. J. WELLS.

Brooklyn, N. Y.

I have read with interest Mr. Brophy's article, "Where Are the Good Mechanics?" and am prompted to put forth a few reasons for the conditions he finds.

To start, is it not probable that the machine shops are growing in size and number faster than it is possible for boys to be trained to fill them?

The trouble that is undoubtedly the most exasperating to employers is the number of men roaming from one shop to another, who do not seem to know anything at all about their trade. I believe that this condition is caused by the good pay that induces men from other lines (not mechanics at all) to try to get by. And a lot of them do.

Another factor is the number of new machines and tools, and the additions, variations and complications of the old ones. There is so much to learn that the boy either does not half learn any of it or settles down to one machine and sticks to it. Is not this latter where we are going to land? All will be specialists—except the exceptional men.

But the principal reason, after all, is that the men in the shops "in the good old days" were trained in the shops of still older days, quite a while ago now. They were right under the eye and tongue (and often the hand) of the "Old Man." They usually were the sons of machinists, had the trade in their blood and were also under the direction of a father, an uncle or a brother—or all three—as well as the Boss. More than that, the Boss was almost always an exceptional man. The boy was not, probably, any more anxious to learn then than now, but he just naturally had it hammered into him.

Since then conditions have been steadily changing; "shops" have grown into "plants," the Old Man has moved into the office, and the boy has been turned over, first, to the foreman and then to a "system"—or "Department for Handling and Training of Apprentices." The result is really perfectly natural.

W. B. GREENLEAF.

Plymouth, Mich.

❧

Successful Suggestion Plan

After carefully reading and considering the article on page 815, Vol. 44, I am disposed to feel glad that I am not a member of that works force in any capacity. More ink has been used and more brain fag has been caused by the question of suggestion systems than the total results warrant; hence the failure of most. It would seem that the system described would likely prove to be a success at the expense of normal routine. The implied penalty to the foreman who failed to send forward his weekly list of suggestions is one bad feature: the incentive to put forward *something*, whether valid or not, for fear of trouble is another.

Suggestion systems are well enough in their way and the object sought is good. The fact that as long as the world lasts improvements will be made, makes desirable some scheme of eliciting criticism and obtaining first-hand grumbles. At the same time, to put a system of suggestions in a prominent place and enforce a weekly return even though nothing has suggested itself, is novel but unpleasant.

Some men with a faculty for finding trivial faults are practically worthless otherwise. Others, without this sense, are hard workers and overcome troubles without effort. In effect, the system outlined seems to be designed to favor the simply ingenious mechanic at the expense of the man who sticks close to his job and has no time for hunting trouble. The scheme seems to have a distinct flavor of favoring ingenuity at the expense of output.

In one of the instances cited—that of the boy mail carrier—the youth probably neglected his primary function in going from point to point in order to alight on what are admittedly minor matters after all.

We are told that a single suggestion saved \$6,700 in a year, and gather by inference that the reward was a gold watch. We are not informed just what all the suggestions in any one year are worth. The point at issue in common fairness is this: The employee must be altruistic indeed who saves a concern \$6,700 multiplied by a term of years and feels adequately compensated by the gift of a watch. For this reason alone the scheme is doomed to extinction. It may survive for a while, but it is not honest to make a small present in return for a large cash saving. The matter for surprise is that, taking the facts as related, it has survived at all.

The firm must be peculiarly fortunate in the matter of its labor, and some remarks of the latter on the system might throw light on a condition which is scarcely credible to anyone having experience with the usual type of shop. Another matter is, that wherever and whenever a superintendent shows himself favorably disposed to any one thing to the exclusion of others, it is evident that the short cut to favor may be gained by fostering this preference. Again, without such a system in vogue, improvements are effected. For example: Drawing-office designs, tools and fixtures that are the work of a smart foreman or tool maker, in a shop not employing a system, would not be considered out of the ordinary. But given a superintendent with the "suggestion bug" and a system in vogue, all these quite usual matters become statistics in the scheme.

If a foreman is employed at full pressure, with the usual amount of red tape and normal troubles to face, the effect of the note demanding suggestions would cause most first-class men to explode. There is an implied threat about it that does not make for the interest of harmonious working or good management. It is pretty certain that whatever be the success of the scheme in a manufacturing concern it would never answer in shops requiring skilled work.

The saving clause in the entire system is the personal note. Some years ago, in these columns, I suggested exchanging the suggestion box for a live man accessible to all and having no specified duties to perform. It is unquestionably this factor and not the chasing and badgering of employees for suggestions that saves the situation. As to the matter of rewards, the writer is

strongly of the opinion that these should be in cash and proportionate to the saving involved. Mean and trifling rewards for large savings have been the death of most suggestion systems.

A man who saves \$10,000 a year by a simple suggestion, the saving being repeated year after year, should receive a royalty as if for a patent. The case is similar to that of a foreman paid on tonnage or output who turns out a lot of work the first week, and is then offered a lower sum. The same thing affects piecework and is a thorn in the side of the production problem. It is generally realized that to earn too much is to suffer reduction in rate, hence earnings are kept just within an estimated margin of safety. This also applies to rewards for suggestions where \$10 is considered adequate payment for a \$1,000 annual saving.

If the shop men have confidence either in the integrity of the firm or in the reputation and personality of the chief, suggestions will be forthcoming. Combine the two—belief in the high character of the chief and the certainty of adequate payment—and any scheme whatever can be made a success. It is confidence that is required in the solution of the troubles incident to all systems and not a particular method.

Since the personal element looms so largely in the system described it must be this and the accessibility of the factory superintendent that should receive the credit. Unfortunately this local adjustment cannot without egotism be put on paper and could so easily be made to appear ridiculous. That suggestions do come forward and that the system is not defunct is a tribute to the character of the author, who only dimly comprehends the actual facts.

I do not believe in any particular system of suggestions but in the basis underlying such systems. Where both parties are honest in intention and impartial in fact, and due credit and reward are given, much may be done. Short of the personal element and established confidence, which latter has in too many cases been forfeited under the present industrial system, any scheme is foredoomed to failure and its sponsor is bound to be disappointed.

I do not dispute facts which are outside my knowledge, and if the suggestion idea can be made successful in any guise or under any system whatever, it is something to be thankful for. Its application to one's own particular problems and how to evolve some solution to suit local needs give one ample food for thought.

London, England.

A. L. HAAS.

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A Babbitting Problem

In the article "A Babbitting Problem," on page 190, the writer seemed to have difficulty in keeping the middle of three bearings from pouring too low. This trouble would not have occurred if Mr. Williamson had taken into account the action of heat upon metal. The shaft became heated at the center on the lower side and expanded, causing a sag at that point. This could have been corrected by warming up the shaft evenly to about the temperature of the melted babbitt, which would have been better than the method used of reducing the diameter of the shaft at the center. Preheating the shaft also causes the babbitt to flow more smoothly.

Stockton, Calif.

J. H. HARRISON.

Editorials

Council of National Defense

One of the most important sections in the recently passed Army Appropriation Act is the one providing for the establishment of a United States Council of National Defense. The following quotation comprises the first three paragraphs of this section:

That a Council of National Defense is hereby established, for the coördination of industries and resources for the national security and welfare, to consist of the Secretary of War, the Secretary of the Navy, the Secretary of the Interior, the Secretary of Agriculture, the Secretary of Commerce, and the Secretary of Labor.

That the Council of National Defense shall nominate to the President, and the President shall appoint, an advisory commission, consisting of not more than seven persons, each of whom shall have special knowledge of some industry, public utility, or the development of some natural resource, or be otherwise specially qualified, in the opinion of the council, for the performance of the duties hereinafter provided. The members of the advisory commission shall serve without compensation, but shall be allowed actual expenses of travel and subsistence when attending meetings of the commission or engaged in investigations pertaining to its activities. The advisory commission shall hold such meetings as shall be called by the council or be provided by the rules and regulations adopted by the council for the conduct of its work.

That it shall be the duty of the Council of National Defense to supervise and direct investigations and make recommendations to the President and the heads of executive departments as to the location of railroads with reference to the frontier of the United States so as to render possible expeditious concentration of troops and supplies to points of defense; the coördination of military, industrial and commercial purposes in the location of extensive highways and branch lines of railroads; the utilization of waterways; the mobilization of military and naval resources for defense; the increase of domestic production of articles and materials essential to the support of armies and of the people during the interruption of foreign commerce; the development of seagoing transportation; data as to amounts, location, method and means of production, and availability of military supplies; the giving of information to producers and manufacturers as to the class of supplies needed by the military and other services of the Government, the requirements relating thereto, and the creation of relations which will render possible in time of need the immediate concentration and utilization of the resources of the Nation.

That the Council of National Defense shall adopt rules and regulations for the conduct of its work, which rules and regulations shall be subject to the approval of the President, and shall provide for the work of the advisory commission to the end that the special knowledge of such commission may be developed by suitable investigation, research and inquiry and made available in conference and report for the use of the council; and the council may organize subordinate bodies for its assistance in special investigations, either by the employment of experts or by the creation of committees of specially qualified persons to serve without compensation, but to direct the investigations of experts so employed.

Thus the Council of National Defense is to be composed of six members of the President's Cabinet. Working with the council will be a civilian advisory commission of seven men, each of whom must have "special knowledge of some industry, public utility, or the development of some natural resource." These requirements make the prediction safe that at least a part of the members of this commission will be engineers. Thus comes another recognition of the place and importance of engineers in our national life. An impartial review of the facts shows that there have been more of these recognitions during the last

three years than ever before in the history of the United States. It is probable that at least one member of this advisory commission will also be a member of the existing Naval Consulting Board. He will be the connecting link between the work already done for industrial preparedness and the work that will be undertaken by the Council of National Defense.

A part of the duties placed upon the Naval Consulting Board will be the establishment and operation of the experimental and research laboratory authorized by Congress in the Naval Appropriation Act. It is expected that at this laboratory the specifications and manufacturing requirements of all American munitions of war will be brought under survey and studied with the purpose of making them as complete and practicable as possible for mass production. This part of the work of the Consulting Board will of course affect the Army, for not only will naval munitions be studied, but those intended for the land forces as well.

Should the emergency of war come to this country within a few years, the benefits from the activities of the Naval Consulting Board and the Council of National Defense will be so tremendous as to pile up an incalculable debt of gratitude on the part of American citizens. It is no small achievement to inventory 20,000 industrial plants in this country as a civilian enterprise and without the legal authority of Congress. Yet this has been successfully done. It is no small thing to arouse the interest of the country in the industrial side of national defense so as to bring about the creation of this council, the providing of ample funds for a beginning of its work, the appropriation of over \$600,000,000 for the Army and Navy for the fiscal year 1917, and to give the promise of a condition of adequate preparedness in the United States within a period of two years.

It is strictly within the bounds of truth to say that this great work could not have been accomplished except through the activities of engineers and manufacturers, the men who have given unstintingly of their efforts and powers to the Naval Consulting Board.

■

Standard Munitions of War

Last week a part of these columns was devoted to comment on the Army, Navy and Fortifications Appropriation Bills, pointing out items to cover the cost of procuring artillery, arms and ammunition. The equipment specified in these provisions must be supplied by the machine shops of the United States.

There is good reason to believe that some work of standardization for manufacture may be done before our shops are called upon to produce these munitions. News from France brings the information that the French Government has done a great deal since the war started to reduce the number of items in its military equipment and standardize those that have been retained. A number of sizes of field guns have been abandoned as regards new manufacture, and those that have been kept have

been standardized in regard to details and methods of production, so far as this is possible under war conditions. It is stated that the celebrated French 75-mm. field gun is arranged so that each barrel has three lives. When the barrel first goes to the battlefield, it is of the proper size to take the regulation 75-mm. shell. After it has been worn and eroded so that its accuracy is lost, the barrel goes back to the arsenal and is re-bored to take an 83-mm. shell. After it becomes worn from this size, it is returned to the arsenal a second time, is bored to take 90-mm. shells and then sent back to the battlefield for its third period of service. This procedure bears the stamp of practicability from a manufacturing viewpoint.

It is possible that something may be done with our own munitions to reduce the number of sizes and kinds and arrange for the maximum use of those parts that can be salvaged from the battlefield. But it appears that there is a larger field for standardization even than the bringing about of uniformity for manufacture.

Would there not be enormous advantages to all, if the countries of the Western Hemisphere should agree to standardize their military equipment? Would there not be an immediate increase in the potential strength of each, if the armies of Argentina, Chile, Brazil, Mexico, the United States and perhaps Canada should be armed with the same rifle, equipped with the same machine gun, provided with batteries of the same field artillery, supplied with siege trains of the same howitzers, and in fact all the way down the line be given identical equipment, except as this would need to be modified by climate and other natural conditions? The United States would be the greatest source of supply for this material. All the military devices and military secrets as regards equipment should be shared by all the countries entering the agreement. This indeed would be the greatest achievement in standardization of machine-shop products that the world has ever known.

Is not this project one of the first that might properly be taken up by the soon to be constituted United States Council of National Defense?

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Importance of Organization in Producing Large Shells

The first comprehensive article on the manufacture of a large-size explosive shell (12-in.) is contained in this issue. Several months ago the *American Machinist* showed the complete manufacture of the 12-in. Russian shrapnel shell. These two are the largest shells that have been made in any quantity in the United States for the belligerent nations of Europe. A small number of 15-in. high-explosive shells have been produced. However, the quantity has not been great, and the methods of production have been essentially the same as those followed on the 12-in.

The problem of producing shells of this size differs in several essential features from that encountered on the smaller sizes. On the small shells special tools, devices and methods are of extreme importance. The subdivision of operations and their sequence must be carefully studied in order to obtain maximum production in minimum time; that is, the manufacturing methods must be worked out with extreme detail before success can be obtained, even although there may exist an excellent manufacturing organization.

The most important difference to be noted when we attack the problem of the larger shells centers around this very feature of organization. The pieces are so much larger in the case of the big shells, so much more expensive per unit, transportation is so much more difficult and important, and the nature of the work is such that special devices and machine tools lack the scope of application that they have in the cases of the smaller sizes; so organization looms up as the dominating feature. It is perhaps not untrue to say that in the case of the small shells manufacturing equipment and methods come first and organization second, while in the case of the large shells organization is first and equipment and methods second.

It must not be thought that an attempt is being made to minimize the importance of equipment in the manufacture of the large shells. But owing to the very nature of the work and the comparatively small sizes of the orders—a few thousand only—special machines, fixtures and tools cannot be utilized in the way that they are applied to the smaller sizes. Thus, as shown by the article in this issue, the manufacture of the 12-in. shell is just a first-class machine-shop job worked out largely on standard machine tools. To gain the maximum result from such methods and equipment, there must exist efficient shop organization. The so-called preparation work—the supply of tools, machining instructions and material—must be attended to with the utmost care and must be continually supervised. There is a lack of that automatic feature that prevails in the manufacture of the smaller shells, where a great deal of special, perhaps automatic or semi-automatic machinery, is employed. In that case the regular run of work gains its own momentum and assists the organization in keeping things going. Not so with the larger shells. There, supervision at all places and at all times must be minute and detailed, if the expected results are to be obtained.

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Machine-Shop Signs

"Put a sign on your shop lest others fail to find you" seems to be as true as the saying, "Blow your own horn lest it be not blown."

Many machine shops do not display signs, not even the firm name, and thereby lose the opportunity to tell the public what is being manufactured. It is equally true that factories other than machine shops fail to display legends or tokens on their buildings indicating the firm name and the products, but machine shops in particular seem to be especially modest in this regard.

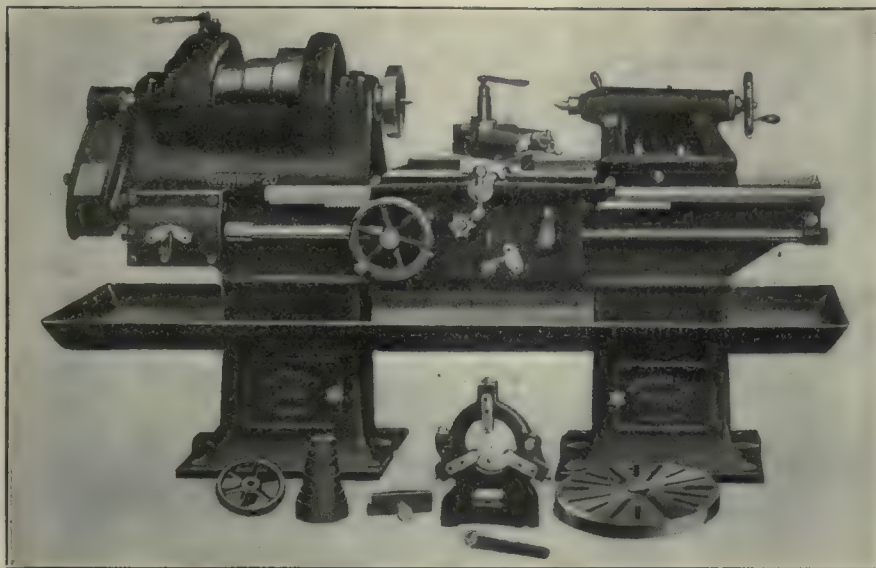
Professor Sweet has pointed the way in this matter, as he has in so many other things. On the roof of his shop in Syracuse, one of the first Straight-Line engines is mounted so that it shows plainly above the cornice. Below is a sign on which the name of the firm is painted in large letters.

Why should not every machine shop display prominently on its most important building the name of the company and something to indicate the nature of its output? In these days of general travel thousands would see such signs every year. They would serve as guiding marks for the visitor who purposes to make his first call and as landmarks for those who know the vicinity well. They would be another part of that desirable publicity that consists in "saying what is so."

Shop Equipment News

Double Back-Geared Engine Lathe

The machine shown is the 20-in. size made by the Chard Lathe Co., Newcastle, Ind. This firm also builds



DOUBLE BACK-GEARED 20-IN. ENGINE LATHE

Swing over V's, 20½ in.; swing over carriage, 13½ in.; distance between centers (7-ft. bed), 28½ in.; travel of tailstock spindle, 9 in.; diameter of tailstock spindle, 2½ in.; centers bored for No. 4 Morse taper shanks; front-spindle bearing, 3½x5½ in.; rear-spindle bearing, 2½x3½ in.; hole through spindle, 1½ in.; diameter of spindle nose, 2½ in. with 5-pitch U.S.S. threads; cone-pulley diameters, 14, 11½ and 9½ in.; width of belt, 4 in.; first back-gear ratio, 3.38 to 1; second back-gear ratio, 11.75 to 1; countershaft driving pulleys, 14x4½ in.; countershaft speeds, both forward, 160 and 200 r.p.m.; countershaft speeds forward and reverse, 200 and 325 r.p.m.; number of thread and feed changes, 28; range of threads, 3 to 42; range of feeds, 0.009 to 0.133; number of speed changes, 18; steadyrest takes 6½ in. in diameter; follow rest takes 3 in. in diameter; takes tool ¾x1½ in.; compound rest travels 4½ in.; lead screw has 4 threads per inch; taper-attachment taper per foot, 3½ in.; taper attachment will turn at one setting, 23 in.; weight, about 3,900 lb.

a similar lathe in the 16- and 18-in. sizes, though only the size shown has pedestal legs and pan. All these machines are built regularly with three-step cones and double back gears, or can be furnished with four-step cones and single back gears; and they are built with quick-change and semi-quick change gear boxes. A taper attachment is supplied when required, as well as a compound turret tool block and in addition front and rear tool blocks.

All parts are made interchangeable, and new parts may be had at any time with the assurance that they will fit without the necessity of handwork. The spindle bearings are lined with an alloy composed of 86 per cent. tin, 7 per cent. antimony and 7 per cent. copper. The spindle is made of steel that analyzes as follows: 0.45 to 0.55 per cent. carbon; 0.50 to 0.60 per cent. manganese; 0.03 per cent. phosphorus; 0.035 per cent. sulphur and 0.20 per cent. silicon. The spindles are machined from forgings hammered down from 6-in. billets. After being forged, the steel is annealed, then reheated to from 1,525 to 1,550 deg. F. and quenched in water. After this they are re-annealed at a temperature of from 1,225 to 1,250 deg. F. The racks are made

of 0.40 to 0.50 per cent. carbon steel. The tops of the lathe beds are chilled to a depth of about ⅝ in. below the bottom of the V's, which gives a degree of hardness that insures perfect alignment of the bed. All the castings used are pickled and sandblasted before machining.

The crossfeed and compound rest are provided with large graduated collars reading to 0.001 in., and the figures are large, distinct and easily read. The dovetail on the carriage is inverted in order to give greater strength. The carriage has shear wipers and an oiling device integral with it. The apron has a double bearing for all studs, obtained by means of a double-plate type of construction. All bearings in the back plate are oiled from one hole in the top of the carriage, and there are no gears running on fixed studs. Particular attention is called to the fact that handles on the handwheel on the apron and the crossfeed crank revolve on fixed studs, so that an operator can take a firm hold without the handle slipping in his hand. Provision is made to prevent the springing of the bed when the legs are bolted in place. The tailstock is graduated to provide for setting over for taper turning. In the size of lathe shown, the pedestal leg under the headstock contains a reservoir provided with two strainers for removing chips and dirt from whatever liquid is used. A pump, however, is furnished only on special order. A steel chip and drip pan gives additional convenience and reduces fire risk.

3

Plain Grinder

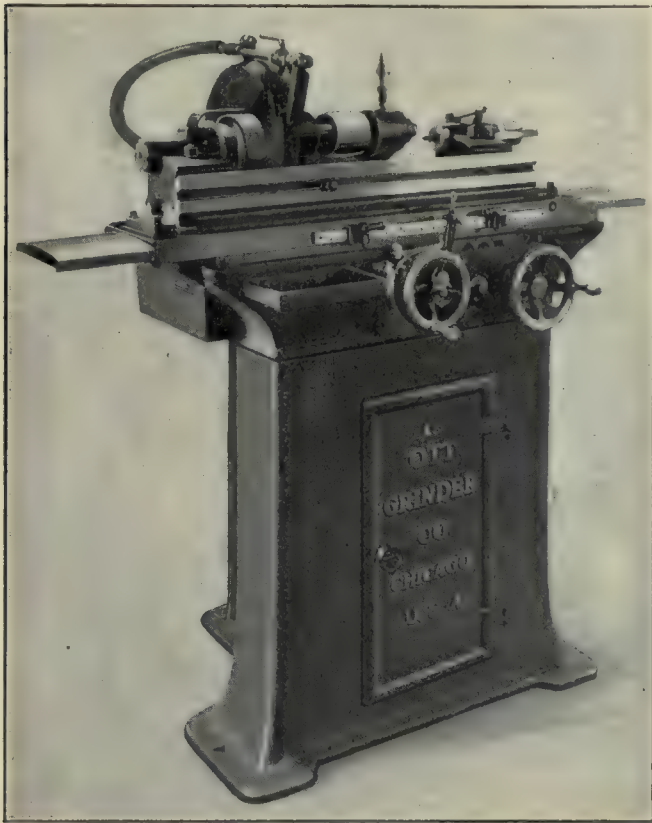
The design of plain grinder shown has been recently added to the products of the Ott Grinder Co., Chicago, Ill. It is considered especially adapted for the production of small duplicate straight or taper cylindrical parts requiring close limits.

The wheel spindle is of hardened steel ground and lapped. The bronze bearings are made adjustable and are provided for lubrication through self-feeding oilers.

The automatic crossfeed can be set to feed at either or both ends of the table reverse. It is automatically thrown out when work is ground to size. The table drive is through a worm and wormwheel. The automatic travel is controlled by quickly adjustable dogs sliding on the rack. The table handwheel is disconnected during power travel of the table. The reversing mechanism is noncentering. The swivel table turns on a large central stud that is hardened and ground. It is clamped on both ends. The headstock is arranged for both dead- and live-center

drive through a single pulley. It slides on V and flat ways and is fastened by a hook-bolt; the footstock slides and is fastened in a similar way.

For wet grinding, an ample water-supply is provided. The tank is cast in the bed and equipped with a settling pan that is arranged to be easily removed for cleaning.



PLAIN CYLINDRICAL GRINDER

Swivel table graduated to grind tapers up to 3 in. per ft.; swivel table graduated to angle of 15 deg.; four work speeds ranging from 130 to 390 r.p.m.; grinding-wheel spindle pulley, 4 in. in diameter for 2½-in. belt; wheel guard will take wheels 10 in. in diameter up to 2-in. face; two wheel speeds, 2,250 and 3,200 r.p.m.; four table traverse speeds ranging from 34 in. to 120 in. per min.; automatic crossfeed, minimum reduction, 0.0002 in.; automatic crossfeed, maximum reduction, 0.004 in.; power required, about 3 hp.; floor space, 31x68 in.; net weight, 1,500 lb.

The universal backrest has both vertical and horizontal movement and is provided with adjustable set collars.

Surface-Combustion Annealing Furnace for Rifle Parts

The type of annealing furnace shown was designed and built by the Surface Combustion Co., Long Island City, for the immediate duty of annealing rifle parts.

The firing system is such that gas under pressure is made to inspire all the air necessary for complete combustion, automatically maintaining constant mixture proportions and eliminating all motors, blowers and air piping. It is a one-pipe system, capable of accurate control from a central pulpit. A mixture of water and coal gas is used.

The work is placed in the cold furnace and the fuel is turned on full until the furnace has reached the correct temperature. The time it takes to reach this temperature varies with the weight of the charge. For a 40,000-lb. charge it takes about 5 hr. After the temperature has been reached, it is held for 4 hr. to allow the heat to penetrate the work. After this 4-hr. interval the fuel is

turned off, and the furnace is allowed to cool slowly, the work not being taken out until a temperature of 400 or 500 deg. F. has been reached.

The furnace is of the type known as the car-bottom. A flat car, with a firebrick top, serves as the bottom of the furnace when in place. This car effects a seal with the furnace walls by means of a sand seal. Two cars are used in each furnace, meeting at the center. Each furnace has two doors which, when closed, rest on top of the cars, the latter extending out beyond the furnace walls about 6 in. The cars ride on rails that run right through each furnace and project about 20 ft. beyond in both directions. The cars are handled by winches. The doors are operated by air hoists.

The furnaces are of heavy rail buck-stave type, with red brick outside. The firebrick lining is backed up by cork-brick insulation. Heavy tie-rods tie the buck staves both across and end to end. To prevent leakage of cold air, in giving an oxidizing atmosphere and lowering the furnace efficiency, a furnace back pressure is carried, the flue openings being adjusted to a size to get this condition. As in all surface-combustion work, the furnaces are so designed as to develop and utilize the maximum possible amount of radiant heat. The flues are arranged so as to distribute the hot gases uniformly and to release them at



SURFACE-COMBUSTION ANNEALING FURNACE

Length, 20 ft.; width, 12 ft.; height, 9 ft.; capacity, 20,000- to 40,000-lb. charges of work

the lowest possible temperature. Each furnace is equipped with 20 surface-combustion high-pressure burners.

The furnace is controlled from a central control point by a single valve that regulates the pressure. By raising or lowering the pressure the gas supply is increased or decreased, thereby raising or lowering the temperature. All pyrometer readings are also taken at this point from a multiple-point indicating instrument. Four couples are located in each furnace, one in the center on each side of each car. A very small amount of a man's time is required to hold the furnace to the exact temperature called for.

Hand Screw Machine

As shown by the illustration, this machine is fitted with a plain three-step cone of large diameter and face. It will be noticed also that a guard is provided for the cone in the form of a well entirely covering the lower half of the cone, which also provides bearing rigidity.

The headstock is cast solid with the bed. The cutoff is large with gibbed bearings. The handwheel for adjusting the position of the cutoff is provided with a large diameter dial with adjustable clips, so that the different shoulder lengths can be accurately duplicated. The turret slide and saddle unit is provided with a supplementary base and taper gibs for vertical and horizontal adjustment.

The slide is operated by turnstile and rack and pinion and the turret is automatically indexed by the backward

pilot end, and is so constructed that the overhang for either bar chuck or casting chuck is reduced to a minimum. Adjusting collars with hardened and ground thrust washers are provided for taking up end thrust.

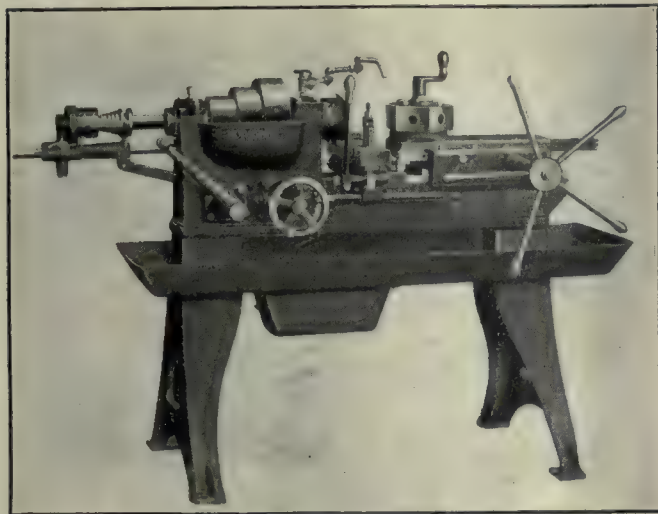
The automatic chuck and bar feed, operated by the long lever at the left of the machine, grips the bar instantly and releases it completely. One movement by the operator serves to open the chuck and feed the bar without stopping the machine. A stepped wedge, operating the fingers automatically, compensates for slightly varying diameter of stock.

Collets can be changed quickly by unscrewing collet hood. Collets and collet hood are hardened and then ground, to insure accuracy. Chucks or fixtures for extra size pieces can readily be attached to spindle nose in place of collet hood.

The oil pump is driven by a separate belt directly from a pulley on the countershaft and operates equally well in either direction. It delivers an ample supply of oil, distributed by means of an adjustable pipe. A partition in the reservoir prevents the possibility of sediment entering the pump.

The machine depicted is a recent product of the Stenotype Co., Indianapolis, Ind.

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TURRET HAND SCREW MACHINE

Bar-stock capacity through automatic chuck, 1 in.; swing over bed, 13½ in.; swing over cutoff, 6 in.; cutoff travel, cross feed, 5½ in.; cutoff travel, longitudinal, 9 in.; diameter of holes in turret, 1¼ in.; center of holes in turret to top of slide, 2⅝ in.; diameter of hexagon across flats, 7¼ in.; greatest distance end of spindle to turret, 15 in.; hole in spindle, 1½ in.; thread of nose, 3¼-in. diameter by 8 pitch; width of drive belt, 2¼ in.; friction pulleys on countershaft, 10x4½ in.; speed of countershaft for steel, 230 r.p.m.; speed of countershaft for brass, 560 r.p.m.; weight, 1,375 lb.

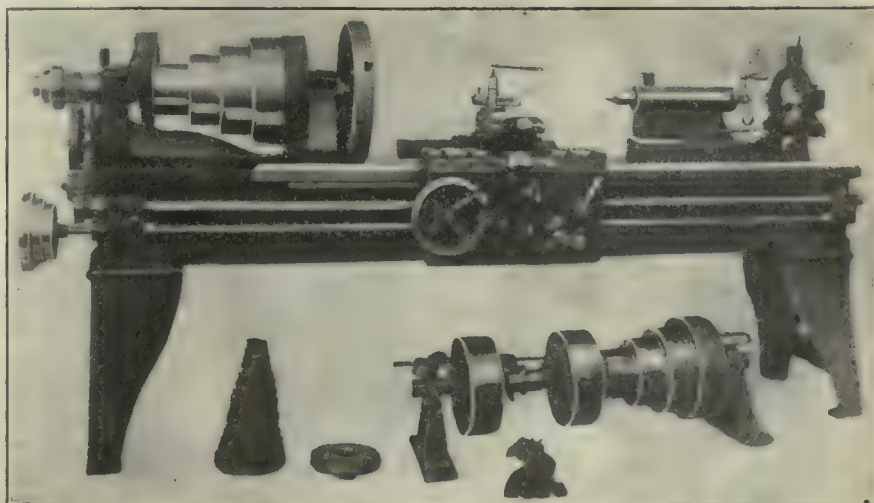
movement of the slide. It is held firmly in its seat by a large steel stud upon which it revolves. This stud is tapered and provides adjustment for taking up wear and is so bored that long stock can pass through the turret, thus permitting the advantageous use of short, stiff tools.

The lock bolt is of large diameter. It operates vertically, locking into hardened and ground steel turret bushings, and is provided with a taper end working into a taper hole in the bushings so that the turret is locked firmly in position. This locking position is at the front end of the slide, almost directly under the tool. The tool holes in the turret are bored in the machine itself after assembling, to insure that the holes line up with the spindle. Six stops are provided, one for each face of the turret, and when set they operate automatically for each position of the turret. They are threaded for their full length and each one is provided with a binder for clamping it into position when set. The spindle is a high-carbon steel forging, ground to size. The bearings are die-cast from a special composition babbitt. Sight-feed oilers are provided for lubricating spindle bearings. The spindle nose is threaded and provided with

Cone-Head, Back-Geared Lathe

The lathe shown is made by the Hollingworth Machine Tool Co., Covington, Ky., and is known as style H. The bed is wide, deep, well webbed and very heavy. It has three large V's and one flat way in front, thereby permitting the making of the crossbridge of the carriage extra strong. The pads for the lead screw and feed-rod brackets are grooved and planed to fit each other, assuring true and permanent alignment. The headstock is massive and braced to prevent vibration or chatter. Four-step cones are regularly furnished with single back gears. Double back gears are supplied on order only.

The spindle is made of special crucible steel and is accurately ground. Spindle boxes are of phosphor



CONE-HEAD, BACK-GEARED 18-IN. LATHE

Swing over shears, 19 in.; swing over carriage, 12 in.; length between centers, 6 ft.; bed, 30 in.; front-spindle bearing, 2¾x5 in.; rear-spindle bearing, 2¾x4 in.; hole through spindle, 1½ in.; spindle nose, 2¾ in. in diameter, 4 threads, U.S.S.; headstock cone, four steps, for 3½-in. belt; back-gear ratio, 7½ to 1; tail spindle, 1½-in. diameter and 8½-in. travel; spindle speeds, 9 to 468 r.p.m.; threads cut, including 11½, two to twenty-six; length of carriage bearing on shears, 22¼ in.; size of tools, 1½x1½ in.; steadyrest takes 5½-in. diameter; countershaft pulleys, 12x4 in.; countershaft speeds, 175 and 225 r.p.m.; weight, 8-ft. bed, 2,550 lb.; skidded, 2,750 lb.; boxed, 81 cu.ft.; extra taper attachment turns tapers up to 19 deg., or 4 in. per ft. by 20 in. in length

bronze, and anti-friction thrust bearings are provided, with nut for wear adjustment. The tailstock has a curved front, allowing the compound rest to be used at right angles to the slide. It also has the usual set-over arrangement for tapers. The carriage is large and securely gibbed. It has both longitudinal and cross power feeds, and the cross-feed screw has micrometer adjustment. The compound rest has wide bearing surfaces and is fitted with taper gibs requiring only one screw for adjustment. The compound-rest swivel is graduated in degrees, so as to be quickly adjusted to any angle. The screw also has micrometer adjustment.

The apron is tongued and grooved into the carriage, so as to avoid the strain being taken by screws. Both longitudinal and cross feeds are reversible from the apron, and both are friction driven and easily thrown in or out. The feeds are taken from the spindle with either belt or gears, making the range considerable. The countershaft has double friction pulleys, very easily operated. The lead screw, feed rod and all racks and pinions are cut from high-grade steel; all gearing is cut from the solid; all spindles, studs and the like are finished and ground to a bearing, and all sliding surfaces are scraped to a bearing. The regular equipment includes compound rest, double friction countershaft, large and small faceplates, steadyrest, follow rest, change gears and wrenches. Extra equipment such as taper attachment, turrets, chucks and the like are furnished on order at extra cost.



Inserted-Tooth Metal Saw

The inserted-tooth form of metal saw illustrated represents a late development of the Simonds Manufacturing Co., Fitchburg, Mass.

The teeth are made of high-carbon, heat-treated steel, flattened without hammering, and the saw is designed to fit any type of arbor-driven machine.

The projection on the front of the tooth holds the bottom of the tooth firmly on the plate so that it cannot work



INSERTED-TOOTH METAL SAW

up or down. This projection is also intended to make it unnecessary to drive the wedge back of the tooth hard enough to disturb or destroy the plate.

The oval teeth are slightly higher than the square teeth, in front of which they cut a channel. Thus the chip is broken into three pieces, so that it clears and comes out freely. Therefore the material will not become welded on the face of the tooth and on the side of the saw.

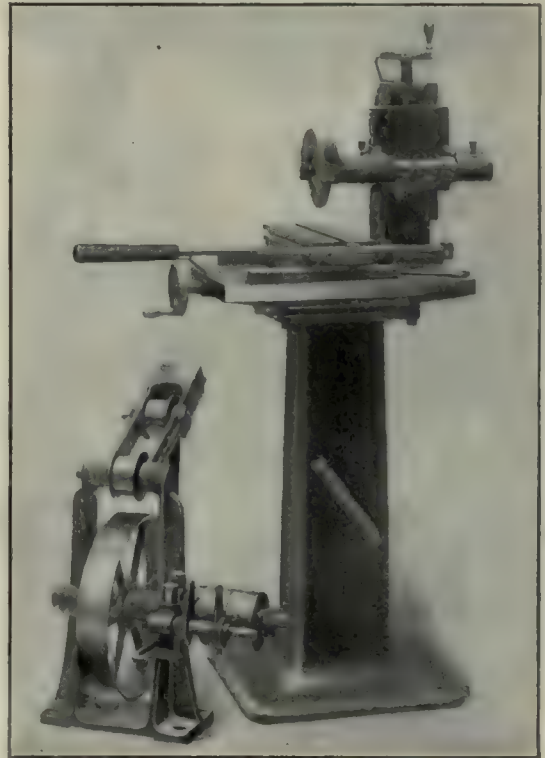


Hand Surface Grinder

The immediate duty for which the machine shown was designed is the grinding and finishing of flat surfaces on punches, dies and other machined parts where the finished surfaces are required to be flat and true.

The spindle is carried in a vertical slide and is operated by a handwheel having graduations of 0.001 in. It is provided for "take up" of wear.

The platen has two movements, longitudinal and transverse, the latter feed being by handwheel, with gradua-



HAND SURFACE GRINDER

Size of platen, 15x5 in.; traverse of platen, 8 in.; vertical adjustment, 7 in.; maximum distance between wheel and platen, 6 in.; minimum distance between wheel and platen, 0; size of wheel, 6x½ in.; crossfeed, 6 in.; weight, with countershaft, 435 lb.

tions of 0.001 in., in the same manner as the vertical feed. Longitudinal movement of the platen is by means of a band lever so proportioned as to give a quick and accurate movement to the work. Provision is made whereby large bearing surfaces are given to both movements. These surfaces are fitted with gibs to take up wear.

The machine described is a recent product of the New Jersey Machinery Exchange, Newark, N. J.



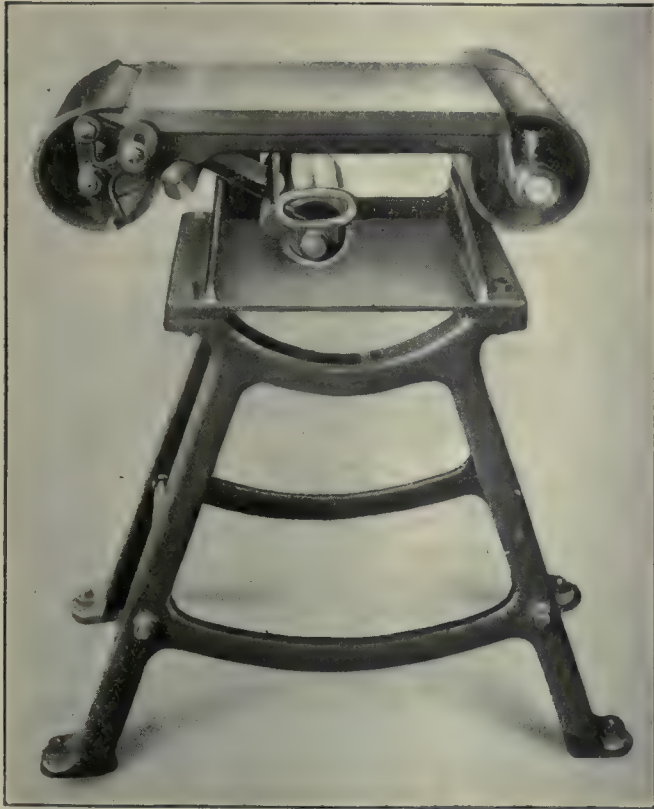
Abrasive-Band Grinder

It will be seen that the frame of the surface endless-belt type of grinder shown is a rigidly braced casting, of which the table is machine scraped. The mainshaft is lubricated by means of grease cups. The abrasive bands are jointless and are drawn over the table by the main driving pulley. A band tension pulley takes up all slack. Quadrants for adjusting the pulley centers, to allow for

unequal stretch of the bands, are provided, and a graduated adjustable rest is designed to eliminate the necessity for a skillful operator in grinding work accurately at any angle.

A flanged pulley on the mainshaft is driven by a separate countershaft.

As all the driving parts are below the surface of the table, the size of work to which it can be applied is unlimited, so far as the application of the machine is concerned.



ABRASIVE-BAND GRINDER

Table, 18x11½ in.; band pulleys, 6x9¼ in.; driving pulley, 5½x2¼ in.; pulley speed, 1,000 r.p.m.; cutting speed, 1,500 ft. per min.; floor space, 30x19 in.; weight, 350 lb.

The grinding band can be adjusted laterally while the machine is running. This is done by two knurled-head screws.

The band may be rapidly put on, adjusted or removed without the use of any tools.

The machine shown was built by the Victor Machine Co., Albany, N. Y., for the Selson Engineering Co., New York City.

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Hydraulic Briquetting Press

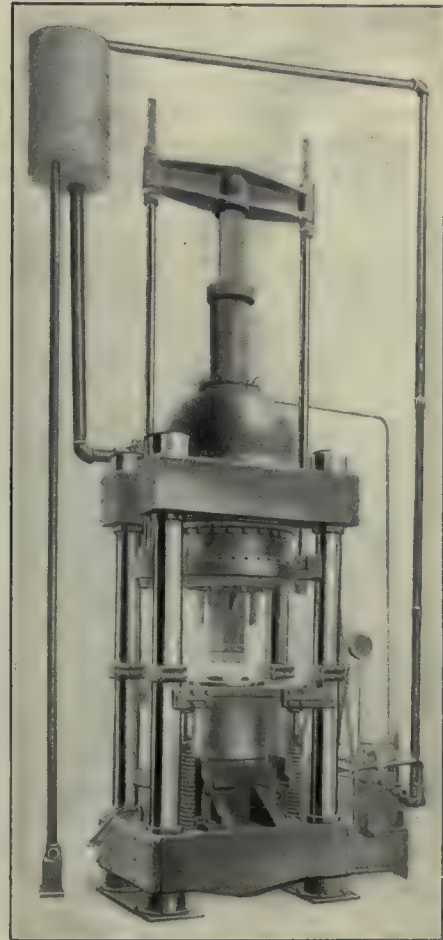
The illustration shows a new design of hydraulic press recently brought out by the Hydraulic Press Manufacturing Co., Mount Gilead, Ohio. The press is used for briquetting metal borings, turnings, etc., so that they may be remelted without the loss of valuable ingredients. This method prevents oxidation and also puts the material in a convenient form for handling.

The briquets are formed by placing the material in a floating mold, which is supported by four springs. When the pressure is applied from above, the friction of the material on the sides of the mold causes it to move down over a stationary plunger that projects into the mold from below. Pressure is thus given to the bottom as

well as to the top of the material, and a briquet of uniform density is obtained.

After being formed, the briquet is ejected from the mold by the pressure of the main ram, the lower plunger having first been removed by a simple movement of a controlling lever. The briquet then falls through to the base of the press, whence it is removed by a conveyor.

The press illustrated is provided with a surge tank, the base of which is located higher than the main cylinder. By a simple movement of the valve lever the plunger drops to the material in the mold, and the main cylinder is filled with fluid by suction caused by the lowering of the ram as well as by gravity of the fluid. Thus the first stroke of the pump initiates the pressure upon the



HYDRAULIC BRIQUETTING PRESS

Three sizes; capacities, 1,000, 750 and 300 tons

material. After the pressing operation the main ram is returned by means of the auxiliary ram located at the extreme top of the press. This action returns the fluid to the surge tank.

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What Caused the Quebec Bridge Disaster?

By no means the least remarkable circumstance in connection with the disaster to the great bridge at Quebec is the fact that although the disaster was witnessed by over a hundred of the most eminent structural engineers in both Canada and the United States, including the expert staff engaged in the erection of the bridge, it was not certainly known for 24 hours after the disaster exactly where was the initial point of failure.

When the first unsatisfactory press dispatches came over the wire, telling practically nothing, save that the span had collapsed and gone to the bottom of the river, the most probable conjecture seemed to be that something had gone wrong during the ticklish process of mooring the span into exact position and transferring it from the scows which brought it to the bridge site to the hanger chains. As this was apparently the most delicate part of the work, the possibilities of trouble from wind or tidal currents or other unforeseen interference with making the connections to the cantilever arms loomed large in the imagination. These first speculations were of course swept one side when the news came that the span had been actually hung from the lifting chains and hoisted some distance when the collapse occurred.

Many engineers, doubtless, then turned their thoughts to a consideration of a possible failure of the lateral bracing of the span. While every precaution had been taken apparently to make sure that the bridge should be kept level while the lifting process was going on, it was of course possible that one corner might be lifted more rapidly than the others, producing a torsional effect on the truss. It was conceivable, at least, that such uneven hoisting might have gone far enough to throw such stresses into the lateral bracing as to cripple some of the members and cause the collapse of the entire structure. It will be evident that the truss would not have to be canted over very far before its enormous weight would overload the wind bracing.

More circumstantial reports from Quebec disposed also of this hypothesis. Had the failure occurred in such a manner, the great number of expert bridge engineers who watched the failure would have promptly identified and reported its evident cause. The same is true of any failure within the suspended span, from whatever source; and more than this, the span was a piece of bridgework of ordinary type, and internal failure was no more likely than in any other large truss bridge in which the elements had been similarly fabricated.

The huge lifting chains by which the truss hung suspended did not fail. They are intact, with the lifting girders still attached to their lower ends. The suspended span alone is gone. That is the basal fact. The swinging chairs on which the span was seated are intact—barely scratched—but their burden has slipped off into the river.

The place of initial failure, then, is narrowed down to the place where the truss rested on the girders which hung from the bottom of the lifting chains. Study of the drawings of this connection shows that the rocker bearing on which the truss rested was over 4 ft. higher than the pin-bearing through the girder by which the load was transferred to the chains. To hold the girder from rotation, there were plate-and-angle connections between the top chord of the girder and the short built-hanger link which formed the means of attaching the girder to the chains.

Of course, so long as the span remained absolutely level, and absolutely central on the lifting girder, there was no tendency to tip or rotate the girder, and no strain against the plate-and-angle connection just mentioned. At the moment of the accident something happened which upset this condition of perfect central loading. If the steel casting which supported the south upstream corner of the span broke under its load of some 1,300 tons, its fracture would have produced the loud report with which the disaster began. As the truss shoe settled down through the broken fragments of the casting, it was bound to destroy irrecoverably the delicate condition of central loading. It may have kicked the supporting girder out from beneath it; it may have shoved it far enough to one side so that the unbalanced load on the girder would rotate it on its pin and let this corner of the truss slide off. In either case the wreck of the suspended span would occur as the eyewitness account describes it. One corner unsupported and only the unsteady swinging chairs under the other three, the ponderous span was bound to go to the bottom.—*Engineering News.*

Personals

Allan R. Risteen, for several years connected with the engineering and inspection division of the Travelers' Insurance Co., has been appointed director of technical research and safety publication work.

Carl N. Richardson has resigned his position as foreman of the barrel department of the Remington Arms and Ammunition Co., Ilion, N. Y., in order to become toolroom foreman of the Champion Ignition Co., Flint, Mich.

John L. Thompson, who has been assistant chief engineer of the engineering and inspection division of the Travelers' Insurance Co., Hartford, Conn., has been appointed superintendent, in charge of the division, the change in organization resulting from the recent death of George Gilmour.

Franklin G. Hubbard, for more than 18 years connected with the Western Electric Co., most recently as chief engineer of the plant at Hawthorne, Ill., has resigned in order to become associated with the H. E. Harris Engineering Co., Bridgeport, Conn. Mr. Hubbard has secured an interest in the company and will act as vice-president in charge of manufacture.

Obituary

John A. Berger, a founder of the Berger Manufacturing Co., Canton, Ohio, died on Sept. 8. Mr. Berger had been inactive for several years.

William H. Jones, vice-president of the International Harvester Co., and head of the Plano

works at the time of the consolidation, died in Pasadena, Calif., Sept. 1.

Levi J. Gunn, who before he retired in 1910 was president of the Millers Falls Co., Greenfield, Mass., of which company he was one of the founders in 1868, died on Sept. 9, aged 86 years.

Max Rubin, a well-known inventor in the metal novelty field, and with a record of over 100 issued letters of patent, covering principally holding and fastening devices, such as clasps and buckles, died at his home in Brooklyn, N. Y., Sept. 13, after a long illness.

Trade Catalogs

Roller Bearings. Hyatt Roller Bearing Co., Newark, N. J. Bulletin No. 401. Pp. 12. 7x10 in. This describes high duty type bearings and gives sizes and prices.

Roller Bearings. Hyatt Roller Bearing Co., Newark, N. J. Bulletin No. 202. Pp. 6. 7x10 in. This describes planished race type bearings, and lists sizes and prices.

Electric Motors. The Lincoln Electric Co., Cleveland, Ohio. Bulletin. Pp. 48. 8x10½ in. Describes induction motors for two- or three-phase alternating current and their adaptation in various lines.

Forthcoming Meetings

National Machine Tool Builders' Association. Annual convention, Oct. 24-25, Hotel Astor, New York City. Charles E. Hildreth, general manager, Worcester, Mass.

American Society of Mechanical Engineers. Monthly meeting, first Tuesday. Calvin W. Rice, secretary, 29 West 39th St., New York City.

Boston Branch National Metal Trades Association. Monthly meeting on first Wednesday of each month, Young's Hotel. W. W. Poole, secretary, 40 Central St., Boston, Mass.

Providence Association of Mechanical Engineers. Monthly meeting, fourth Wednesday of each month. J. A. Brooks, secretary, Brown University, Providence, R. I.

New England Foundrymen's Association. Regular meeting, second Wednesday of each month, Exchange Club, Boston, Mass. Fred F. Stockwell, 205 Broadway, Cambridgeport, Mass.

Engineers' Society of Western Pennsylvania. Monthly meeting, third Tuesday; section meeting, first Tuesday. Elmer K. Hiles, secretary, Oliver Building, Pittsburgh, Penn.

Rochester Society of Technical Draftsmen. Monthly meeting, last Thursday. O. L. Angevine, Jr., secretary, 857 Genesee St., Rochester, N. Y.

Superintendents' and Foremen's Club of Cleveland. Monthly meeting, third Saturday. Philip Frankel, secretary, 310 New England Building, Cleveland, Ohio.

Western Society of Engineers, Chicago, Ill. Regular meeting, first Wednesday evening of each month, excepting July and August. J. H. Warder, secretary, 1785 Monadnock Block, Chicago, Ill.

Philadelphia Foundrymen's Association. Meetings first Wednesday of each month. Manufacturers' Club, Philadelphia, Penn. Howard Evans, secretary, Pier 45 North, Philadelphia, Penn.

Technical League of America. Regular meeting, second Friday of each month. Oscar S. Teale, secretary, 35 Broadway, New York, N. Y.

Old-Time Tools and Mechanics in a New England Shop--I

BY FRANK A. STANLEY

SYNOPSIS—In what is stated to be the oldest pump-manufacturing plant in the world, located in Connecticut, there are a number of machine tools dating back to 1832, or nearly a century ago. Some of the lathes have six lead screws of odd pitches, so as to cut threads which could not be easily duplicated. This necessitated repairs to be sent to the shop where the work was done.

In an earlier article on the manufacturing plant and methods of the W. & B. Douglas Co., Middletown, Conn., reference was made to some historic tools built at this plant nearly a century ago, for the concern dates back

facturing processes. At one time or another it has had in its employ, either as apprentice boys or journeyman machinists, many pioneer mechanics who later became prominent engineers.

EARLY LATHE DESIGN AND CONSTRUCTION

As most readers are aware, the early engine lathes in this country, like those in Europe, were more or less modifications of the still earlier woodworking machines. The latter, in many cases, consisted of simple headstocks and footstocks mounted on sharp V's made of metal strips secured to wooden beds, which in turn rested on wooden columns or other supports of similar nature. The ways were generally very narrow and of insufficient



FIG. 1. ENGINE LATHE BUILT ABOUT 1833

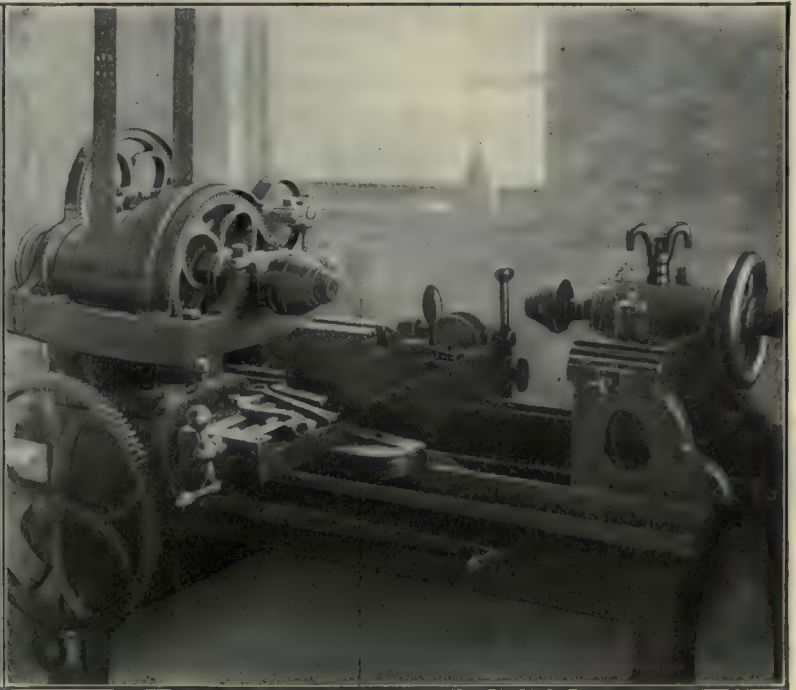


FIG. 2. EARLY ENGINE LATHE WITH POWER CROSSFEED

to 1832 and immediately started to construct its own manufacturing equipment. Some of these machines are still in operation. A number, particularly engine lathes, built about that time, have seen almost continuous service through the 80-odd years intervening and are today utilized for certain simple operations in connection with the manufacture of pump castings.

It is purposed in the present article to illustrate some of these tools and later to refer to a number of mechanics who have been continuously employed in the Douglas shops, not for 80 years, but for upward of half a century. This is quite a record even for the older generations of machinists in New England, where one occasionally knows of individuals who have spent the greater portion of a long lifetime directly engaged in shopwork.

The Douglas plant, springing up as it did in the center of the early manufacturing district of Connecticut, did its part in the developing of machine design and manu-

bearing surface. This construction prevented smoothness of operation, and the ways were apt to wear quickly as compared with later designs, so that such tools after having been in use for a time were thrown out of alignment in different directions, assuming that they ever were correct. The methods of construction and erection at the time were very crude as compared with those developed in later years as a natural evolution, along with the improvement in the design of the tool itself.

These early machine tools at the Douglas plant incorporated a number of features from the design of woodworking machinery and had originally other characteristics still more conspicuously allied to the wood-turning lathe. Many of these details have been superseded by one feature after another more in harmony with a machine devoted to the handling of metal parts.

Figs. 1, 2 and 3 illustrate three lathes made by this company about 1833 and therefore now over 83 years

of age. The machine in Fig. 1 is the oldest of the group, although the others were built shortly after. This lathe, like several other old-timers in the plant, was originally constructed with a wooden cone pulley for the spindle, but this was replaced many years ago by a regular iron cone.

The difficulties attending photographing such machines, where much of the mechanism is suspended below the bed and down toward the floor, were such as to make it practically impossible to secure entirely adequate views showing the entire construction. The different views, however, make it quite easy to understand the

on the spindle and passing over the spindle pulley near the bottom of the machine, this lower pulley being mounted on a wormshaft with worm engaging with a large gear wheel located on a shaft placed crosswise of the lathe, where it is supported in suitable bearing brackets mounted upon the inner sides of the legs under the head of the lathe.

Above the gear wheel is a second worm, and the carriage feed is obtained in either direction by throwing a lever at the front, which engages the proper worm. The power from the driven shaft below, operating through the medium of either one of the worms, is carried back

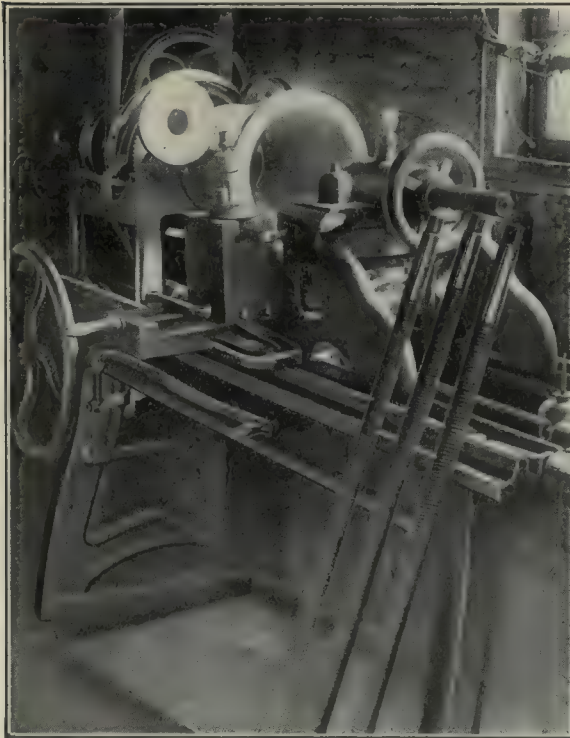


FIG. 3. OLD LATHE WITH SET OF FEED SCREWS



FIG. 4. A FACING JOB IN OLD LATHE

method of driving the feed mechanism, besides bringing out the principal features of design.

Fig. 4 is a view of the same machine as in Fig. 3, but is taken from a different position, in order to show more clearly the mechanism below the bed. The two views combined enable one to follow the general arrangement of mechanism from driving cone down to feeding apparatus. While this machine was built a little later than the one illustrated in Figs. 1 and 2, it is essentially the same in design and construction, and the principal features of the earlier lathes may therefore be understood upon examination of Figs. 3 and 4.

FEED-SCREW DRIVE

As will be noticed, the carriage was designed to rest upon the tops of rounded ways, with a shallow guiding surface to prevent twisting, and in the center is a lead screw directly under the carriage bridge. This is an ideal position for smooth operation, long wear and accurate results, assuming suitable means could be devised for preventing the dropping of chips and dirt into the screw and nut. The method of gearing this screw from the spindle is clearly shown in all the views. The turning feed is derived from a round belt coming down from the grooved pulley at the small end of the driving cone

to spur gearing which, by means of a pinion under the lathe bed engaging with a rack shown projecting from the left-hand end, operates the carriage for the turning cut. This gearing is shown in the different views, and its general arrangement will be readily understood.

In the case of the lathe illustrated in Fig. 2 the feed gearing is at the front of the head, although in most of the instances represented in the Douglas equipment this large gear and pinion are at the back of the head out of the way, and a good-sized handwheel is carried on the front end of the shaft for hand traverse of the carriage.

Referring again to Fig. 2, this lathe is equipped also with power crossfeed, the mechanism being seen at the back of the carriage bridge. This is supposed to be about the earliest power crossfeeding carriage built in this country. It was developed in the Middletown shop about 1834 or 1835. It is designed to feed the carriage either in or out, the screw being driven from the rear by a pair of bevel gears. Either pair is thrown into operation by an engaging pinion between the two, this being thrown back or forth by the handle extending upward above the cross-slide guide. Three of the lead screws will be seen standing up against the front of the bed in Fig. 3. They are only part of the equipment of lead

screws for each of these old lathes, each screw being a different pitch from the others.

As many mechanics are aware, it was customary in the early days of the machine industry in this country to make a good many parts with odd threads and odd sizes generally, the belief being that in this manner a manufacturer of a certain line of goods retained for an indefinite period a practical monopoly of repair and replacement work. It was thought that other manufacturers would be unlikely to duplicate such parts as odd sizes of screws, odd threads and various pieces whose actual proportions could not be readily determined owing to some peculiarity in threads, in angle of surface or otherwise.

This condition existed for a long time, and most of us have seen more or less of the hold-overs of the practice in fairly modern times. The benefits of standardization, along such lines had not occurred to early machine-shop proprietors; and it is quite possible that 100 years or even 50 years ago not only would our modern systems of standardization have been impossible, but if they could have been adopted at all, their influence might have been entirely different from what they are at the present time. Today we view everything in the metal-products line as necessarily made to some common standard and expect not only interchangeability throughout the product of a given plant, but to a greater or less extent even look for interchangeability between one man's product and another's. This is most commonly seen of course in the case of the screw-thread situation, where bolts, nuts and screws are gathered from all parts of the country and expected to be interchanged more or less freely and to enter holes tapped out by miscellaneous taps, also gathered from all sources.

Yet this question of screw threads has not always been an easy proposition for the shop determined to standardize its work. Even today we have more or less difficulty in the attempt to induce progressive manufacturers consistently to adopt certain recommended standards tending toward elimination of odd sizes of taps and odd sizes of threads. These often vary only a few thousandths, but just enough to make a good, snug-holding fit impossible unless, through a happy circumstance, an off-size screw happens to be put into a hole made with a tap off size by the same amount.

IMPORTANCE OF REPAIRS NOT RECOGNIZED

In the early times referred to, the Douglas plant and many other of the now well-known New England concerns were just getting on their feet, and the proprietors could not foresee an unlimited market for their product.

Recognizing then, as they do today, that repair work must always be a more or less important part of the entire sum of shop production, they took pains by adopting arbitrary standards to secure to their plant the work of repairing and replacing their own machine parts as required in service.

The conditions of the times did not impose through high speeds and feeds such severe stresses upon machine tools and other equipment as is the case in modern industry. But a general lack of knowledge of the strength of materials, less definite information of how to prepare foundry mixtures and how to select suitable steels, assuming such steels were available, all tended to make the life of certain machine parts rather limited at the best. This was

still more the case in concerns where the uses of machine tools were not always in accordance with what was even then the best practice. A general acquaintance with shop operations was unusual; and while the so-called all-around mechanic was just beginning to come into his own in those days, he represented a class few and far between. And too often, even in those idealistic bygone times, machinery was put into the hands of utterly unskilled men for its operation. They were quite as careless as some of the thoughtless machine operators now occasionally found in large establishments working under the high pressure imposed by modern manufacturing conditions.

One of the most interesting features of the work done at this old plant at Middletown in its early days was the odd screw standards produced and maintained by the use of a number of lead screws for each machine. These lead screws were not of even threads, such as 4, 5, 6 or 7, but were cut to some peculiar fractional thread, such as $4\frac{5}{7}$, $5\frac{6}{7}$, $7\frac{2}{3}$ threads per inch, and so on. With this outfit of screws some very awkward threads to measure and duplicate could be easily produced. The modern manufacturer could have many a smile at the possibilities of controlling replacements of all threaded parts by the simple device of adopting a set of six lead screws for each lathe, each screw so cut that no ordinary combination of gears could possibly translate the threads cut into one of the modern pitches.

THE TRANSITION PERIOD

As a matter of fact, in the course of time this shop began making threaded parts to standard dimensions as then determined, and added translating gears to its old gearing, so as to cut all standard threads with these fractional-pitch lead screws. So today, while the screws are still in use in so far as these lathes are employed at all for threading purposes, the change gearing in the equipment is suitable for producing the usual standard pitches.

As originally built, there were few change gears with the equipment; hence the series of screws required for threading different jobs. It is probable that while there were originally but few change gears used, there was a single lead screw used for each of the odd threads. In any event, for a good many years now, change gears have been attached to each lathe for translating the fractional threads into the conventional standards.

The shifting of one screw—that is, the removing of one lead screw and its replacement by another—is a simple matter. The screws are formed at one end with a coupling connection to enter a sleeve on the inner end of the geared driving shaft projecting forward under the headstock of the lathe, while the outer end of the screw is adapted to take a bearing against a center carried by a bracket at the right-hand end of the lathe bed.

SOME SIMPLE OPERATIONS

Brief reference may be made at this point to some of the work handled on these old tools. The castings in Figs. 3 and 4 are typical of the average run of work so handled, although this is perhaps a somewhat more awkward piece to chuck and face than the majority of castings coming to this department. It is, however, so far as the machining process goes, a simple job of passing the facing tool down across the outer flange to surface

it flat and smooth. After all, the principal part of the undertaking with a good deal of such work on any machine is to place it in the chuck or secure it to the faceplate. The method of holding is often a matter of more importance to the operator than the means provided for tooling the surface itself.

A large share of the material coming to this department is made up of simple castings to bore and face, short connections to bore out and thread, and a thousand and one parts of similar character, simple in nature and not heavy in weight. The principal requirements for their satisfactory production are a simple spindle, sufficiently rigid to support them without appreciable vibration, feeding apparatus to cover a short longitudinal distance, and a crossfeed and tool-holding device for surfacing ends or portions of work of no extensive area. This is a class of work that abounds in a great many other shops, and it is a field where the simple engine lathe is always likely to find liberal use. Hence these old tools, dating as far back as they do, with few of the modernized special features of our latter-day equipment, serve their purpose satisfactorily and are doubtless good for a number of years' service yet on this character of material.

(To be concluded)

Interesting Methods Used in a Machine-Tool Shop.

By A. TOWLER

The Becker Milling Machine Co., Hyde Park, Mass., employs a number of interesting methods and tools in the machining of elements for machine tools. The illustration, Fig. 1, shows a fixture for testing the head

Fig. 2 is shown the planing of a vertical miller stand. After the casting has been securely fastened on the machine table, the planing fixture is set in position. It will be seen that with this arrangement, by using the correct size block against the dovetail gage, the planing tool may be set to the desired location.

The tool is then fed against the casting and the various surfaces are planed. By using the set gages all laying out and measuring of the casting to set the tools are avoided.

The operation of planing four miller knees is shown in Fig. 3. The castings are held in fixtures as shown and the gage block, after being lined up with the slot in the table, is fastened. A similar sequence, as described, is then followed in the machining of these castings.

Polishing Lathe for Shells

By JOHN S. WATTS

Before putting the shells in for final government inspection it is necessary to clean all varnish, rust, grease, dirt, etc., from the outside of the shell. To do this quickly the lathe shown by the accompanying illustration has proved very successful. It requires no countershaft, as it does not have to be stopped and started to put shells in or out. It can be belted direct to the lineshaft. It can be bolted to a stand or put on a bench in any convenient place.

The headstock is simply two babbitted bearings with a $1\frac{1}{4}$ -in. shaft for the spindle onto which a faceplate is keyed.

The faceplate is faced with a circular piece of leather or other material at A. To fasten the leather to the face-

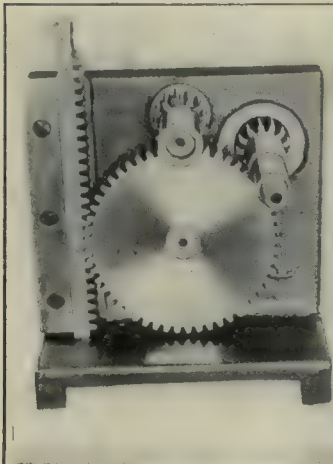


FIG. 1. TESTING DEVICE FOR ELEVATING GEARS

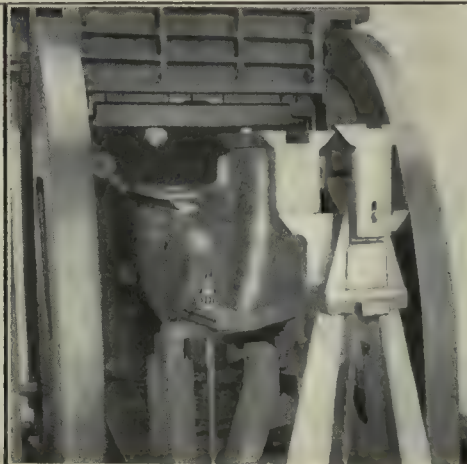


FIG. 2. PLANING THE STAND OF A VERTICAL MILLER

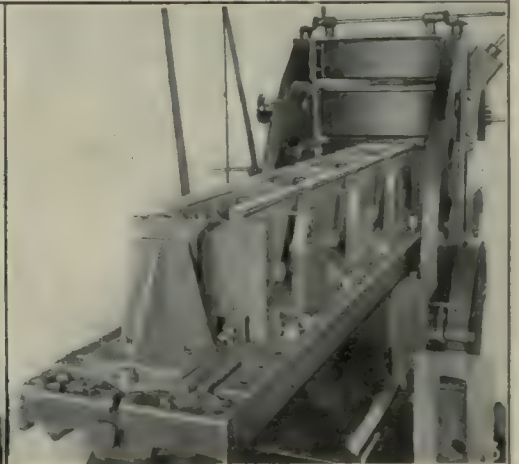


FIG. 3. STRING MACHINING FOUR MILLER KNEES ON THE PLANER

elevating gears. After the various parts have been machined, the gears are mounted on pins as shown. The rack is then slid against the tool-steel block by turning either of the sleeves on which the pinions are cut. The large gear must then slide the rack up and down without friction. The tool is fitted with tool-steel bushings and pins to avoid wear. By using this testing fixture it is known whether the gears and rack have been correctly machined before mounting them in the head.

An interesting method of performing planing operations at this factory is illustrated in Figs. 2 and 3. In

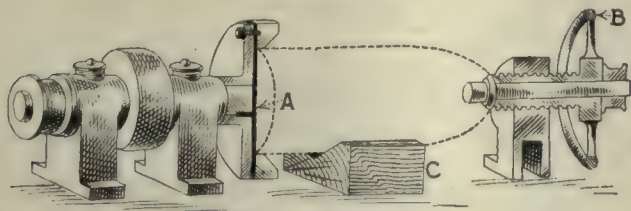
plate a steel ring is bolted over it by means of a capscrew through the faceplate. This ring is bored out slightly larger than the diameter of the shell and chamfered to make it easy to enter the shell.

The tailstock spindle is a cast-iron hand-wheel B with a long threaded hub, and bored out to take the center spindle that fits into the nose of the shell and revolves with it.

The method used to polish the shell is to drop it onto the wooden V-block C, which brings it approximately central with the lathe but slightly below the center line.

so that when the shell is placed and running it will be clear of the wood block. Next screw up the tailstock, which will press the base of the shell against the friction surface of the faceplate and in that way cause the shell to revolve.

A piece of aloxite cloth held by hand against the shell will now quickly and effectively remove all dirt and rust. When the shell is clean, backing off the tailstock will allow



SHELL-POLISHING LATHE

the shell to drop back into the V-block and come to rest. It can then be removed and another shell put in.

Limiting the Value of Inspection

BY P. G. LITTLE

The manufacturer who has installed a thorough system of inspection and considers it to be of vital importance in the operation of his plant, does not regard the purchaser's inspector as a necessary evil, but rather as an aid who will assist with suggestions tending toward the improvement of the product. Such a manufacturer does not have a vast quantity of rejected material on his hands; for the factory inspection will reject and in many instances correct material before production has gone very far.

On the other hand, the manufacturer who regards inspection as too expensive and unproductive often finds he has a shop full of assembled machines that have been rejected by the purchaser, and which must be completely disassembled in order to correct some minor detail. It does not take much figuring in a case of this kind to discover that the lack of a proper inspection method has proved costly.

Some plants that I have visited have had sufficient inspectors of ability to take care of the work satisfactorily, but the way in which these inspectors were compelled to do their task has been such that the inspection was of no value.

At one factory where several thousand men are employed this was especially noticed, as at this plant there is no chief inspector, the inspectors being under the jurisdiction of the respective department foremen. It can easily be seen that in such a case when the decision as to the rejection or acceptance of the material rests with the foreman who is producing the work, it is only natural to expect that many parts will be accepted even against the wishes of the inspector; for what foreman desires to have a large quantity of the material he has produced go to the scrap heap—even if it is wrong?

Where this kind of inspection is in force the expression, "We'll see if we can get by with it," is frequently heard; and the fact that other departments are forced to work with this defective material causes much friction.

At another plant that has come under my observation, it is the practice to pay close attention to the inspection of parts in the machining departments, and the inspec-

tors are well supplied with gages and other equipment to insure correct limits and tolerance; but it is considered that inspection ends when the material passes out of the machine shop. On inspection of the finished machine, in a case of this kind, I have found that during the hardening process parts have cracked and warped, or they have otherwise been spoiled during assembly. Yet this concern considers that its system of inspection has been developed to a state of perfection, and as far as the machine shop is concerned this might be regarded as almost true. But of what value is the inspection unless it applies on the finished machine?

At plants where rejections have been few, it has been observed that almost the same system of inspection is in force; that is, the inspection in every department throughout the shop is in charge of one chief inspector, usually a technically trained man with practical experience.

To enable the chief inspector to produce the best results it is necessary that he be directly responsible to the executives of the concern and not be under the supervision of any superintendents; for when controlled by superintendents he is apt under pressure to sacrifice quality for quantity production, and for like reasons the inspectors should only be under the supervision of the chief inspector.

The point sometimes overlooked in otherwise good systems is that there is no inspector detailed to the shipping department. It will be found that if an inspector is installed there to make final inspection it will be a profitable investment; for many things are found which if allowed to slip by will spoil an otherwise excellent product. For instance, parts are left unpainted, bolts are loose or missing, special equipment that has been ordered is not found, and if the machine has been stored for any length of time it is likely to rust in places, and many other details will need to be corrected.

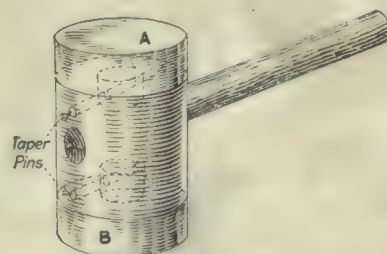
It is a shipping clerk's duty to see that the product is loaded and shipped correctly, and it is foolish to imagine that he can finally inspect it, as is sometimes expected.

Unless the manufacturer realizes that efficient inspection is absolutely necessary to the smooth operation of the plant, he must not expect the product to approach perfection, even if the plant is laid out and equipped along the best lines.

A Soft Hammer

BY B. A. DONLEY

The illustration shows a form of soft hammer more convenient than the ordinary kind. Ends A and B are

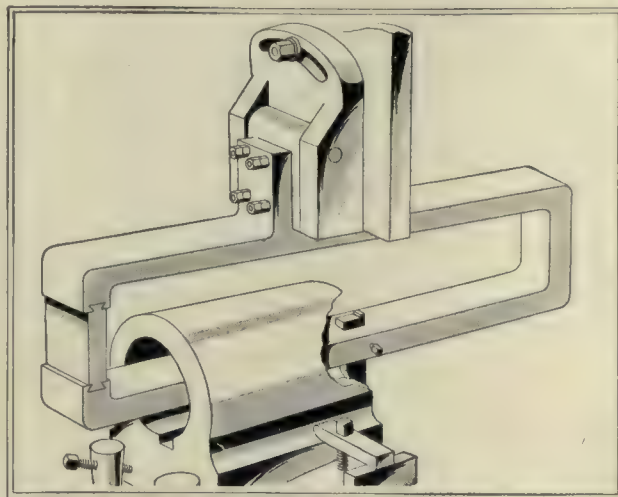


CONVERTIBLE SOFT HAMMER

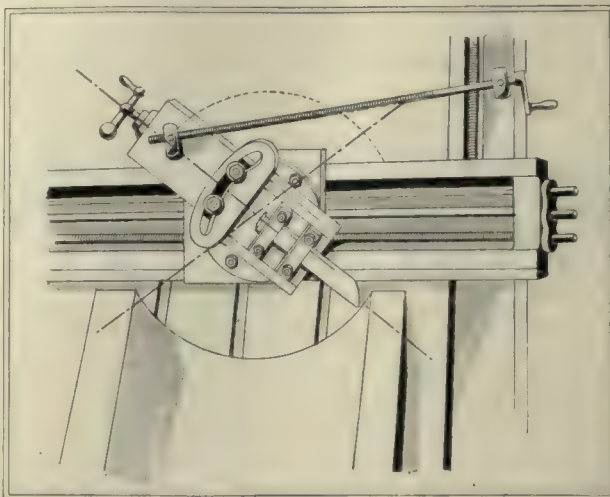
of copper, lead or brass, which may be changed to meet varying needs, being held in position by taper pins. The solid part of the hammer is of iron.

From a Small-Shop Notebook

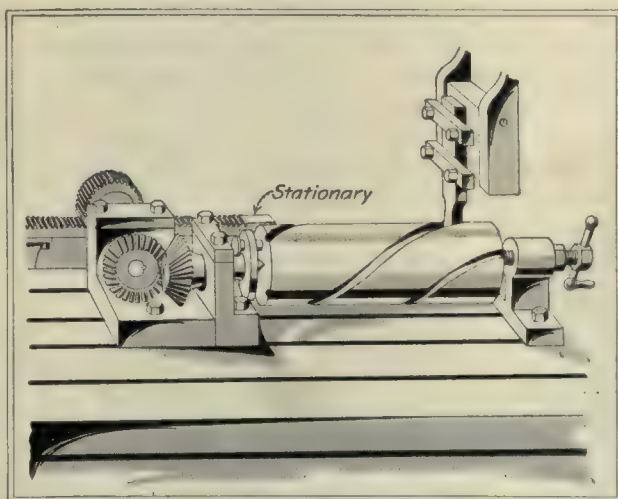
By JOHN H. VAN DEVENTER



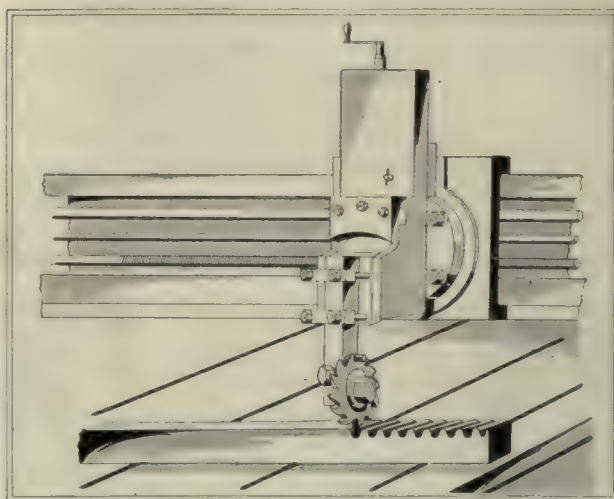
A RIGID RIG FOR KEYWAYING



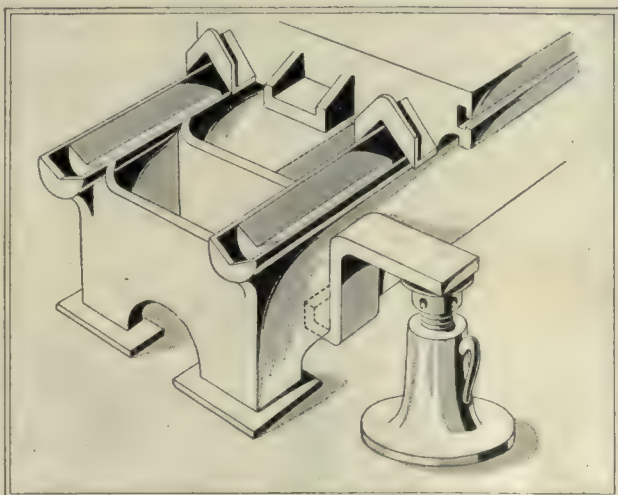
PLANING A CONCAVE RADIUS



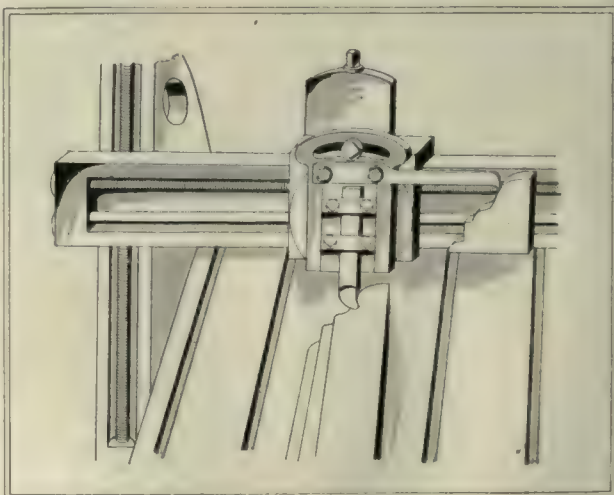
CUTTING SPIRALS ON PLANER



RACK-CUTTING ON THE PLANER

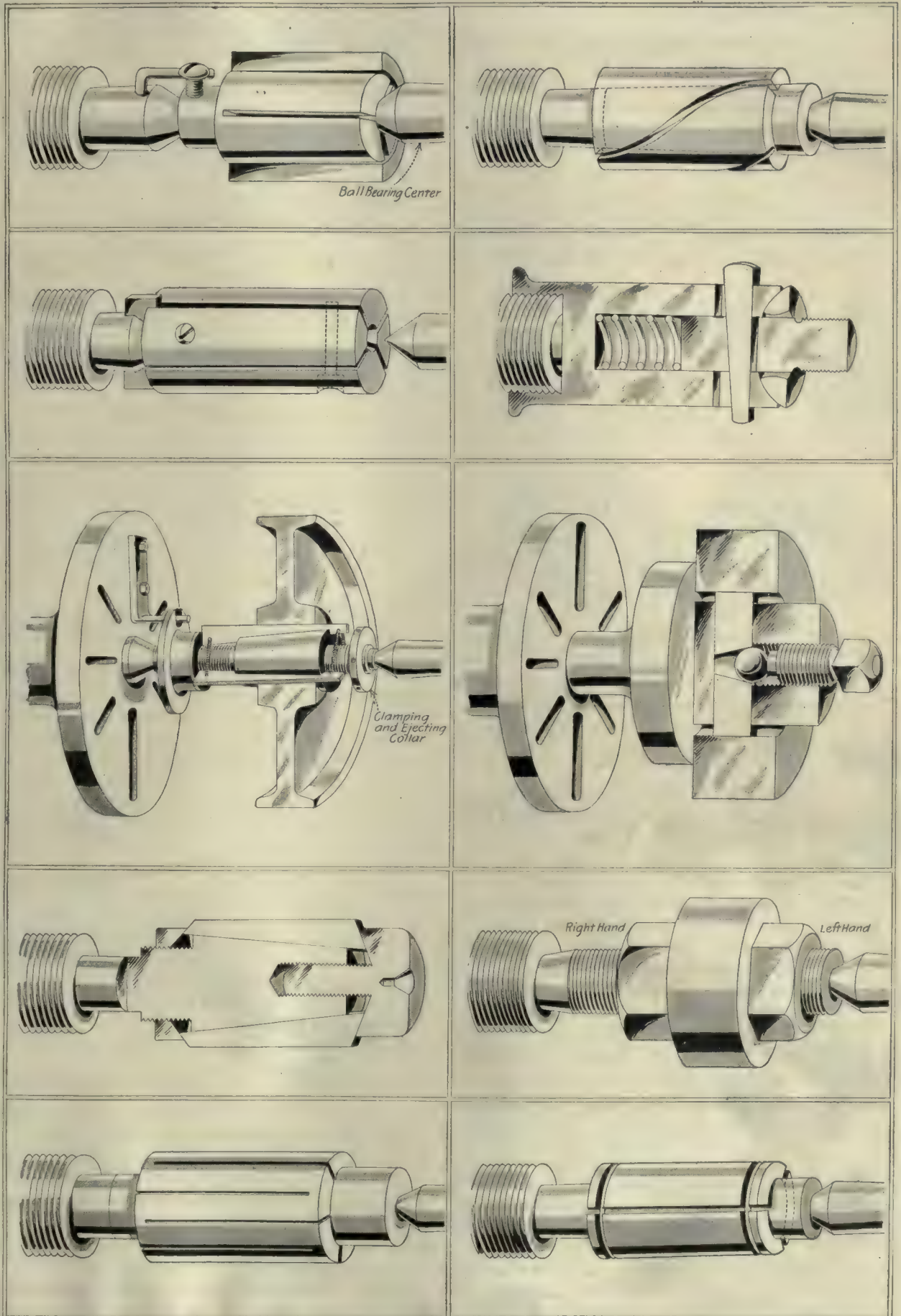


"SHORTENING" A JACK.



PLANING TO A TEMPLET

SOME USEFUL PLANER KINKS



A VARIETY OF EXPANDING ARBORS

Dies for Small Brass Holder

BY GEORGE F. KUHNE

The dies illustrated are used in the blanking and forming of a small brass holder. *A* (Fig. 1) is a casting that is milled $\frac{3}{4}$ in. deep and $1\frac{5}{8}$ in. wide. At *B* the side is shaped in the manner indicated and acts as a guide for punch *C*. It also prevents the shearing of the tools when in operation.

D is half of the die, showing the radius and also the slots for the ears of the holder. The edge at *E* is rounded so as to eliminate the tearing of the metal during forming. *F* is the other half of the die. A slot at *G* is milled across so that when feeding the piece to be cut the ears of the

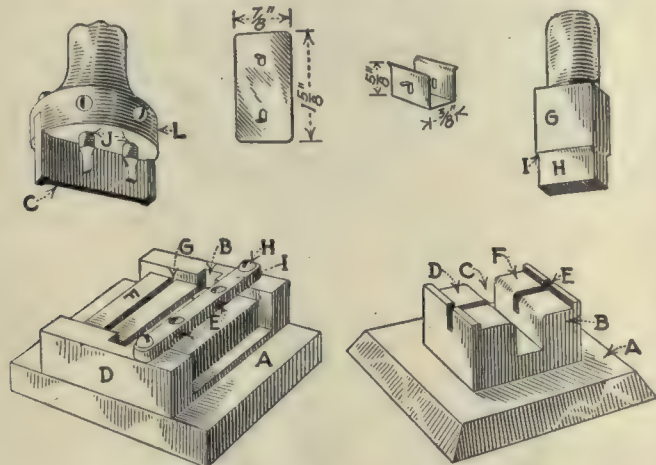


FIG. 1. THE BLANKING PUNCH AND DIE

FIG. 2. THE FORMING PUNCH AND DIE

holder are projected into this slot and act as stops. At *H* two holes are drilled and tapped for the stripper *I*.

The punch *C* is milled to the form of the die slot to a depth of about 1 in., the rest being left full size so as to strengthen it.

The punch and die for the forming operation are shown in Fig. 2. *A* is a flat piece of $\frac{1}{2}$ -in. thick cold-rolled steel, upon which is fastened the hardened piece of steel, or die, *B*. The center of *B* is milled to the proper width and depth, as at *C*, and the top at *D* is rounded over as shown. A slot is milled across the die *B* the same width as the ears of the holder. This slot is used as a locating point, and also for the clearance of the ears when forming down into *C*. The die is also milled about $\frac{1}{16}$ in. deep as at *F*, to locate the piece lengthwise. The punch *G* is made of steel with the shank turned and milled as pictured. The thickness of the punch at *H* must be minus the amount of 0.020 in. to allow both the walls of the piece to enter at *C*.

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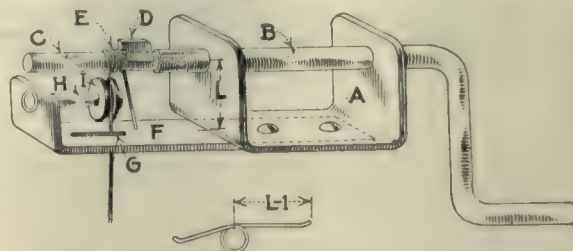
Hand-Operated Spring Winder

BY JAN SPAANDER

Anyone having use for small quantities of varied shapes of springs is as a rule forced to make them himself. The jig shown does away with all trouble and produces springs of unvarying diameter. Further accuracy depends on the operator.

The jig consists of a U-shaped plate. At *A* is a bearing for the handle *B*, tapped at the end for the threaded side of the rod *C*, to which a carrier *D* is brazed. At the joint a narrow slot *E* has been made to pass and grip a wire of given size. The diameter of the rod *C* determines the

diameter of the spring. The plate *F* is riveted to the plate *A* and is narrower. This enables the jig to be put in a vise, the grip being on the edges of the lower plate and the top one resting on the claws. A narrow slot *G* in the plate *F* passes the wire from the spool to the slot *E*; and when gripped, turning the handle will produce a perfect



HAND-OPERATED SPRING WINDER

spring. The distance *L* between the center of the handle and the plate *F* has to be larger than the free end *L-1* of the spring.

To prevent the on-running wire from bulging, it may be run against a V-grooved roller *I*, running along a rivet *H* fastened into the plate *F*, which is bent up for the purpose. The rivet must not project beyond the free swinging end of the spring.

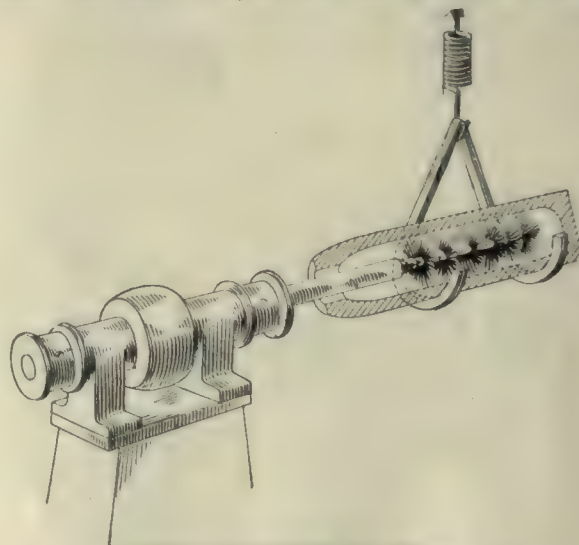
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Cleaning Shells Inside

BY W. S. JOHNS

The accompanying illustration shows an arrangement for removing rust and dirt from the inside of the finished shell preparatory to varnishing.

A $1\frac{1}{4}$ -in. shaft is used for the spindle and is run at about 250 r.p.m. The bearings are plain solid babbitted bearings. The end of the spindle is turned down and threaded to suit the brush, which is an ordinary wire-tube brush. The shell is suspended in the special hook, shown



SHELL-CLEANING MACHINE

in the drawing. This hook is hung on a spring to allow a slight vertical movement of the shell. The operator moves the shell so that the brush comes in contact with the whole inside surface of the shell.

The spindle could be made double ended if necessary, but as shown, single ended, it will easily handle an output of 300 shells per shift under the most rigid inspection and will clean out shells that have been badly rusted.

Labor and Production Control in Typewriter Plants

By L. P. ALFORD

SYNOPSIS—The functions, principles and some of the rules that govern timekeeping and production control in the plants of the Remington Typewriter Co. These have been put into effect during the installation of scientific management and with the counsel and advice of H. L. Gantt.

An article on page 457 briefly sketched the results of the installation of scientific management in the four principal plants of the Remington Typewriter Co. A following article, on page 497, described the storekeeping system and gave the principles and some of the rules

2. To know when each workman worked.
3. To know what each workman did.
4. To know what each workman was paid for what he did.

To show the way in which timekeeping and production control are knit together and become inseparable, the prime functions of production control must be stated before any of the functions are discussed. The production-control functions are:

1. To make specified articles in an economical manner.
2. To deliver specified articles at specified times.

The demand for manufacturing and delivering reaches the manufacturing office as records of sales, orders for shipments or requests for manufacturing orders for stock. Production control insures that these demands and requests will be carried out properly, on time and in the most economical manner that it has been possible to devise.

To provide the knowledge that gives control, the manufacturing office must have the same kind of information that the owner of a small shop carries around in his head. In the Remington plants this consists of the following: An exact knowledge of (1) all work to be done (orders and routes); (2) material available (stores balances); (3) men, tools and equipment (man records, machine capacities, etc.); (4) best methods available (instructions).

Records of this kind are in a continual state of flow. They are constantly changing. The source of many of the items needed to keep them up to date is the time cards turned out by the timekeeping system. Inasmuch as production is the all-important thing in any manufacturing plant—the reason for which the plant exists—Mr. Gantt is beginning to do away with the name “time card” and use instead “production card.”

THE TIME CARD OR PRODUCTION CARD

The time card designed and used to give the information called for by the four prime functions of timekeeping and also to give a part of the data required for production control is illustrated by Fig. 1. It will be seen to be more comprehensive than the ordinary time card or time slip, for it is the means of bringing into the manufacturing office an exact knowledge of what has happened in the shop. It may be added that the securing of this exact information is one of the most difficult problems of shop management.

Inasmuch as this card tells exactly what was done and—by subtraction—what still remains to be done, it is really a record of production as well as time and justifies the name “production card.” Furthermore, as the card shows not only what has been done, but what was paid for doing it, and how long it took to do it, the card becomes the basis of providing information for labor costs and for wage payment. And still further, the card shows the machines used, hence gives a basis for obtaining machine expense and machine utilization.

Too much emphasis cannot be laid upon the necessity of having such production cards made out accurately.

RET'D ISS'D		PART AND ORDER NO.	
MAN'S NAME		MAN'S NO.	
TIME ALLOWED	TIME TAKEN	FINISHED	
BONUS	HOURLY RATE	NOT FINISHED	
PAY FOR	WAGES	TRANSFERRED	
		BREAK DOWN	
		CAUGHT UP	
NAME OF PART OR JOB			
OPERATION NAME	OPER. NO.	MACHINE NO.	NO. PIECES FINISHED
			RATE
			WAGES
ENTERED IN		O. K. FOR QUALITY	O. K. FOR QUANTITY
DEPT. CLERK	SCHED- ULE	COLOR CHART	PAY ROLL
			COST RECORD
AP 14			

FIG. 1. FORM OF TIME OR PRODUCTION CARD

that govern its operation. This article takes up the functions of timekeeping and labor and production control, with the purpose of giving the practical reasons for the methods used rather than the details of operation. In order to control labor, in other words to say what the employees shall do and when they shall do it, it is absolutely necessary to provide the workmen with the needful material and tools when they are required. This means that before anyone can install a satisfactory production system, he must have a suitable storekeeping system, which enables him to have on hand what he wants when he wants it.

The production system must not only consist of a mechanism for issuing, but must contain a means of knowing what each workman does each day, so that one may see promptly whether plans are being lived up to or not. The mechanism to give this information is a combined time and production card, which is shown later.

FUNCTIONS OF TIME AND PRODUCTION CONTROL

Mr. Gantt gives the four prime functions of a timekeeping system as follows:

1. To know what workmen worked.

If they are correct they provide a most valuable source of information, enabling the management to know promptly what has been done and consequently what must be done. In view of this important function which they perform in the scheme of management too much emphasis cannot be laid upon having them right. Mr. Gantt says that as a matter of fact he seldom finds that ordinary timekeepers and cost clerks are accurate enough to supply data upon which operating plans for the shop can be based. The reason for this is evident. It is a lack of proper previous training and a failure to appreciate the value of accuracy. The errors that exist in cost records as usually kept are rarely discovered. They

Not finished (when the operation has not been completed at the end of a day on all of the pieces ordered).

Transferred (when a man is transferred to another job before he has completed the total number of pieces ordered).

Breakdown (when his machine or tool has failed).

Caught up (when no more parts are available on an order not yet finished).

The lower half of the card has spaces to record the individual operations, their numbers, machine numbers, number of pieces finished, the rate and wages. Below these spaces at the left are squares to be checked as vital information is posted from the card into the permanent

	MACHINE	APR	MAY	MAY	MAY	MAY	MAY	MAY	JUNE
		27 28 29 30 1 2	4 5 6 7 8 9	11 12 13 14 15 16	18 19 20 21 22 23	25 26 27 28 29 30	1 2 3 4 5 6		
Graduating	640-M								
Gear Cutters	711-M								
"	712-M								
"	732-M								
"	733-M								
"	844-M								
Profilers	870-M								
"	871-M								
"	872-M								
"	873-M								
Sp. Drills	5-D								
"	7-D								
"	7-D								
"	65-D								
"	66-D								
"	67-D								

FIG. 2. A SPECIMEN LAYOUT SHEET

are history. They deal with the past and no one has occasion to make an investigation to find out how accurate or inaccurate they are. But errors in time cards which enter so vitally into a shop system as do those used in the Remington plants influence future plans and work and hence must be prevented. If mistakes are allowed to creep in, they mislead and overthrow the best of preplanning.

Viewed from this angle, the shop clerk, who may be both timekeeper and production clerk, becomes a much more important man than the one who under the usual scheme of management simply keeps time or figures costs. This is one reason why it takes so long to get this work properly started.

By glancing at Fig. 1 it will be seen that the time or production cards are arranged to provide space for the results of a number of calculations, as well as for recording the work done and the money paid. The sections immediately under the man's name record time, rate, bonus (if any) and wages. The spaces at the right, under the one that records the man's number, are planned to care for the changing of the time card. Each man changes his card at the end of every operation on which it is desired to keep an exact time record. Before he turns his card in, he fills it out properly and indicates the condition of the work by checking one of the following items (see Fig. 1):

Finished (when the operation has been completed on all the pieces ordered).

records, while at the right are spaces for the inspector's O.K. for quality and quantity.

This card has been traced through with all this detail to show the bearing that the information it carries has upon production.

To show how some of the details of the timekeeping system are worked out, a few of the rules follow. These are by no means complete and are given by way of explanation and not with the thought that anyone will put them to use in his plant and thereby believe he is obtaining a timekeeping system that will perform all its required functions.

PREPARING AND ISSUING TIME CARDS—CHECKING THE LATE MEN

Before the close of each working day the time clerk must prepare a time card for each man by writing his name and number on the card and stamping it with the starting time. He must place the card in the "in" rack and lock it.

At least ten minutes before the beginning of a working period the timekeeper must open the "in" rack and take a position from which he can see that each man takes his card, and his only, from the rack as he enters. As soon as work begins, the timekeeper must take the remaining cards from the rack and lock it. He will then stamp these cards, "This man not in on time."

A man arriving after the card rack has been closed is given a red time card stamped with the time when he

panied by an instruction card that gives the best known method and time for performing each operation.)

A specimen layout sheet from which the various operations are assigned to proper machines is shown in Fig. 2. It covers gear cutters, profilers, single-spindle and three-spindle drilling machines. By means of such sheets the work is planned as new manufacturing orders come along in such a manner that there is no interference with work already in process or assigned. The work set apart for each machine is graphically indicated by a horizontal red line covering the time during which that particular machine will be employed on the operation assigned to it on a particular order. As the work is done, a black line is drawn indicating the period during which the machine was actually at work on the operation.

These layout sheets not only show the amount of work ahead of each machine, but exactly when each operation already planned should start and finish. The dates for each operation, determined from the layout sheets, are entered on the manufacturing orders, the shop orders and the route cards.

To schedule an order properly it is evidently necessary to assemble on one sheet information in regard to the starting and finishing date for each operation. In this way there will be a graphical presentation of all the various steps in assigning the order to the machines. Such plottings are made on what is called a schedule sheet, Fig. 3. Here starting and finishing dates of the operations are indicated by red lines. The entries from the time cards and rejection notices show for each day to what extent the plans and schedules have been lived up to and permit planning the work intelligently for the succeeding day. Completed schedules are also valuable guides for future planning. The total at the completion of each operation is checked from a completed operation sheet, and if found correct the fact is indicated by drawing a horizontal blue line under the last entry. Any discrepancy is investigated at once. All lots of work are accompanied by two route cards, one buff and the other green. The buff card moves with the first pieces of the lot and serves as a means of indicating to the "move men" just where the pieces are to go after each operation. The green route card remains with the lot and accompanies the last piece. The receipt by the schedule clerk of the green route card is a signal that the order is finished. The completed schedules are forwarded to the cost clerk after all discrepancies have been adjusted. Thus the layout sheets and the order-schedule sheets give control of the work of the machines in the shop and the progress of manufacturing orders. It may be difficult to grasp the important possibilities of planning and scheduling unless one fundamental fact is perceived. In inaugurating these features it is im-

possible in any plant to have accurate information as to the time required to perform each and every operation. It may be thought that this lack is an unsurmountable obstacle in making a beginning. Such is not the case. Planning and scheduling should be begun, using the best data available. Remember, "A half loaf is bet-

ter than none." The inaccuracies will disappear as the work progresses and exact records are accumulated. As in all other things in shop practice, errors tend to offset each other and reduce the total final error. The beneficial results of scheduling and laying out, even with imperfect original information, are so great that no one should hesitate for this reason to begin this part of the work of installing scientific management. This course is the one that was so successfully followed in the Remington plants.

Varnishing Shells

By W. H. WATSON

The following method of varnishing the 4.5-in. British high-explosive shell is the one developed by the writer after experimenting with the various other ways described

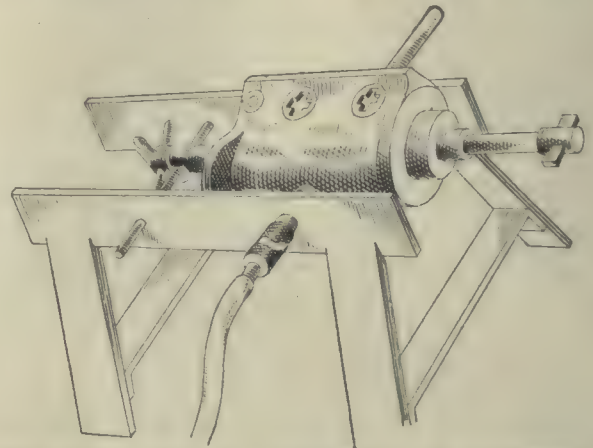


FIG. 1. MACHINE FOR INSERTING AND REMOVING BUSHINGS

in the technical journals. It has proved so satisfactory that I am disposed to suggest its general adoption. The shells are cleaned before varnishing. Then a brass ferrule having a screwdriver slot in one end is screwed

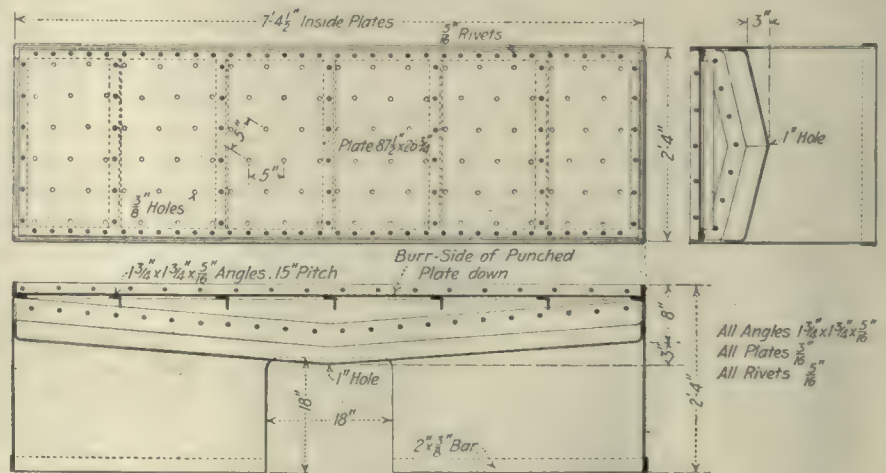


FIG. 2. DRAINING TANK FOR 4.5-IN. SHELLS

into the nose of the shell to protect the threads from being covered with varnish. The machine shown in Fig. 1 is used for screwing the ferrules in before varnishing and out again afterward.

As will be seen from the sketch, the rig consists of a reversible air drill mounted on an ordinary cast-iron horse that has been spread out so as to take the air drill

between the two halves of the horse. The "business end" of the air drill is fitted with a round plug turned to fit freely inside the ferrules and having a flat bar through it to act as the screwdriver. The shell is simply pushed onto the revolving screwdriver, and the flat bar catches into the slot in the ferrule and screws it in or out as the case may be.

The varnishing is done by simply filling the first shell with varnish and then emptying it into the second shell, and so on until the batch is done. Each shell, after the varnish is emptied out of it into the next one, is placed on the draining tank, Fig. 2, nose down. As holes are punched in the top plate where each shell will stand, this tank will accommodate 100 shells. By the time it is filled, the shells first put on are thoroughly drained and can be transferred to the baking-oven truck.

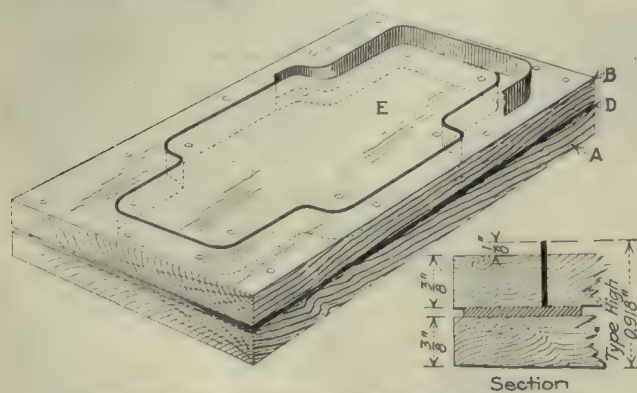
The varnish trickles down through the small holes in the top plate and drops upon the lower plate, which is inclined both ways. The small trickles from each shell run into the central valley and there form a stream large enough to keep the varnish from drying and sticking to the plate. A small varnish tin is kept under the hole in the center of the bottom plate and catches all the varnish drained from the shells. This arrangement gives perfect drainage and keeps the varnish from contamination.

Our experience shows that this method of varnishing is economical and gives the smallest percentage of shells returned for revarnishing. The shells are next baked in the usual way in an electric-heated oven having a holding capacity of 100 shells.

Built-Up Dinking Die of Wood and Steel

BY J. HARMER KNIGHT

The sketch shows a simple and easily made but efficient cutout die designed and used for cutting special envelope forms in paper and cardboard in the printing press. It will serve equally well, however, in the arbor press—



THE DINKING DIE AND ITS CONSTRUCTION

between two metal blocks to distribute the pressure—for cutting gaskets, washers, etc., in rubber, fabric, leather or other material.

This form of die has the advantages of being cheap, quickly made and requiring no special tools in its construction. White pine or any good pattern wood and an old 1/2-in. wide clock spring will usually answer all requirements.

The arrangement shown brings the cutting edge to the height of the ordinary cutting or perforating rule as used

in the printing press and leaves 1/8 in. for clearance above the wood.

The outline is carefully sawed on a fret or scroll saw, with a saw blade if possible slightly less in thickness than the gage of the metal to be used. It is important to have the saw-cut at right angles to the face of the wood; therefore do not crowd the work in sawing, particularly around the curves. The reason for this is that if the cut leans to one side or the other it will twist or warp the cutting strip when the latter is driven into the saw-cut, making it impossible to seat the cutting strip down properly on the steel pressure plate so that it will take the cutting pressure evenly.

After the pattern has been sawed out and all ragged edges of the wood have been cleaned up, the outside piece *B* is squared up, leaving at least 3/4 to 1 in. of wood outside of the design on all sides. Now cut out *A* the same size as *B*. Then cut out the steel pressure plate *D*, making it square and true with *A* and *B*, but 1/16 to 1/8 in. less in size all around. This allows the finished die block to be trued or dressed with a plane if necessary.

The parts *B*, *A* and *D* are carefully assembled and drilled through for about No. 14 wire nails 1 to 1 1/2 in. apart, or wherever it seems necessary to resist the outward pressure of the cutting strip when driving it into the slot.

Lay part *E* within *B*, and work a strip of paper or cardboard or tin into and around the entire slot until it meets the other end. Mark this and take 1/16 in. more for the length of the cutting strip to allow for final dressing with the file, so that the two ends of the cutting edge will meet perfectly.

It will save some time in shaping the edge of the die strip if it is partly beveled before inserting in the block. Do not bring it to a sharp edge, however, as this would cut the face of the rawhide or hardwood mallet used to drive it to its seat in the die.

As an ordinary clock spring will be nearly 3/2 in. in thickness, it will be necessary to shape it with the fingers or pliers to conform approximately to the curves and angles of the design before putting it in place.

The joint should be located in the middle of a straight portion of the die or on one of the larger curves, as it is impossible to make the cutting edges meet perfectly in a corner. Start with one end as shown, to insert the cutting strip, and with the mallet gradually drive it home until near the end, where it must be dressed off gradually with the file so that when finally driven in the cutting edge will be continuous. If for any reason the two ends should not be quite in line, a little tapping sideways on one or the other will bring them true, which could not be done if the joint was located in a corner. The part *E* should be riveted in place in the same manner as *B*.

A small flat file and a half-round bent die sinkers' file for the curves, finishing with an India or a carborundum slip, will with a little patience soon bring the cutting edge into shape, and the die is finished.

Different Types of Electric Furnaces, whether for laboratory or for commercial use, may be classified according to the methods employed to transform the electrical energy into heat in the material. These are: (1) By passing the current through the metal to be treated, so that the metal forms a part of the circuit; (2) by passing the current through a resistance material, the heat thus produced being radiated and conducted to the metal; (3) by surrounding the metal with an alternating-current circuit, so that eddy currents are produced in the metal, these currents generating the necessary heat.

Manufacturing Methods Used in Making Machine Tools

BY ROBERT MAWSON

SYNOPSIS—Some jigs and fixtures that are used in the manufacture of elements for machine tools are described and illustrated. It will be seen that these jigs and fixtures are of modern design, embodying successful methods of holding and locating the pieces.

Many of the jigs, in fact the majority of them, shown on the previous jig and fixture data pages in the *American Machinist* have been of the box or inclosing type in which the work is completely inclosed in the jig.

There is another class of jigs as valuable as time-savers as the first which come into play on work too large and heavy to be successfully inclosed and handled in a box jig. These are attached to various parts of a large casting and located from some finished surface for definite working points.

Jigs of this type are found in large numbers in machine-tool shops where the parts to be machined naturally occur in large sizes and heavy weights. Their use makes

it possible to manufacture with precision and low cost, parts which otherwise would call for expensive laying out and machining.

The field for jigs of this type is not restricted to the machine-tool industry, although it must be said that the larger part of their use probably occurs in this field. The manufacturer of any large piece of machinery who wishes to reduce his costs and secure interchangeability, may very profitably make a study of his work with a view of adapting to it jigs of this type wherever possible.

Since the cost of machining work varies with the labor necessary in handling and moving it about, it is natural that, other things being equal, a light total weight of jig and work is more economically machined than one which is bulky and cumbersome. No doubt many jigs of the box type might be advantageously replaced by those of the type shown in these illustrations.

A few of the tools used by the Becker Milling Machine Co., Hyde Park, Mass., in the manufacture of its vertical millers were illustrated on page 448. Other high-grade tools for manufacturing the same machines are here shown.



FIG. 2

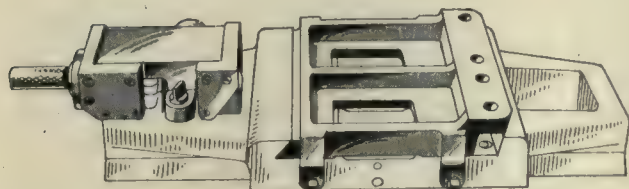


FIG. 3

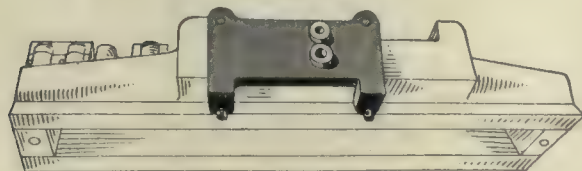


FIG. 4

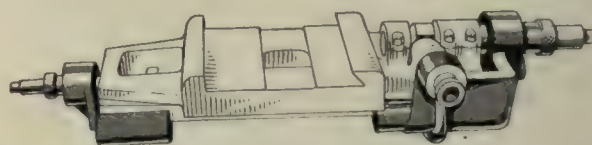


FIG. 5

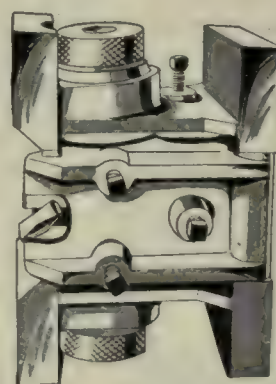


FIG. 7

JIGS AND FIXTURES USED IN MANUFACTURING MACHINE-TOOL PARTS, WITH WORK SHOWN IN POSITION

FIGS. 2 AND 2-A

Operation—Drilling the carriage, Fig. 1. The jig is located by two large and one small plug that fit into holes that are previously machined.

Holes Machined—One $\frac{3}{16}$ -in. and one $\frac{1}{16}$ -in. drilled. The former hole is afterward counterbored to 1 in. in diameter.

FIGS. 3 AND 3-A

Operation—Drilling the carriage, Fig. 1. The jig for the slide is located by a stop and held in contact with setscrews. The jig at the bearing end is located by plugs that fit into machined holes.

Holes Machined—Four No. 11 drilled on the slide surface; three $\frac{3}{16}$ -in. drilled in the jig at the bearing end.

FIGS. 4 AND 4-A

Operation—Drilling the carriage, Fig. 1. The jig is located by two pins that rest against finished surfaces on

the casting. Setscrews are then tightened against the piece to hold the tool securely.

Holes Machined—One $\frac{3}{16}$ -in. drilled, afterward being reamed to $\frac{1}{2}$ in., and one $\frac{3}{16}$ -in. drilled.

FIGS. 5 AND 5-A

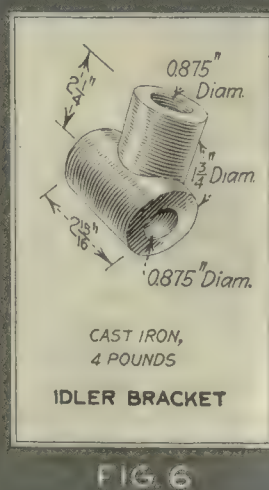
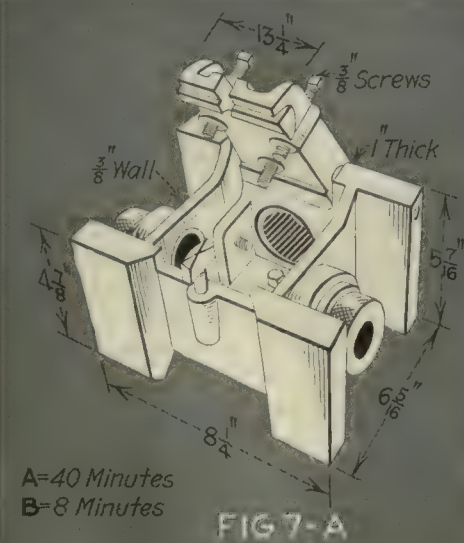
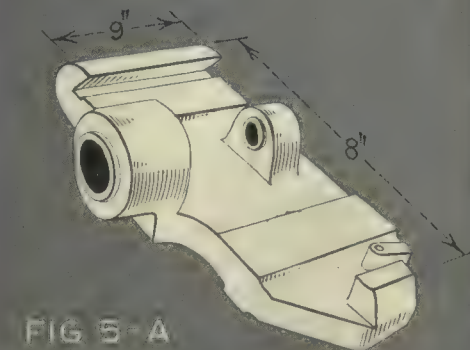
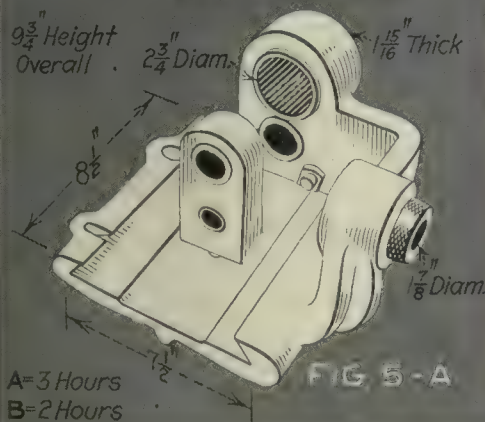
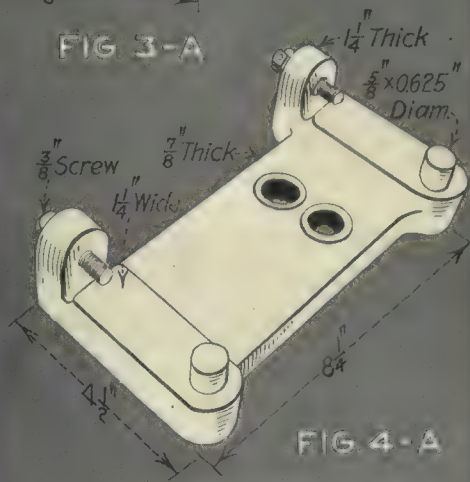
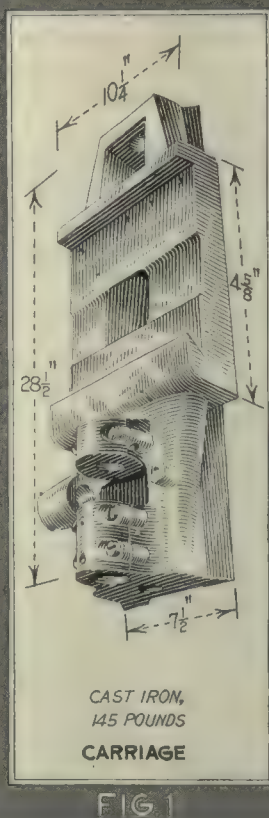
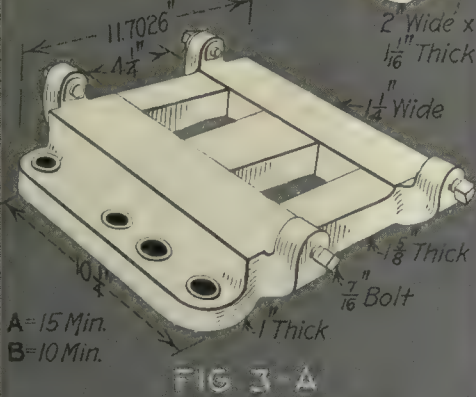
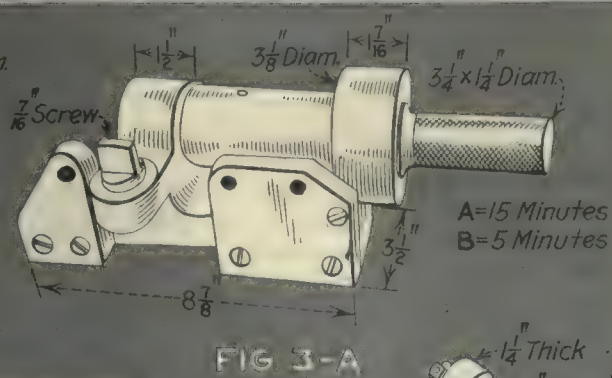
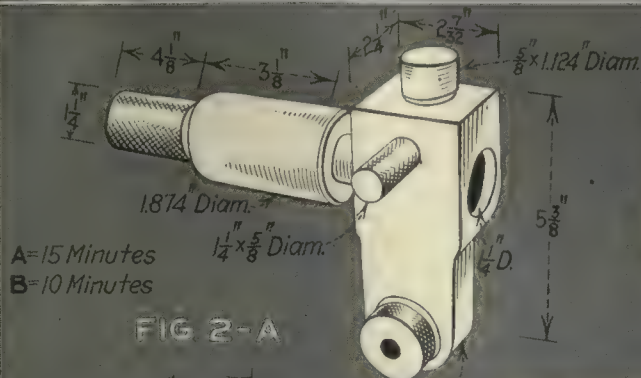
Operation—Boring the carriage, Fig. 1. The fixtures are located on the casting by fitting on the V-surfaces, which have previously been machined.

Holes Machined—One $\frac{3}{16}$ -in. drilled, with $1\frac{1}{2}$ -in. drilled and then reamed to $1\frac{1}{2}$ in.; two $1\frac{1}{2}$ -in. drilled and then reamed to $1\frac{1}{2}$ in.; two $1\frac{1}{2}$ -in. drilled and then reamed to $1\frac{1}{2}$ in.

FIGS. 7 AND 7-A

Operation—Drilling and reaming the idler bracket, Fig. 6. The casting is located on V-blocks in the jig and is held securely by setscrews, through the jig body and cover.

Holes Machined—Three $\frac{3}{16}$ -in. drilled, then reamed to $\frac{1}{8}$ in.



NOTE
ALL BUSHINGS USED FOR GUIDING TOOLS ARE BLACK-ENED OR HEAVILY RULED. ALL JIG AND FIXTURE BODIES ARE CAST IRON. STRAPS AND FASTENINGS, MACHINERY STEEL. GUIDE BUSHINGS ARE TOOL STEEL, HARDENED AND GROUND

A=TIME REQUIRED FOR OPERATION WHEN NO SPECIAL TOOLS WERE USED
B=TIME REQUIRED FOR OPERATION WHEN TOOL DESCRIBED IS USED

Does Technical Writing Pay?

By F. B. JACOBS

If one were to analyze the contents of any technical journal it would be noted that the articles are derived from three sources: The editorial staff, the members of which are on fixed salaries; free-lance writers, who submit contributions at space rates; and the occasional contributor, who writes whenever he notes something of importance. There are any number of writers who contribute articles for a few months and then cease, under the plea that it does not pay to spend time in this manner. It is my opinion as a free-lance writer, taken from several years' experience, that technical writing does pay, provided one has the ability to write rapidly and has acquired the knack of preparing copy to suit the editor. It is a fallacy to state that the rates paid by such papers as the *American Machinist* are not liberal. On the contrary they compare favorably with the prices paid to the average fiction writer.

ESSENTIAL QUALIFICATIONS

The necessary qualifications for successful free-lance writing can be described briefly as follows: First, an ordinary knowledge of grammar and rhetoric as taught in our public schools. Second, the ability to weave ordinary everyday facts into a smooth-reading article. Third, the knack of composing rapidly without having to write and rewrite with the object of getting the article to read correctly. (This rule holds good whether one uses the typewriter or the pen.) Fourth, and most important of all, a broad training in mechanical lines, otherwise one would soon find his stock of knowledge exhausted.

I consider these foregoing factors the prime essentials in successful technical writing, and for the sake of argument it may be well to analyze them briefly. If the average person would remember and apply the simple rules of grammar and rhetoric that were taught to him in his early school days, he would experience no difficulty in forming correctly constructed sentences, both in his writing and speaking. For some unknown reason many men engaged in the mechanical pursuits, and this includes executives and salesmen as well as machinists and tool makers, are prone to use poor English. While editors primarily are after ideas, they naturally look with favor upon contributions that do not contain a superfluity of incorrect expressions and vulgar colloquialisms. Therefore it is wise for the aspirant who has a burning desire to break into print—and stay there—to learn to use fairly correct English.

ABILITY TO FIND LANGUAGE TO EXPRESS IDEAS

The ability to turn ordinary facts into a readable article comes naturally to a few persons, but with the majority this talent has to be acquired. We all know what we want to say, or at least we think we do, but many of us experience difficulty in putting our thoughts down on paper. Many who are masters of English as far as correctly speaking it is concerned, are at a loss when they attempt to impart their knowledge to others in the form of a written article. On the other hand, men of limited education often succeed in preparing interesting stories. As a matter of fact, the whole secret lies in the ability of the individual writer to teach or impart his special knowledge to others.

A well-written technical article is always devoid of high-sounding expressions or meaningless phrases. Every sentence is written for the purpose of conveying information in ordinary everyday English that is easily understood by the average person. It is a fact generally acknowledged that the desire to write denotes latent ability, and I do not hesitate to say that the average person can acquire the ability to turn out acceptable copy if he possesses enough perseverance to tide him over the dark days of his early efforts, when rejected manuscripts are more frequent than editors' checks. Editors have many reasons for rejecting articles, but when an author's efforts are invariably returned, after being examined by several editors, the fault is with the writer, not the editor. A remedy for this state of affairs is to study the work of successful authors, noting their style and the manner in which they handle their subjects.

All copy for technical publications is edited before it goes to the compositor for two reasons: First, to eliminate mistakes in grammar, etc., and second to make the copy conform to the style sheet of the particular paper that is handling the article. Briefly stated, a style sheet is a little pamphlet that gives certain fixed rules that are to be observed by the employees of any publication who produce, edit or correct copy. As different journals use different style sheets, it is not expected that the technical writer and contributor should conform to the style of any particular one.

NEED OF THOROUGH SHOP TRAINING

A broad training along mechanical lines is an absolute necessity to the man who expects to succeed at technical writing. Without this training his field would be limited and would result in a lack of the knowledge necessary to handle a diversity of subjects. Technical writers as a class are men who have worked in several manufacturing sections as machinists, tool makers, draftsmen, salesmen or demonstrators. Thus, having had access to a large number of manufacturing plants, their minds are well stocked with practical knowledge concerning methods, processes, shop kinks and kindred subjects. Most of us realize that it is impossible to receive a broad mechanical training in one shop, or one locality, and for this reason the man who has not worked in many manufacturing centers will find himself at a loss if he attempts to turn out copy week after week and month after month—that is, acceptable copy.

FINANCIAL AND OTHER ADVANTAGES

From my own experience, I am convinced that technical writing pays very well. The remuneration, of course, is set by the law of supply and demand, as there is a market price for manuscripts as for everything else. It must be borne in mind that there is competition in writing as well as in other lines of effort. Thus it is necessary to acquire the habit of writing rapidly and correctly, otherwise valuable time is sure to be wasted. Eliminating the monetary point of view, technical writing offers other advantages. It trains one to think decisively, which is a great help to the man who desires to rise in his calling, whatever it may be. The man who cannot think in constructive lines is sure to remain in a rut, whereas the individual who trains his mind is fitting himself to take advantage of the innumerable opportunities that present themselves from time to time.

Floating Foundry and Forge Shop

SPECIAL CORRESPONDENCE

SYNOPSIS—The scope of the work that can be handled on board a repair ship is far greater than is realized by the average mechanic ashore. This article shows some of the interesting details of the foundry, where large iron and brass castings can be made, as well as the forge shop, with the equipment of hammers, and the oxyacetylene and electric-welding outfits.

The majority of engineers and mechanics who have not followed closely the recent developments in floating repair equipment for naval vessels will probably be much surprised to read a description of an iron and brass

or any portion of the fleet going out for maneuver or target practice. In other words, the repair ship is to be considered, temporarily at least, nothing more or less than a repair shop, movable under its own steam and capable of accompanying the fleet to any portion of the world where required. Whenever feasible it anchors at the naval base to take care of whatever repair work may arise during the time that the men-of-war are in that locality.

Notwithstanding this intention, however, there is bound to be, as has already been proved, more or less work to go through the shop with the ship steaming under varying conditions of wind and weather, sometimes in fact unusually rough weather having been experienced. A navy machinist becomes accustomed to handling tools,



FIG. 1. THE FOUNDRY OF THE U.S. REPAIR SHIP "PROMETHEUS"

foundry afloat, as well as a forge shop, both installed as fully equipped and important departments on the United States repair ship "Prometheus."

Descriptions of the machine shops and other mechanical departments on this vessel have already appeared in these columns. Undoubtedly, many readers have ere this become accustomed to the idea that machine tools can be operated on board a ship in the same way as in a permanent shop ashore, although the "landlubber" machinist will probably always find more or less difficulty in understanding how a repairman in the navy can operate a lathe, a planer or any other tool with the deck and machinery plunging about under stress of bad weather and rough seas.

It has already been pointed out that it is the intention, so far as possible, that the navy repair work handled by the repair ship shall be done with the floating shop at anchor in what is practically still water, in the harbor constituting the naval base, the headquarters of the fleet

doing benchwork and general fitting with the deck of the vessel swinging to all conditions of roll and plunge. It is, in fact, quite a commonplace matter for the mechanic to forget entirely that he is on board ship as he goes ahead with his work in the conventional manner. It is, in other words, merely a matter of becoming accustomed to one's environment, learning to keep one's feet and to accommodate oneself to the motion of the ship and the consequent movement of the tools.

The foundry and the forge shop form two distinct propositions as compared with the machine-shop development. The handling of molten metal, as in the foundry, or of red-hot bar material, as in the forge shop, must always be accompanied by a considerable degree of judgment and caution, even under the best of conditions in shore establishments. To accomplish similar work upon the deck of a naval vessel constitutes a problem in which continual care and watchfulness must be exercised. It is not at all likely that under normal conditions

much pouring of molten metal will be attempted on the "Prometheus" while she is steaming in a rough seaway. On the other hand, it is entirely possible that there will be occasional times when it will be necessary to use the foundry either for making a repair part for the ship herself or for some of the other vessels in the fleet. Similarly, it is equally likely that there will be more or less forging of medium and heavy parts at some time or other when the ship is out at sea and when the artisans

of the fact that there are cupolas for iron melting and quite a number of brass-melting machines there is ample space for a large sand pit in the middle of the department and for ordinary molding purposes around the deck as a whole.

The sand pit near the center of the foundry floor is 14x18 ft. in area and about 6 ft. deep.

A general view in the foundry, looking aft toward the cupolas, both of which are clearly visible in the back-



FIG. 2. FOUNDRY OF THE "PROMETHEUS"

below deck will have to exercise precaution to produce satisfactory work and avoid injury to themselves and others, due to the fact that the vessel may be rolling in heavy seas.

Still, for generations men have known how to stand below in crowded engine rooms amidst high-speed machinery, and to carry on their work without apparently much more danger of mishaps than on the floor-plate of the stationary engine room. Also, in the fireroom of vessels of all kinds the difficult undertaking of stoking continuously has been passed through by thousands upon thousands of men of ordinary ability, without much more risk of burns or other injuries than would occur in similar service in a power plant ashore. Locomotive engineers and firemen become accustomed to carrying on their respective occupations with a machine that is vibrating and lurching while running at high speed; and presumably the extension of repair work in various mechanical departments on board ship is along the lines of natural evolution in the extension of different mechanical callings.

FOUNDRY DETAILS

The foundry on the "Prometheus" is installed aft of amidship and is in dimensions approximately the same size as the machine shop described in an earlier article. It is a little over 50 ft. long and extends the full width of the ship. It presents a liberal amount of space for the operations it is expected to take care of. In spite

ground, is presented in Fig. 1. A second view, looking forward and across the sand pits, is given in Fig. 2. In each of these illustrations a number of molds are shown, with the flasks closed ready for the pouring operation.

X=1 Furnace, Tilting, Crucible, 110-lb. Capacity
Y=2 Furnaces, " " 165-lb. "
Z=3 " " " 110-lb. "

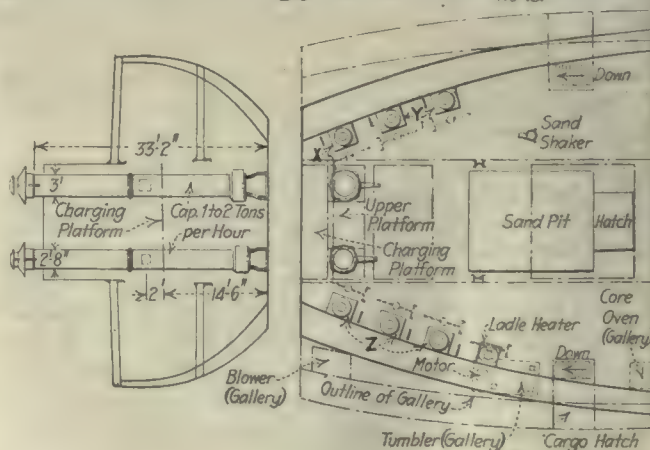


FIG. 3. FOUNDRY ARRANGEMENT

The floor plan of the foundry with the equipment in place is given in Fig. 3, and also an elevation showing the cupolas for iron melting. One of these cupolas is to cast one-half to one ton per hour; the other, one to two

tons per hour. So it will be seen that it is possible to pour castings up to 6,000 or 7,000 lb. in weight, which is quite as heavy as any work that is ever likely to come to this foundry. Provision for handling flasks and for taking care of heavy work generally is made. A suitable crane has been installed, and the block and hook

illustrated. In one of these galleries is installed the woodworking and pattern shop, and in the other the storage for patterns and flasks for the foundry.

On the starboard gallery are a motor-driven tumbler barrel, a core oven and a blower for the cupolas, as indicated by the dotted lines in the plan, Fig. 3. The

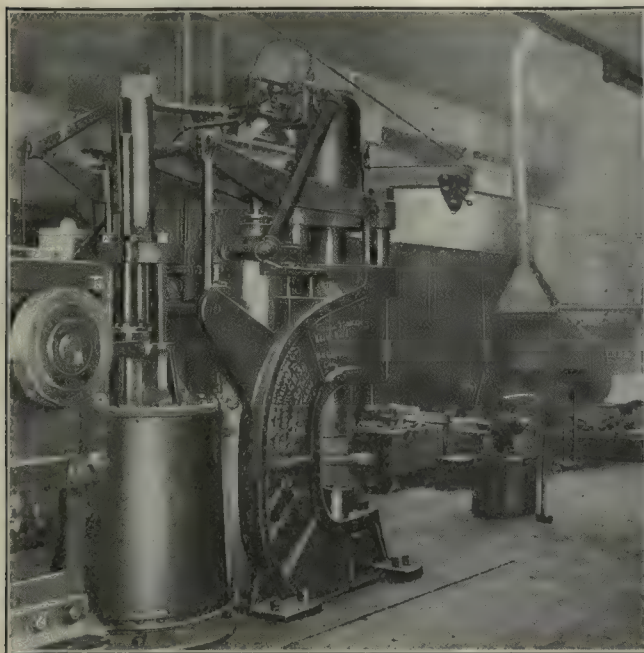


FIG. 4. BOILER AND SHIPSMITH SHOP

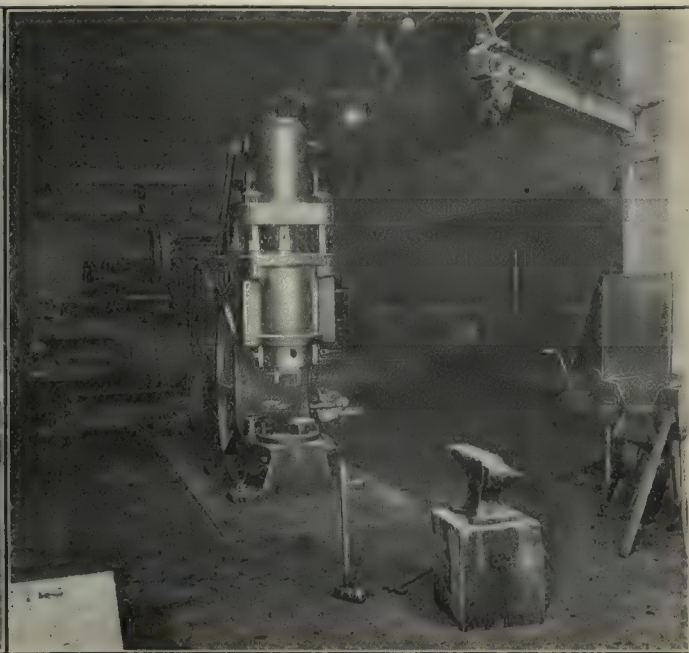


FIG. 5. IRONWORKERS' SHOP



FIG. 6. BOILER, SHIPSMITH AND SHIPFITTERS' SHOP

for this crane will be seen depending at the right in Fig. 2. In addition to the iron cupolas there are on each side of the foundry three tilting furnaces for brass. Four of these tilting crucibles have a capacity of 110 lb. each; the other two have a capacity of 165 lb. each.

The foundry is located upon the lower deck, the same as the machine shop, and has galleries on each side, as

elevation in Fig. 3 gives the proportion of the cupolas, the height between decks and the position of the charging platform for the cupolas.

Figs. 4 and 5 are general views in the forge shop and show in the foreground in each case a 150-ton hydraulic pneumatic forging press. This is used extensively for various jobs which otherwise would have to be handled

under some form of hammer. This press acts upon the squeezing principle and is considered desirable for use on such a ship, as there is no shock due to hammer blows in its action. Fig. 4 illustrates clearly the arrangement of the press proper, the piston control, the accumulator and all the operating levers and rods, and Fig. 5 shows

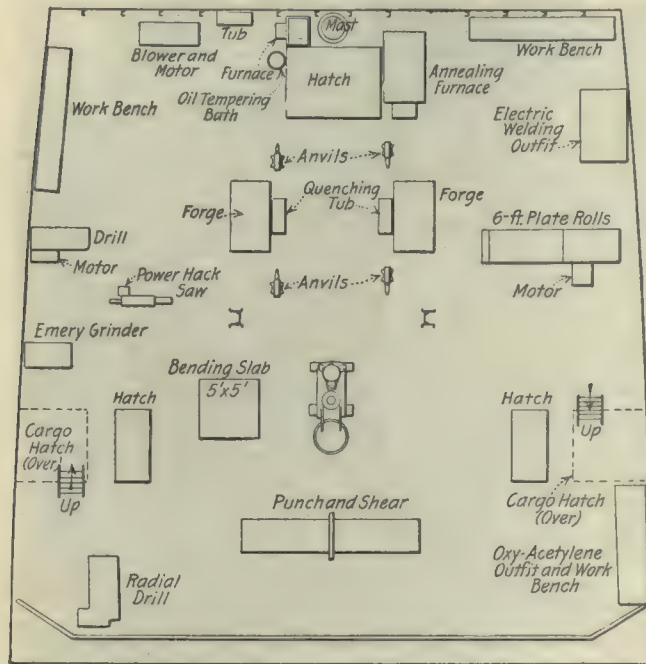


FIG. 7. PLAN OF FORGE AND BOILER SHOP

the same machine as it appears from the front, while the job is being placed between the dies.

The arrangement of ship cranes, trolleys and overhead crane service generally is very clearly presented in the photograph. Immediately behind the forging press will be seen a large punch and shear and other apparatus of value in such a department. The boiler-shop apparatus is also installed in this department and includes a set of 6-ft. plate rolls, the punch and shear referred to, a slip roll-forming machine, drill, etc.

Fig. 6 is a view of the portable oxyacetylene outfit. There is also a portable electric-welding outfit. At the left in Fig. 6 will be seen an annealing furnace, and directly behind this is a tempering and hardening furnace. The position of all this equipment, of the various forges and of the remainder of the apparatus will be understood from Fig. 7, which is a plan view of the department and gives the location of all of the different pieces of equipment.

Efficiency of Rope Drives

By WILLIAM HIRST

To one who has not had experience with rope drives it may be difficult to understand why a single strand of rope will show a higher efficiency than two or more. The natural inference is that if one rope has an efficiency of 97 per cent., a drive of ten should have the same.

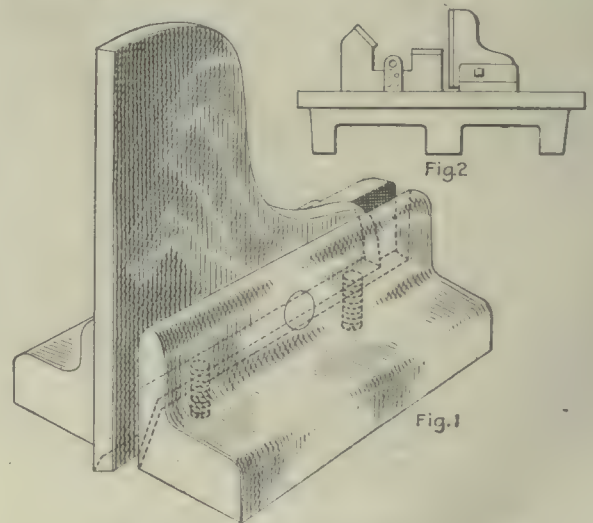
To have each individual rope pull exactly its share of the load each groove must be exactly the same pitch-diameter and shape. Furthermore, the ropes themselves must be of the same diameter and tension when running, so that each will rest at the same depth in the groove. If

this condition could be realized, then the same efficiency could be attained with a number of ropes side by side as with one, but this degree of perfection is never realized; hence the actual efficiency depends largely if not altogether on the degree of accuracy in the sheaves and uniformity in the size and tension of the ropes. No matter how small the difference in the pitch diameter may be, the rope or the groove having the greatest diameter in the driving sheave, or the one having the smallest in the driven sheave, will pull the hardest. Assuming this difference to be 0.01 in., it will be 0.0314 in the circumference and in 100 revolutions the rope in one of these grooves would have drawn ahead of the others more than 3 in. and taken more than its share of the load: therefore, this rope or some other must slip. In most rope drives some of the ropes are slack on the pulling side and they can be heard creeping in the grooves. This accounts for the relatively low efficiency of the rope drive.—Power.

Inspection Square of Special Use With Surface Plate

By A. G. CHARLES

In Fig. 1 is shown a very handy square of advantage chiefly in conjunction with the surface plate. While this tool will not serve the wide variety of purposes covered by the beam square, it is handier for use on the surface plate. Beam squares are often used for testing in the manner shown in Fig. 2. They are inferior to the tool shown, which will prove to be especially valuable for rapidly inspecting finished work. If the bottom of the square is lapped flat and a good surface plate is at hand, the square may be rubbed around slightly upon the plate,



THE SQUARE AND ITS APPLICATION

pressure being applied to the square, which will adhere somewhat to the plate.

If the operator wishes to test the squareness of a piece by using tissue paper, it will not be necessary to hold the square. The blade may be readjusted at any time by means of the screws at the bottom. If this readjusting feature is thought undesirable, the blade may be firmly pinned in position in the base. I prefer the latter method of construction, as the square may be easily re-ground and relapped in case errors occur.

Making the Small Parts of the British Time Fuse

BY FRED H. COLVIN

SYNOPSIS—The smaller parts of the time fuse for the most part simply require a good grade of automatic screw-machine work. No special methods are used, so that sizes, gages and production are all that seem necessary.

In addition to the body, cap, base plug and timing rings that have been described in more or less detail, there are also many other parts that are largely made in the automatic screw machine and the punch press. Instead of showing these individually, they are grouped in Fig. 1, the designating letters corresponding to those used in connection with the assembled fuse, which appeared in the first article of this series.

Fig. 2 shows the brass fuse cover as originally called for and gives some idea of the work that it involved. It consists of the body *A*, the brass wire ring *B*, which must be butted together and brazed at the joint, the tearing-off strip *C* and the short brass strip *D*. This strip is soldered to the cap of the body *A* in order to hold the ring *B* on the side opposite the hold of the tearing-off strip.

The object of the fuse cover is to protect the fuse from exposure to dampness and to guard it against mechanical

injury. Another form of cap was made of heavy tinfoil, although this later gave place to a cap of lead thoroughly coated with tin in order to prevent any possible contact

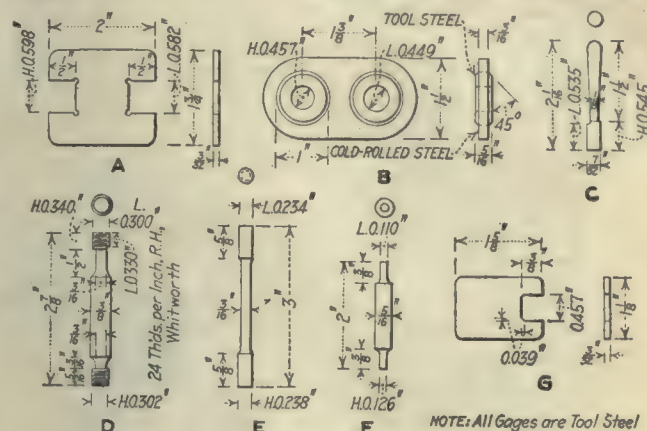


FIG. 3. TIME PELLET

A, total length; B, diameter of body; C, depth of detonator recess; D, diameter and steps of threaded parts; E, diameter of detonator recess; F, diameter of central hole; G, shape of top

of the lead and the explosive material, which make a dangerous combination.

The screw-machine work covers everything but the

washers, detonating time and percussion body and the stirrup spring. These are all punch-press operations, and while seemingly simple in themselves, some of the specifications are not easy of fulfillment. The stirrup springs, for example, are made of hard rolled sheet brass. The spring for the percussion pellet must be gaged after having been subjected to a pressure of 60 lb. in a steel counterpart of the fuse pellet and should return to the mean dimension. It must yield at a load of not less than 77 lb., nor more than 99 lb., these pressures being the limits to which the fuse is supposed to be subjected under firing conditions.

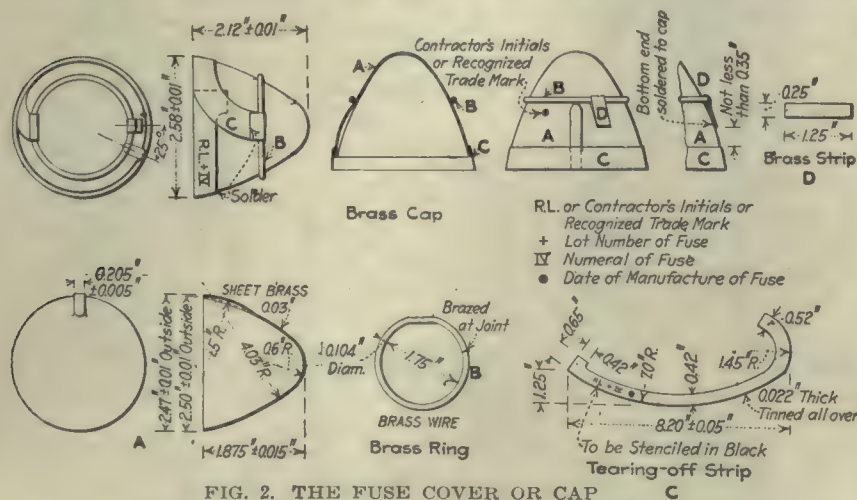


FIG. 2. THE FUSE COVER OR CAP

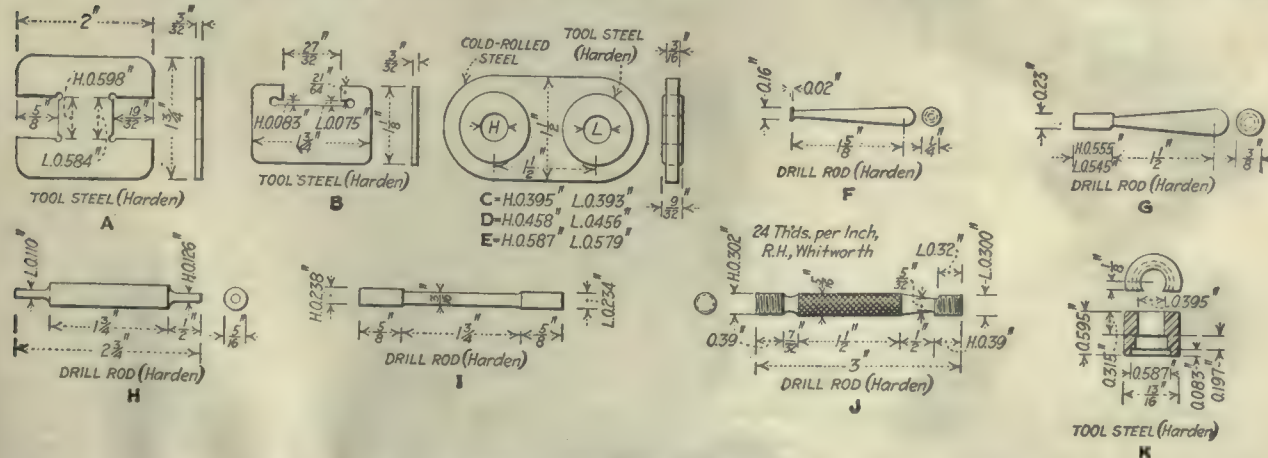


FIG. 1. PERCUSSION PELLETT

A, total length; B, thickness of flange; C, diameter of front part; D, diameter of body; E, diameter of plan; F, diameter and recess in top; G, depth of recess detonator in top; H, diameter of central hole; I, diameter of detonator recess; J, diameter and depth of threaded part; K, external forms

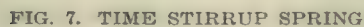
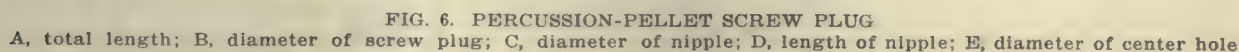
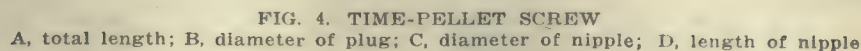


Figure 1 consists of four diagrams (A, B, C, D) showing the dimensions of tool steel parts. Each diagram includes a side view and a cross-sectional view.

- Diagram A:** Shows a tool steel part with a central hole. The side view has a total width of $1.023''$ and a central hole diameter of $0.24''$. The cross-sectional view shows a diameter of $0.24''$. The part is labeled "TOOL STEEL".
- Diagram B:** Shows a tool steel part with a central hole and a side hole. The side view has a total width of $1.7''$ and a central hole diameter of $0.24''$. The cross-sectional view shows a diameter of $0.24''$. The part is labeled "TOOL STEEL".
- Diagram C:** Shows a tool steel part with a central hole and a side hole. The side view has a total width of $2.0''$ and a central hole diameter of $0.24''$. The cross-sectional view shows a diameter of $0.24''$. The part is labeled "TOOL STEEL".
- Diagram D:** Shows a tool steel part with a central hole and a side hole. The side view has a total width of $2.0''$ and a central hole diameter of $0.24''$. The cross-sectional view shows a diameter of $0.24''$. The part is labeled "TOOL STEEL".

FIG. 8. PERCUSSION BODY

A, total height; B, diameter of outside; C, thickness of base;
D, diameter of central hole in base

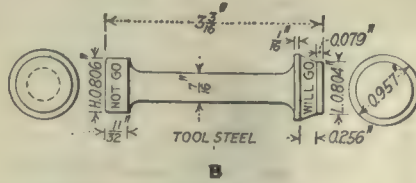
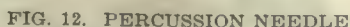


FIG. 10. CAP HOLDER

A, total length; B, internal diameter and form; C, diameter of central hole



A, length of screw; B, diameter of screw; C, diameter of flange; D, thickness of flange; E, length and cone of time
needle from face of flange; F, length and form of percussion needle

Screw-machine times on these parts are as follows:

Time pellet, 140 per hr.	Ferrule, 300 per hr.
Time-pellet screw, 380 per hr.	Time-pellet screw plug, 400 per hr.
Percussion pellet, 130 per hr.	Slotting time-pellet screw plug, 1,200 per hr.
Percussion-pellet screw plug, 380 per hr.	Rethreading time-pellet screw plug, 800 per hr.
Base-plug screw, 260 per hr.	Polishing time-pellet screw plug, 1,200 per hr.
Time pellet, Delta metal, 360 per hr.	Percussion-pellet automatic, 130 per hr.
Rotating pin, 600 per hr.	Reseating top of percussion-pellet automatic, 800 per hr.
Slotting rotating pins, 1,800 per hr.	Polishing top of percussion-pellet automatic, 2,000 per hr.
Cap setscrew, 450 per hr.	
Slotting cap setscrews, 2,000 per hr.	
Polishing top of cap setscrews, 1,700 per hr.	

The foregoing are the number of pieces the automatics are timed to produce. The actual work turned out, however, is considerably less—as is always the case. In the average shop from 75 to 80 per cent. of the camming time is a good output.

The gages used for the different parts of the fuse are shown in Figs. 3 to 16, each gage being lettered so that its particular function with relation to the various component parts shown in detail in Fig. 5 can be found by referring to the caption beneath it.

Another Record Year for Machine-Tool Exports

BY LUDWIG W. SCHMIDT

SYNOPSIS—The fiscal year 1916 was the greatest ever recorded in the history of American metal-working machinery exports. The huge total is \$61,315,032 worth. Roughly, five-sixths went to the allied nations. Tables and charts show the distribution and give a significant comparison.

When one year ago the total exports of metal-working machine tools had reached the total of \$28,162,968, there were many who thought that the high-water mark had been touched. Certainly nobody would have thought that one year later these reports would reach the sum of \$61,315,032, making the total exports for the last three years over \$100,000,000. Nevertheless, this has happened, and according to all appearances even the present high figure will be repeated.

Viewing the marvelous growth of the machine-tool exports during the last two years, it is of course apparent that only war could have brought about such an enormous demand. A chart giving the development of the exports during that period shows that only during the first month of the war the exports fell below the peace standard (see Chart 1 and Table 1). From that time on they have been steadily increasing. They had practically doubled in October, 1914, and had trebled in March, 1915, when the highest point was reached for the United States official year. A decline took place during the middle of the year, after which a new rise set in, finding its climax in November, 1915. The really sensational climb, however, was made only in the first half of the present year, when the exports touched nearly \$10,000,000 a month during May.

Looking at the total of the export trade again, the great influence of the Port of New York is shown. About 75 per cent. of all the machine tools exported left this country by way of New York. The condition of New York, nevertheless, is somewhat changed, as the 25 per cent. which was exported via other ports and across the Canadian frontier had a value approaching nearly to the total value of machine tools exported by this country during peace time. This is possibly the best outward sign of the enormous quantity of machine tools that has been exported during the past year. Philadelphia, Baltimore, Boston and several of the Pacific ports have taken care of that part of the exports. Also, over \$6,000,000 worth went to Canada.

Commercially, February, March, April and May, 1916, were the most busy months for the export of machine tools which the American machine-tool trade has ever seen or most likely will see for some time to come. June shows a small decline, which by some coincidence is found also in the corresponding month of a year ago. The American machine-tool industry felt the pressure of the orders shipped during those four months very acutely during the last months of the past year and the first of the present. Undoubtedly this huge volume of orders had its foundation in the preparations made in England, France and Russia for the great military drive that began a few months ago. It is a matter for speculation whether with this huge equipment the Allies will have reached their maximum or whether further exer-

TABLE 1. EXPORT OF METAL-WORKING MACHINERY, FISCAL YEAR 1916

1915	By Port of New York	Total	Total, 1914
July.....	\$3,160,598	\$3,872,358	\$810,247
August.....	2,891,648	3,624,411	298,257
September.....	2,836,012	3,256,973	550,106
October.....	2,654,480	3,236,079	2,110,397
November.....	3,923,954	4,644,713	1,871,171
December.....	2,458,020	3,205,788	2,432,331
1916			1915
January.....	2,587,029	3,249,595	2,903,740
February.....	3,505,609	4,662,905	2,523,722
March.....	5,069,294	6,501,022	3,863,913
April.....	4,221,715	6,552,367	3,300,953
May.....	8,422,872	9,935,806	3,762,567
June.....	6,121,637	8,465,985	2,735,582

tion and the upkeep of the ammunition supply will result in new orders. Approximately \$58,000,000 worth of metal-working machines was supplied to the allied countries during last year. Eight-two per cent. of the machine tools sent to Europe alone went to the allied countries.

Great Britain again has been the largest customer. Her imports have reached during the last year the enormous amount of \$20,437,803. An inspection of Chart 2 shows that British imports began to rise very substantially during the first half of the present year, continuing to be on a high level until the end of June. An interesting coincidence, if it is one, is that the French orders, while slightly smaller than the English, nevertheless show practically a connected movement. They start with a decline in the middle of last year, followed by a slight upward curve, ending finally with a high movement. This similarity is best explained by the fact that the two nations have acted in coördination with regard to the placing of orders for machine tools and metal-working machinery.

The business with Russia has been very erratic, but Russia today can claim to have reached the high record for one month's imports for machine tools of the countries of the world, with the exceptional total of \$3,581,173 during May, 1916. The real meaning of this figure is best understood by the fact that the highest total for one month of all the exports of machine tools during the preceding year was \$3,863,913. Another striking fact in connection with the Russian business was that this forward movement followed a period of comparative quietness, the Russian deliveries rising suddenly from \$275,748 to the amount mentioned. A surprise also came from Italy. This country so far has belonged to the minor buyers of American machine tools. The exigencies of the war suddenly have raised it above the class into which England belonged before the war. The Italian imports may have reached approximately \$4,650,000. There is at present no indication of a decline.

Compared with these figures, the turnover with the rest of the European countries is small, although larger than before the war. Germany, of course, has dropped out entirely as a customer of American machine tools; also Austria, Turkey and Bulgaria have gone. An estimate of the trade done with the remaining European markets had offered great difficulties already during the previous year. The task was still more difficult during the present year, owing to the fact that the actual value of the machine tools shipped out of other ports than New York is so much larger than during the previous year. Portugal, the last of the allied powers, has possibly not taken more than \$20,000 worth of machine tools.

TABLE 2. METAL-WORKING MACHINERY EXPORTED TO EUROPE DURING FISCAL YEAR 1916

United Kingdom.....	\$20,437,803
France.....	13,316,702
Russia.....	10,280,566
Italy.....	4,650,000
Portugal.....	20,000
Spain.....	800,000
Netherlands.....	350,000
Sweden.....	250,000
Norway.....	250,000
Denmark.....	100,000
Switzerland.....	100,000
Remaining Europe, including Finland.....	37,360
Total.....	\$50,592,431

On the other hand, great changes have taken place in Spain. That country has during the last two years made enormous progress in manufacturing. Her development was very much hindered during the first year of the war owing to difficulties in the acquisition of raw materials and machines. This fault, however, was remedied during the past year, and the country, therefore, has appeared as a large buyer in the American market. Spanish machine-tool buyers have frequently visited New York and other centers and have placed considerable orders. It is likely that Spain has bought about \$800,000 worth of machine tools during the past year.

The Netherlands, which had been able to secure only small amounts of supplies during the year before, has reappeared as a buyer; and the total exports to that country may have reached approximately \$350,000. Sweden and Norway together have taken about \$500,000, while Denmark imported about \$100,000 worth of American machine tools, possibly as much as Switzerland. The figures, official as far as obtainable and estimated where this was impossible, are given in Table 2.

The progress of the war, therefore, has brought to this country not only increased orders from the countries at war, with the exception of the Central Powers, but

after a short depression at the beginning of the struggle has also drawn an increased trade from neutral European markets. This latter movement in the export trade of machine tools possibly deserves more attention with a view to future business than the unnatural increases in the turnover with the countries at war. It is only reasonable that every machine sold will act as an advertisement for other American machine tools in all those markets. Of course, it will depend finally upon the enterprise of the American manufacturer whether he will be able to hold the markets in question.

Turning to our own continent, material increases in the Canadian trade have already been mentioned. The sudden forward movement from \$1,199,365 in 1914 to

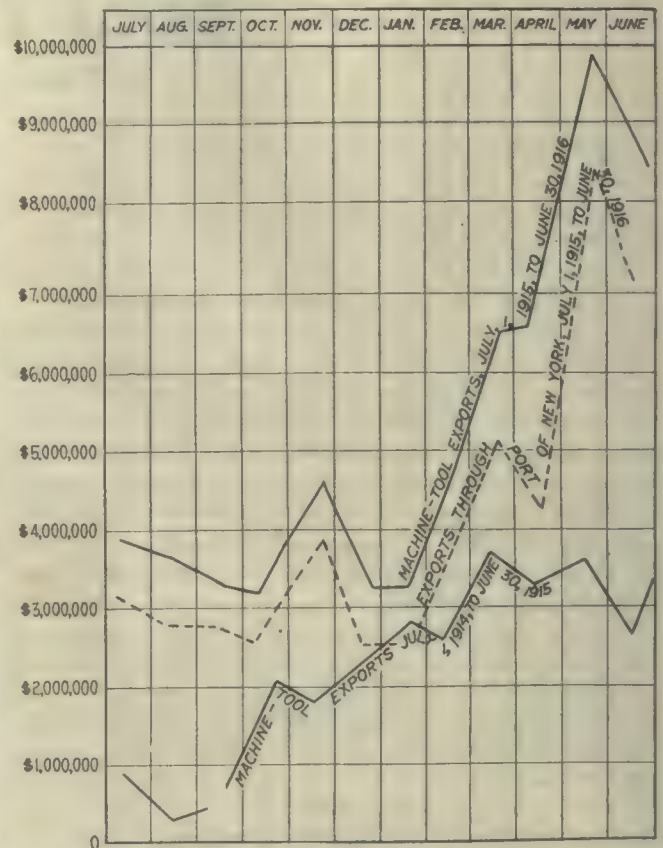


CHART 1. GROWTH OF MACHINE-TOOL EXPORTS DURING PERIOD FROM JULY 1, 1914, TO JUNE 30, 1916

\$1,813,188 in 1915 and finally during the latest fiscal year to \$6,464,144 is astonishing. It is unfortunately still impossible to estimate the actual size of the business done with South America. Brazil, Argentina and Chile have not quite returned to the usual equilibrium of trade existing before the war. Nevertheless, increases in the orders from that part of the world are reported, and it is certain that more could be supplied if our manufacturers would be willing to do so at the prices still governing in South America. New York has had a good export business to South America, and it is not uninteresting to read the development of the export trade during the last year, as shown in Table 3, which gives month by month statistics covering exports from the Port of New York.

Unfortunately, these figures show best that the increase in exports still is not very settled, and great changes are evident during the different months. The year has been one of many changes generally. Not only

has the war affected the inflow of orders, but also shipping facilities have not always been so regularly available as could be desired. For instance, the closing of the Panama Canal for several months has had a material effect on the carrying of machine tools destined for the Asiatic market. British India may have been less touched by these influences, but the deliveries to China and Japan have undergone frequent changes. The New York exports of machine tools to China and Japan, with those of British India (see Table 4), certainly do represent,

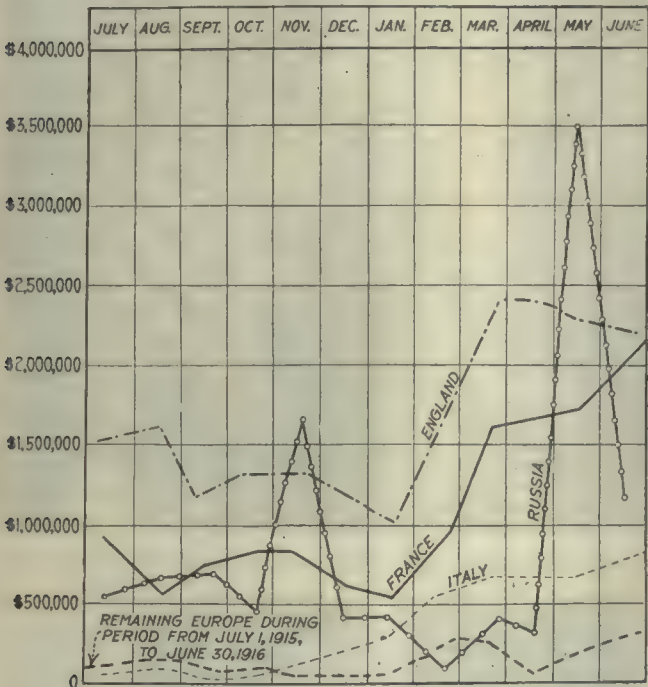


CHART 2. MOVEMENTS OF MACHINE TOOLS DURING PERIOD FROM JULY 1, 1915, TO JUNE 30, 1916

especially in the case of Japan, only a small percentage of the total. It is practically impossible to give exact figures, but the whole Asiatic trade should have been worth about \$2,000,000 or even more, which to some extent is borne out by the large amount carried in the monthly governmental statistics under the heading, "other countries." This sum in the present year is more than \$3,457,632, against \$938,011 during the previous year, and includes such important markets as the whole of South America, the markets mentioned just

TABLE 3. EXPORTS OF METAL-WORKING MACHINERY TO BRAZIL, ARGENTINA AND CHILE BY PORT OF NEW YORK

1915	Argentina	Brazil	Chile
July.....	\$5,095	\$5,363	\$848
August.....	5,745	328	10,562
September.....	10,188	...	...
October.....	2,276	560	...
November.....	3,192	4,508	10,707
December.....	4,534	1,115	50
1916			
January.....	19,191	2,303	1,895
February.....	3,456	224	802
March.....	13,580	3,862	2,845
April.....	10,103	212	13,313
May.....	3,990	10,253	12,876
June.....	2,932	878	4,599
Total.....	\$84,282	\$29,606	\$58,437

now, Russia in Asia, New Zealand and South Africa. The exports to the latter can hardly have been more than \$80,000.

Outside the increase in foreign orders shown by the vast increase of the total of the exports, the year has also brought a renewal of orders from countries only indirectly associated with the war. This is possibly the most pleasing fact brought out by the preliminary Gov-

ernment statistics and the special researches made in this article on behalf of the *American Machinist*. The resurrection of ordinary trading with neutral markets

TABLE 4. METAL-WORKING MACHINERY EXPORTS VIA NEW YORK TO JAPAN, RUSSIA IN ASIA, BRITISH INDIA AND CHINA

1915	Japan	Russia in Asia	British India	China
July.....	\$6,464	.....	\$6,883	\$4,780
August.....	3,753	.....	3,503	.....
September.....	5,028	.....	817	9,145
October.....	999	\$9,604	2,091	1,201
November.....	9,388	288	2,030	762
December.....	97,500	.....	423	159
1916				
January.....	87,538	2,568	4,293	2,823
February.....	6,285	27,588	1,951	2,729
March.....	5,066	.....	3,763	.....
April.....	5,617	23,636	11,941	2,787
May.....	35,785	1,851	3,402	2,425
June.....	5,694	24,376	8,770	1,352
Total.....	\$269,117	\$80,911	\$49,867	\$28,165

finally will prepare for the transition in the export market from the state of war to that of peace.

Machining Motorcycle
Cylinders

When one stops to consider that motorcycle motors are air cooled, and need as much exposed cylinder surface as possible, one of the big reasons for casting cylinders sep-

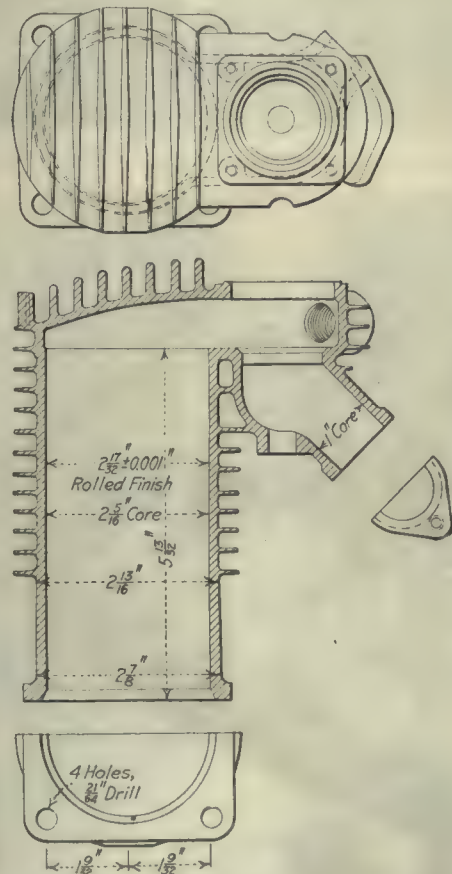


FIG. 1. DETAILS OF CYLINDER

arately for even multiple-cylinder motors will be understood. The Henderson Motorcycle Co., Detroit, Mich., uses a four-cylinder motor, and details of the type of cylinder used are shown in Fig. 1.

The machining operations on cylinders are not at all complicated, and the major ones are comparatively few. The first operation is to chuck a cylinder and rough-bore the inside. The flange is also faced off. In common with most work of this kind, the castings are allowed a certain amount of time to season after the roughing cuts.

The flange holes are then drilled and reamed, as shown in Fig. 2, using a multiple drilling head.

The jig used for holding the cylinder for the flange drilling and reaming operation is interesting. The cylinder is slipped up onto a locating pin that fits the bore. A screw jack *A* holds it firmly in contact with the underside of the top plate of the jig. When putting in or remov-

tion of this screw and the crank, is clearly given in Fig. 4.

Some work on the valve chamber now intervenes, and then the cylinders are reamed in the jig shown in Fig. 5. In this jig, the cylinder is located by means of the drilled and reamed flange holes, which fit over pins on the underside of the top plate of the jig. The casting is forced up

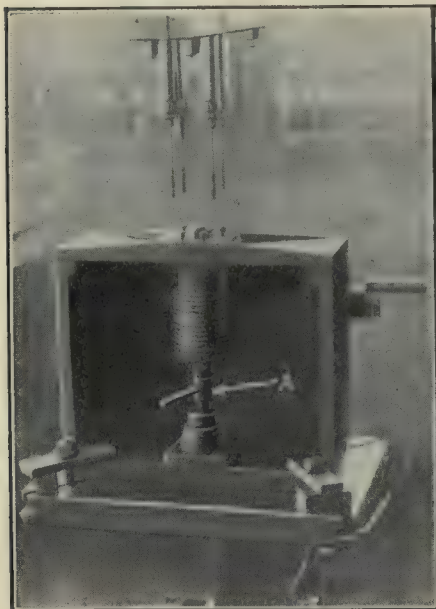


FIG. 2. FLANGE-DRILLING JIG

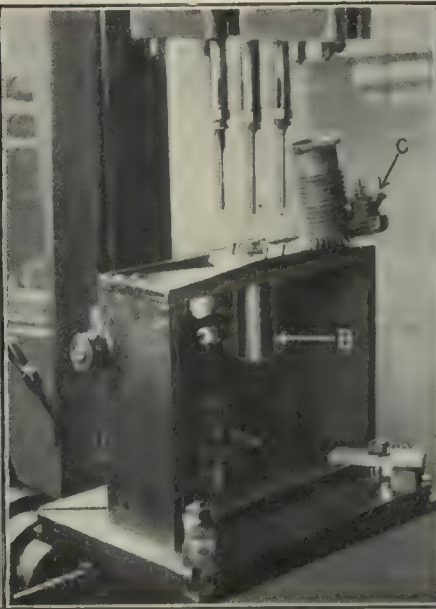


FIG. 3. JIG WITH CYLINDER REMOVED

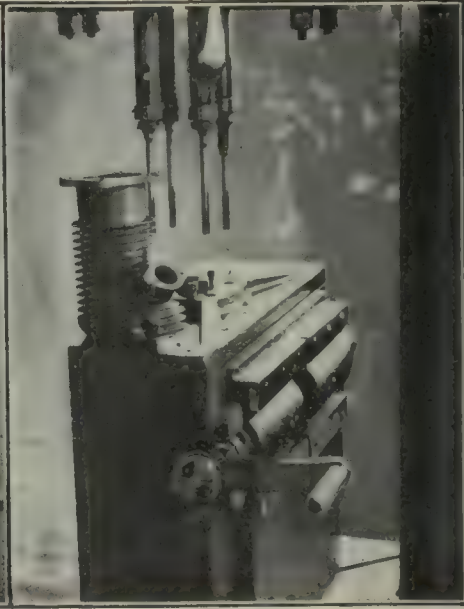


FIG. 4. REAR VIEW OF JIG

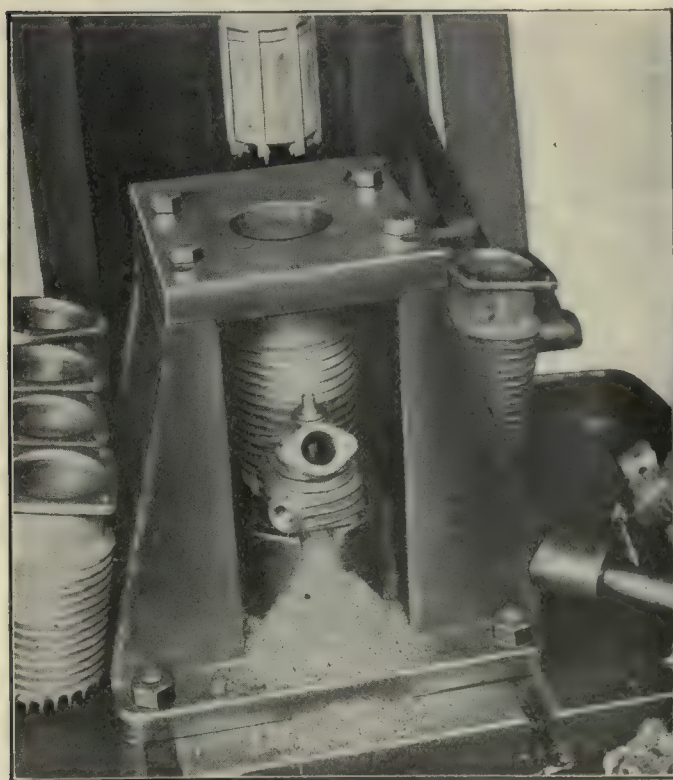


FIG. 5. REAMING OUT THE BORE

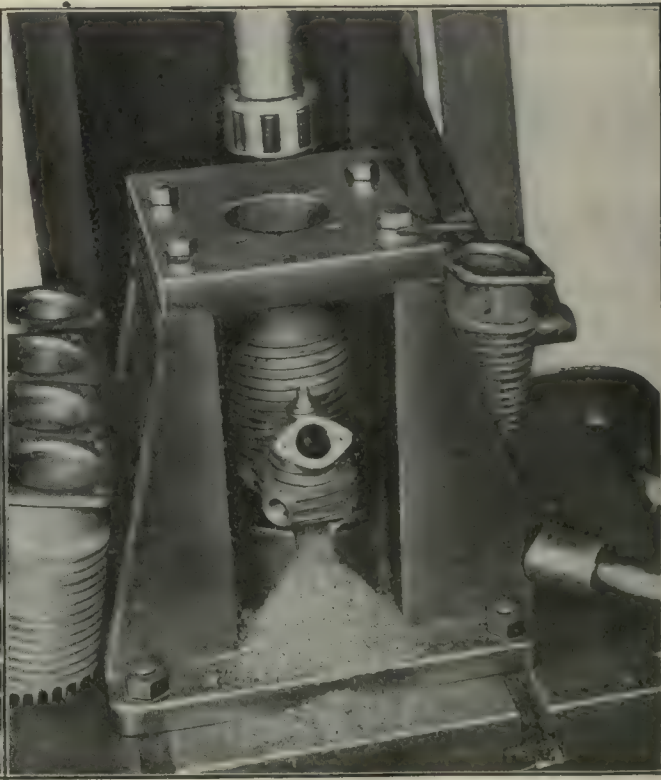


FIG. 6. METHOD OF ROLLING THE BORE

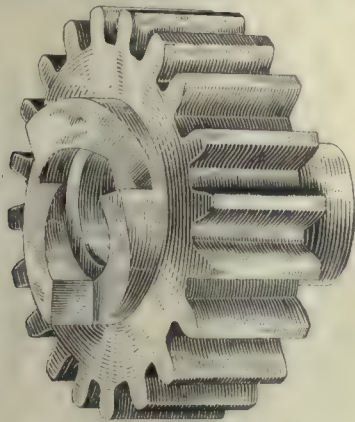
ing a cylinder, the jack is made to slide along to the left out of the way. This is necessary, since the locating pin or plug, shown at *B*, Fig. 3, projects downward quite a way. The cylinder is located in the jig radially by means of the valve chamber *C*, which fits in between two clamping jaws, worked by a right- and left-hand screw and a crank. A back view of the jig, showing the exact loca-

tion of this screw and the crank, is clearly given in Fig. 4. After being reamed, the bore is rolled with the tool shown in Fig. 6. This rolling tool carries six hardened-steel rollers and turns at about 150 r.p.m. This operation gives the bore a hard, smooth surface.

Letters from Practical Men

How Would You Gate These Patterns?

A customer recently sent us six 4-in. gears like the one shown in the illustration and wanted to know if we could gate these without placing the leader on the face of the



THE PATTERN TO BE GATED

teeth, as he did not want to do any finishing on this part of the casting. The teeth were also to be free from fins.

Mr. Patternmaker, how would you have gated these patterns?

A. E. HOLADAY.

Naugatuck, Conn.

Drilling Oilstones

It is sometimes necessary to drill holes in broken oilstones and emery wheels to make them available for work by fitting to a handle or arbor. This can be done with a "star" drill made from drill rod. The drill is made with relief behind the cutting edge and is hardened, but not drawn. It is held in the hand and kept constantly turning while it is tapped with a hammer.

Springfield, N. J.

F. J. DITTMAR.

Readers and Correspondents

To be a correspondent of the *American Machinist* means many pleasant experiences, one of which may be cited—the friends you get to know among the many readers. One instance of my own may be given.

Some three years ago, after a description of a certain works, an old boy of mine, now holding a responsible position in America, wrote me a very interesting letter. He had waited, he said, a long time, reading the *American Machinist* diligently, to get my name. Finding it he chanced a letter through the firm I happened to be writing about. He said he had almost given up, although the writing under a certain name he felt sure was mine. His chance letter arrived home, and many interesting letters have passed since.

Two letters from readers reached me quite recently, seeking for information, and I did my best to oblige. I

suppose I ought to feel proud that, living in a city of upward of 400,000 inhabitants, letters can reach me when devoid of all such details as number, street or district. But it is not fair to the postal authorities or the *American Machinist*.

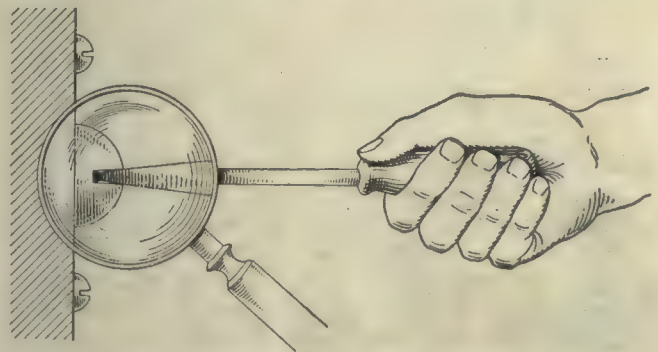
Many correspondents, myself included, use pen names for quite honorable reasons, and no doubt many readers who desire acquaintance with the writer of a contribution meet with disappointment (perhaps they blame the *American Machinist* quite unjustly) because the writer is unknown to the postal authorities under his pen name. But the reader is alone to blame. Just send your letter care of the *editor*, who will put matters right. It is the royal road and the only safe road between readers and correspondents.

F. P. TERRY.

Belfast, Ireland.

Correct Shape for Screwdriver

The illustration shows how to file or grind a screwdriver so it will tend to hold itself in the slot of a screw and not slip out. The sides of a screwdriver should be



WELL-FORMED END ON A SCREWDRIVER

flat and parallel to fit the slot in the screw and not, as usually found, beveled like the point of a chisel. For especially hard jobs the concave form shown is advantageous.

E. M. KEYS, JR.

New York City.

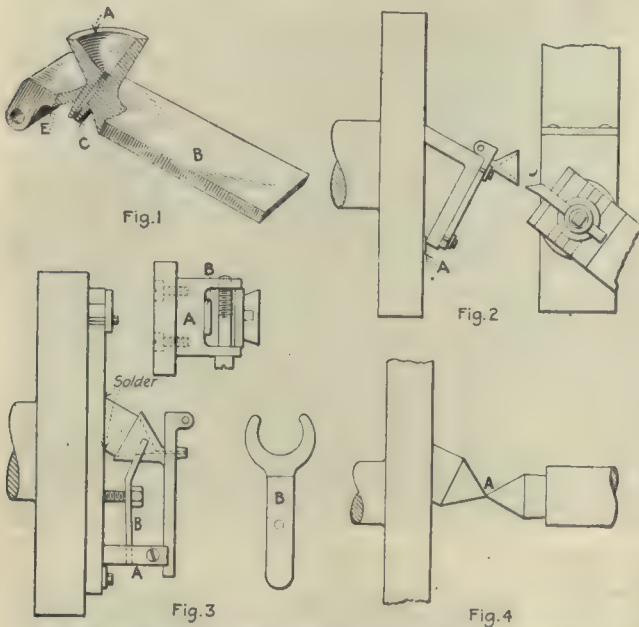
Use of Angle Plate on the Faceplate

The part shown in Fig. 1 was difficult to hold while machining the surfaces A, B and C. The part to be machined was a bronze casting.

An angle plate was found, which when packed up a little as in A, Fig. 2, held the piece at the proper angle to allow for machining the inner surface of the funnel. There were quite a number of these parts to be made, and once the angle plate in Fig. 2 was properly located for the first piece, it was left undisturbed while the rest were machined. In this manner the remaining pieces were easily located. The set-up for machining the face

B and turning the teat *C*, Fig. 1, is shown in Fig. 3. The piece is securely held in position by the clamps *A* and *B*, Fig. 3.

In Fig. 4 is shown the simple manner in which the holding device is properly located upon the faceplate of the lathe, so that the small hole that is reamed through the teat will run into the center of the funnel. When the device had been located and securely clamped in position so that the point *A*, Fig. 4, was in line with the tail center, it was not moved from its position on the faceplate until all the pieces had been machined. When



FIGURES 1, 2, 3, AND 4
FIXTURES AND METHODS USED ON AN UNUSUAL
FACEPLATE JOB

drilling and reaming the hole through the teat, the point *A*, Fig. 4, was removed by the drill, but this mattered not after once the device had been located and clamped. Face *B*, Fig. 1, could not be machined over the entire length in the lathe, owing to the interference of the lug. The portion of *B* that was not finished in the lathe was handled in the shaper, the piece being mounted upon the same device, the cut running longitudinally.

Newark, N. J.

A. R. WILLIAMS.

Punches for Leather, Rubber and Fabric Washers

The illustrations show simple and practical punches for cutting blotting paper, leather, cloth and rubber washers for different uses.

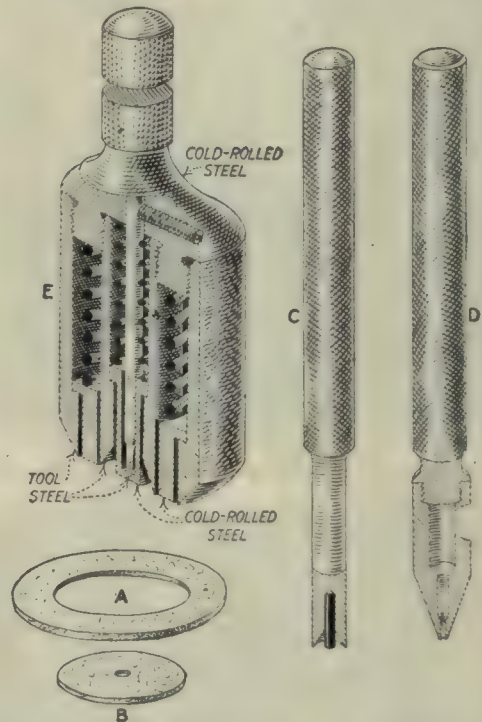
The punch illustrated at *E* cuts a large circular ring *A* and a small one *B* with a $\frac{1}{8}$ -in. hole. It may also be used to cut either of these by removing the outer ring or the small punch. The stripper has to remain to strip the scrap. This style of punch is practical for any size or shape up to 3 in. in diameter. It can be used by hand or in a punch press.

We have always used cold-rolled steel for shanks and strippers, and a coarse knurled surface on the handle. We use 20 threads per inch on all threaded parts—drill rod for the small punches and Paragon oil-hardening steel for all other cutters. This allows us to make irregular punches to size and harden them without changing their

shape. The edges are honed or ground on the outside to a cutting edge. At *C* is shown a punch we use for punching holes through leather after it has been glued to certain parts of wood in which holes have previously been drilled. With this style of punch we not only get a clean-cut hole, but can work rapidly as the punch is the size of the hole in the wood and is guided thereby.

This punch is made of cold-rolled steel turned to the desired size. A combination center drill is used to open the end and form the edge. It is then casehardened. A piece of rubber is pushed into the small hole and fastened with shellac. The rubber acts as a stripper.

At *D* is shown a pencil punch for making corrections in stencils and cutting. By this method we are able to



SEVERAL FORMS OF PUNCHES FOR FABRIC PAPER,
RUBBER AND LEATHER

get any size required from No. 60 drill to $\frac{1}{8}$ in., which is the largest size in use for this purpose. In this style of punch, you will notice that the punching comes up through, so as not to fall on the cutting or stencil.

Buffalo, N. Y.

G. C. HOFF.

A Tailstock Feed

I had a large number of gasoline-motor valve guides to drill in a lathe. There was not spindle travel enough to drill the entire length in the usual manner without resetting the tailstock, so I bolted a strap of iron to either side of the carriage by means of the T-slots and bent the other ends at right angles to fit over the adjusting setscrews in the tailstock, fastening the carriage and tailstock firmly together. I then tightened the tailstock just enough to allow free movement on the ways. By using a fast carriage feed I found the guides could be drilled and reamed very rapidly.

This arrangement works equally well in drilling and reaming small bushings and does not interfere with facing the ends.

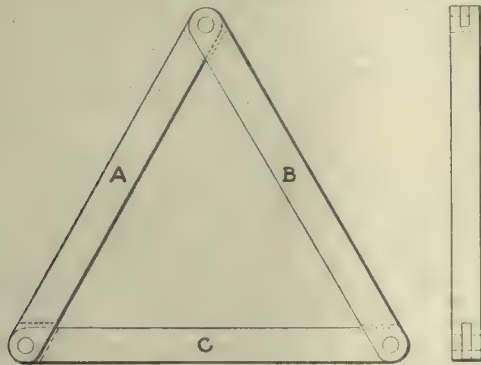
RALPH C. BICKFORD.

Waterville, Maine.

Discussion of Previous Question

Exact Angles for Lathe Centers

In answer to R. W. Greene's article on page 298, I will say that a 60-deg. angle can be readily originated by the method used by me some years ago for a standard with which thread gages could be compared. The principle employed is that in an equilateral triangle each interior angle is equal to 60 deg. Then, if three bars are made, as



60-DEG. ANGLE GAGE

A, B, C in the accompanying illustration, each of them exactly equal to the other and with the holes the same distance apart and in the same relative positions in regard to the sides, the center lines of these bars when connected by pins passing through the holes will form an equilateral triangle. As the inside and outside surfaces of the bars are parallel to the center line, all angles included between the inside or the outside of the bars will be 60-deg. angles.

Brooklyn, N. Y.

EDWARD A. STEIN.

Co-operation in Buying

The frequency with which articles appear about the man who does the buying is an indication of the lack of coöperation between the purchasing agent and the man in the shop.

The tendency of the buyer is to discount the experience of the mechanical man, believing that his preference for a certain tool comes from his having used no other. As a matter of fact this preference is probably the result of a process of elimination extending over months or even years.

A recent contributor to your columns has stated, "I have never met a purchasing agent who was a highly qualified draftsman, screw-machine expert, brass molder," etc., and he never will, for as the countryman said after gazing at the giraffe, "There ain't no such animal." On the other hand, many buyers have to show their directors that they have spent less money than their predecessors, or that expenditures grow proportionately less each year.

When the whole proposition is boiled down there are only two principles for the purchasing agent to follow. The first is to be assured of the integrity of the house from which he is purchasing. When a salesman's card

is handed in, it is a simple matter to ascertain if his firm is in the buying section of such papers as the *American Machinist*. If so, all question as to responsibility for mistakes or defects is set at rest in the buyer's mind. If not, then it is only fair to request other evidence as to such responsibility.

The second is that the much or little money spent is not what will show economical buying at the year's end. It is the service and production which the superintendent has obtained from the articles bought. Any man who is responsible for production will gladly submit reports to the purchasing agent, and a simple system can be devised to keep a record of these which, in turn, can be presented to the board of directors on demand.

Jersey City, N. J.

H. D. MURPHY.

Take Warning!

On page 1089, Vol. 44, I observe that George G. Little has a few words to say on the merits of the English system of measurement as compared with the metric system. I have worked in shops using the two systems for the past 20 years and I have yet to hear the first complaint from a practical shop point of view against the metric system.

At the works where I am at present, the tool makers and machinists when they have a job to do where the dimensions are given in inches (such as locating holes in jigs, etc.) invariably transpose them to millimeters, as there is less chance of error in reading measuring instruments in millimeters than in inches, notwithstanding the fact that an equal number of measuring tools are provided for each system.

I have had a number of apprentices under my charge from time to time, and I have found that in every case they grasp the method of reading the instruments in the metric system in about as many minutes as they do the other system in the same number of weeks. As the millimeter is a small unit, 0.01 mm. is equal to approximately 0.0004 in. Surely it is as easy to say "one hundredth" as "four ten thousandths." It is readily seen that shop calculations are much simpler with the metric system, especially where there are many to be worked of the form, $z = \sqrt{a^2 \pm b^2}$. In 90 per cent. of such calculations a and b will be an even number of millimeters where in inches they would probably be to the nearest $\frac{1}{32}$ in., which might involve five places of decimals in each, making *ten places* in the square of each.

In the other case, all one has to do is to refer to a standard pocketbook giving numbers squared and write down the answer, thus eliminating errors. A job came before my notice about a week ago where there were over thirty calculations of the type mentioned—($x = \sqrt{a^2 \pm b^2}$). Just think what figuring this would have entailed had the dimensions been in inches instead of millimeters. I have also observed that it is much easier for draftsmen to visualize sizes in millimeters than in frac-

tions of an inch. I have reserved the most important point, in my opinion, until last—namely, the educational point of view.

Think of the enormous amount of work entailed in memorizing tables of long measure, square measure, cubic measure, dry measure, avoirdupois weight, troy weight, apothecaries' weight, *ad infinitum* (and in England an obsolete money system also). Just think what a confusing effect this has on the juvenile mind, each separate weight or measure being totally different and (to the juvenile mind) no connecting link between any of them. Then think of the enormous amount of time wasted reducing miles to inches, tons to drams, etc. With the compulsory adoption of the metric system all this would disappear and it would give each child the opportunity of almost two years' higher education (keeping the years of attendance as they stand at present), which is so necessary in the competitive world of today. As an instance of what I mean, let us compare, bringing inches to miles with millimeters to kilometers. Let us proceed to convert 50,204,378 mm. to kilometers. Starting from the right-hand side tick off each figure—50 km., 2 hm., 0 decam., 4 m., 3 decim., 7 cm., 8 mm. With the other system the process would be, first divide by 12, then by 3, then multiply by 2 and divide by 11, then divide by 40, then by 8. When the conditions are reversed think of the multiplication required compared with the metric, which is simply writing down after your kilos a suitable number of ciphers and you have your result correct. Surely if all the continental states of Europe have adopted it, the change cannot be such a revolutionary one as your correspondent suggests. I might mention that the British Association, which is composed of the most eminent men of science in the British Empire, has adopted the metric system long since for all their scientific work. For proof see sizes of B. A. screw threads, and surely the British Association are as a body conservative enough for anyone.

Walthamstow, England.

J. PEARMAN.

Drawbacks of a Compulsory Metric System

I would like to say a word about the metric system from a purely personal standpoint. If I were to go to any foreign country to live, I would do my best to adopt its language, use its systems of weights and measures, obey its laws and observe its social customs. If that were too large a price to pay for being in the foreign land, I would leave it and regret that I did not have a more adaptable mentality.

If in this country, in my own shop, some foreign customer should come and want me to build cornshellers of the same type as those now in use here, and would offer sufficient inducements in the way of volume of business and profits, and specify that they should all be in metric sizes and have the capacities marked on them in kilograms, I would take the order and would not expect to have any serious trouble.

Admitting all this, and also admitting other matters that are often mentioned by advocates of the general adoption of the metric system in this country, I will attempt to make plain why I am opposed to any action that seeks to force the system on those of this country who do not want it enough to adopt it voluntarily. To do this I may have to do some explaining. By profession

I am a mechanic, and my technical education has been grafted on from time to time because I found that I needed it in my business. It has been hard work to get some of the grafts to grow and properly thrive.

I find that I cannot mentally translate this knowledge that it has taken me years of hard work to get into terms of the metric system. I find that much of my library will become obsolete. I will admit that this may be simply a sign of my own stupidity, but I want also to submit a few facts to show that even great minds can fail to exactly score a bullseye.

During my schooldays I was taught the rudiments of the metric system, and was told of how "scientific" it was, and how it was founded on the size of the earth; and how, if you had one unit, you could get all of the others. With this information I was not told that the earth could not be measured accurately, or that the measurements of different men did not agree closely enough to allow the size of the earth to be used as a standard, and so a certain piece of metal was used as the unit; and that it is so used today.

Since mentally trying to convert the things I know into the metric system, I have concluded that the scholars who devised the system were not practical men or they would have seen the necessity of linking it to the inch, if for no other reason than because many of us find it hard enough to think in one system.

As the advocates of the system all proclaim that its virtue resides in the fact that it is decimal, and that the divisions of the system can be obtained by either multiplying or dividing by ten, it is evident that in the beginning it was not important as to what the length of the meter should be. All the beautiful relations of the units to one another could be maintained regardless of this length.

A practical man might have realized that the diameter of the earth could not be measured correctly without instruments, and that while the divisor used to get the meter was large, so also was the error from a small instrument likely to be large when expanded to the diameter of the earth. One authority gives a difference of 16,008 ft. in the diameter as found on later measurements. Now the meter is a piece of metal that the United States Government says is 39.37 in. long in the United States, but which is a little bit longer than that according to some textbooks. One of the books states that it is 39.37043 in., another that it is 39.3707904 in., and still another states that it is 39.36996 in.

As I am a citizen of the United States, 39.37 in. it legally is to me, and I am rather forced to think that our meter is either 39.37 times our inch or else our inch is the meter divided by that number. I am not certain which is which, but I do know that if I am reading in the English system and trying to think in the metric system, my inches must be divided by 39.37 and the answer pointed off at the right place to have them changed to centimeters. I cannot do this mentally, and when I take a paper and pencil I generally get so mixed up that I lose all interest in the article I am reading.

If I am trying to think from pounds to kilograms the situation is not improved, for I find that one pound is 0.4536 kg. and one kilogram is 2.2046 lb. It does not rest my brain to find that a square inch is 645.2 sq.mm., a cubic inch 16.387 cu.mm., and that one pound per square inch is 0.070308 kg. per square centimeter.

If, instead of worshipping the theoretical, the *rabid* advocates of the metric system will divert their efforts toward changing the units of that system to dimensions that are thinkable, they will be doing me a good turn. I would suggest that they start by having the length of the meter changed to 40 inches. That would divert their attention to something practical.

As I have said before, it has cost me years of hard work to get the technical education that I now have, and to rob me of it is no more right than it is to rob me of any other of my possessions. And to make me think and work in the metric system would be doing just that.

It seems to me that many of those who are so much in favor of putting the metric system into our shops, and who hold up the English system to ridicule, do so because they have been educated in the metric system and cannot translate it into the English system any better than I can translate the English system into the metric.

The inertia of the human mind is not one of the least among inertias. If it did not offer resistance, phonetic spelling, an educational system suited to the needs of present conditions, would be in vogue, along with numbers of other blessings. It does offer resistance and we must allow for it, or we will find that our theories do not work out.

I have a number of other reasons why I am opposed to the metric system being forced on this country, but I fear that the editor and the readers will be glad to know that the "cornsheller" and other business take up most of my time and keep me from attempting to put them into print.

I will consider that I have done a pretty fair job if I have been able to transplant some of my ideas in an understandable way into the minds of some of my studious fellow mechanics.

W. OSBORNE.

Oil City, Penn.

✱

Helping Along the Metric System

I have been very much interested in the recent articles about the metric system, both pro and con, because I had some work to do that required the use of this system sandwiched with the regular line using the English standard. I feel that my experience is similar to what many others have had—and as time goes on are having more frequently—that is, getting accustomed to the metric system of measurements.

A doctor once told a friend of mine that no man's appendix was of any use to him, and that people while yet in good health should have it removed as a safety-first plan.

My friend found on investigation that this doctor, although apparently in good health, was still the possessor of that particular member which he so strongly advised others to part with. All of which made my friend think that it did not make a great deal of difference whether we act the part of doctor or patient, and that we as a class are to an extent the victims of custom—sometimes slow to take up improvements because they don't happen to get just the right kind of a start to make them fashionable, and at other times following the fashion rather than seeking out that which is of merit.

If Uncle Sam is going to be the doctor he surely is going to have all classes of patients, and I fear there will be many among them who cannot meet the expenses of such a serious operation. Although many of the doctors say we must submit and some of us are quite willing, others are not willing; neither are they convinced that such an action would be for the general good.

However, whether the metric system is ever made compulsory or not by law, conditions would seem to indicate that as time goes on and the intercourse between nations increases, we will be called upon more and more to use the metric system. So why not take to it kindly?

The information for conversions found in the various handbooks is very complete, but many workmen do not care to consult such books. Conversion tables printed in large type and posted around the shop would be very helpful. I would like to see the *American Machinist* get out a decimal table showing the equivalents of hundredths of an inch in terms of the millimeter as a companion to the one now issued showing the decimal equivalents of the sixty-fourths of an inch.

The micrometer seems to be the logical tool to help us to work out these changes, and the difficulties are not so great as often pictured.

MARTIN H. BALL.

Watervliet, N. Y.

✱

The Advantages of Machinist Draftsmen

There is a temptation to dismiss discussion on the question of machinist draftsmen with the cryptic advice, "Let the shoemaker stick to his last." On the other hand, I am inclined to indorse what Mr. Mundy implies on page 336—that the average machinist makes about as good a draftsman as the average draftsman makes a machinist!

I have had some experience with draftsmen as machinists and more experience with machinists as draftsmen. Concerning the former I can only say that every draftsman ought to turn machinist at least for a time. It is the only way he can thoroughly learn the trade of drafting. In the shop he will learn in a short time how important it is for the draftsman to know the practical side of construction, its possibilities and limitations, and he will discover how little many so-called draftsmen know about this side of their work.

Concerning the machinist who turns draftsman I must say that his efforts on drawing paper are about as crude as the average draftsman's effort in the shop! If a machinist really wants to learn to draw, is willing to give the necessary time to learning how and has some native ability along that line, it is obvious that his training in the shop will be invaluable. But most machinists who turn draftsmen are inclined to leave off their drawings the data which they know from their shop experience how to supply. They seem unable to appreciate that a drawing is a fixed thing which must specify exactly and not allow inferences or opinions or guesses.

There will be less difficulty between drafting room and shop if there is more consultation before ideas are worked out in metal, if the men from the shop are called into the drafting room to advise and suggest before the drawings get into finished form or into the shop, and if the men from the drafting room are called into the shop to offer a way out when difficulties are encountered. What is

needed is more and constant coöperation between drafting office and shop.

Finally, let us not forget that the machinist who does not know how to read a drawing is no better than the stenographer who cannot read shorthand notes, and that the draftsman who is not acquainted with shop practice is no better than the stenographer who cannot care for her own machine. Competent workmen in both of these fields of endeavor should have a good working knowledge of each trade.

F. G. HIGBEE.

Iowa City, Iowa.

✱

The Suggestion System

Much has already been said in relation to the various suggestion systems in operation and those that ought to be in operation. There seems to be a matter of fact that is not looked upon in quite the right light. When a thinking individual hits upon an idea that means perhaps the saving of many hours of labor, he will gladly contribute the scheme in the shape of a small article to some technical paper. His reward for so doing will be slight, but he will be pleased, partly because of the money earned and partly owing to the satisfaction derived through telling others "how to do it." But let him drop the same suggestion into the suggestion box at the shop, and what is the result?

Assuming that the plan is a real saver and is put into practice, he will figure the apparent amount saved and then feel that he is being treated harshly if he does not receive a fair portion of the apparent saving. The chap does not seem to realize that soon after an improvement is put into operation, competitors will adopt it also. These competitors will not pay a reward to the originator of the idea; and if the firm which obtained the suggestion in the first place pays a large sum or a regular bonus to the suggester, it will be laboring under a handicap. When a manufacturer obtains a new and more efficient method of doing something, he has the better of his competitors only until they adopt this idea, and we all know that any innovation that is not iron-bound with patents and money to back them will soon be copied.

Suggestion systems are intended for and should be helpful in keeping institutions up to their highest point of efficiency. They are the means by which the mass, if they know how, may get behind the big thinkers and help push the wagon of efficiency up the hill to a higher plane.

The *American Machinist* might be called a gigantic and highly efficient suggestion box, even though the title is lacking. Suggestions are poured in at the rate of several thousand a year and are looked over by many thousand readers every week. The *American Machinist* seems to have no difficulty in obtaining suggestions. It pays promptly for all matter of interest. But the money-earning qualities of a contribution cannot be considered in the payment. The very men who advocate large remuneration for shop suggestions appear satisfied with what they receive from technical papers for the same material. Of course, a firm should pay promptly and somewhat more than a technical paper, since it has more of a start on its competitors than in cases where the suggestion is received through the medium of a periodical.

My only experience with the suggestion system has been to work in a shop that had one. On the printed forms

to be filled out with a suggestion was all the information necessary to enable the suggester to present his idea in good shape; never a word as to whether the reward would be ridicule, thank you, or what. The shop was headed by an "efficiency engineer" (?) and was bubbling over with opportunity for improvement. I wisely overlooked the suggestion box in this shop, as the best suggestion that I could have offered would have been to put a better man in charge of the shop. That such a change commended itself to the owner of the plant was proved by later events. As this very efficiency engineer was the first to look over the suggestions, I fancy that the reward for such an intimation would have been heavy payment from the end of his boot.

To sum up, if a suggestion system does not pay and the possessor of a good plan is overflowing with a desire to express himself, there are technical papers and periodicals of all kinds, which are equally glad to publish the idea.

If you prefer the suggestion system and it is either unsatisfactory or not in evidence, publish your idea. Then hint to the boss that he may get a good suggestion by paying the price of a certain issue of a certain paper.

Newark, N. J.

GUSTAVE A. REMACLE.

✱

Method of Analyzing Motions by Graphical Charts

Referring to the article "Methods of Analyzing Motion by Graphical Charts," by Frank B. Gilbreth, on page 237, I beg to call your attention to an erroneous surmise. When referring to his paper, "Motion Study for the Crippled Soldiers," Mr. Gilbreth writes: "Somewhat to my surprise and regret, this chart and the disclosure of the methods of its preparation and use called forth no discussion whatsoever." This error is probably due to the fact that he did not personally read his paper. I happened to be present at the meeting and not only discussed his paper, but criticized some points therein. While the title of the paper was very timely and attractive, practically nothing was said in reference to crippled soldiers. I fully appreciate the enormous amount of work that is necessary for an investigation such as Mr. Gilbreth has made. Nevertheless, I do not hesitate to state that in the form presented it is only of indirect value and as such should be handled with utmost care. His investigation represents an appreciable step in the direction intended, but is by no means complete enough to make conclusive deductions.

In investigating the mechanical side of the anatomy of beings, observations made must be so classified, tabulated and charted that the geometry, mechanics and kinematics pertaining to the case are brought into accurate, absolute relation, which is most suitably done by nomographical representation.

I realize the difficulty of such a problem, but that should make it the more interesting for the specialists handling such work. The main criticism I have to make on the motion as presented in your issues of Aug. 10 and 17 is that the employment of one cross-section plane gives two-dimensional results, while most performances of man while working occur in three dimensions. Complete investigation of motion study embraces kinematics and mechanics; and when I speak of geometry, I mean it in the sense in which the linguist would speak of grammar.

In making artificial limbs for cripples we must first consider the construction of a suitable limb; secondly, suitable joints; and thirdly, means for harmonious operation of the limbs so that they may serve the purpose intended. It is not always advisable to follow the exact line laid out by Nature to accomplish certain movements and operations, although from an æsthetic point of view it is desirable. It has, for instance, not been found practical to construct an artificial hand that performs its operations exactly like the natural one. In several articles published in *Zeitschrift des Vereines Deutscher Ingenieure* many excellent results were illustrated. We find there, for example, that a series of devices were made which could be inserted and exchanged to take the place of the hand.

No matter how substitute limbs are constructed and devised, the owner must always learn how to use them; and it seems to me that through patience and practice these unfortunate men attain almost unbelievable skill.

Three-dimensional kinematographs may readily be made with the aid of a mirror set at a proper angle. But even results so attained will not be of such vital importance as may be expected. Nevertheless, the third-dimensional observation must necessarily change the periods of performances as shown in the charts. The fact that the kinematographs are in perspective and not in orthographic projection I presume has been considered when setting up the relation between the magnitude, duration, etc., of the motion on the cross-sectioned background. The function "time," I understand, is the most important one in the efficiency engineer's mind. From that point of view, the method of investigation and the devices introduced by Mr. Gilbreth and described in his paper are commendable. They represent great time- and labor-saving items if intelligently applied to suit each individual case. But let us keep in mind that while theory is the greatest aid in analysis it is not always a cure for lack of experience.

Just preceding the article by Mr. Gilbreth is one by J. P. Brophy, "Where Are the Good Mechanics?" Aside from the fact that the *American Machinist* has from time to time kept us informed on the subject, I beg to call Mr. Brophy's attention to Mr. Gilbreth's article, which answers at least one of the many questions Mr. Brophy puts. He will notice that the tendency prevails to make more efficient, special, automatic machines of the men in the shop. This course and the deficient general shop education we give our youth, combined with the decrease in immigration of skilled labor, I think are responsible for Mr. Brophy's complaint.

New York City.

RUDOLPH L. HANAU.

Same Hours for Office, Drawing Room and Shop

Before we adopt the same hours for office, drawing room and shop, as suggested in the editorial on page 125, let us view the matter from a few more angles.

The office clerk who stays fifteen minutes or half an hour to "clean up" his day's work neither gets nor looks for any extra pay. The pattern maker or tinsmith who is detained five minutes after the whistle blows puts in a ticket for overtime for the minimum unit.

The bookkeeper or cost accountant who works until ten o'clock two or three nights a month has to be

content with "supper money." No man at a machine puts in night work without getting at least time and a half, including the time he is eating a light lunch.

During the vacation season the office help doubles up on the work, and thus nothing is added to the expense of running the office. The character of the work in the shop is such that when a machine is idle because of the operator's absence, production suffers.

As far as the rank and file in office and shop are concerned the latter have the advantage in pay. If the clerk is dissatisfied with his remuneration, he is allowed to go; and his place is filled with practically no trouble and inconvenience. The screw-machine hand or spinner, on the contrary, is reasonably sure of securing at least a portion of any raise that he asks for. Of course, we know this is the difference between training and the lack of it.

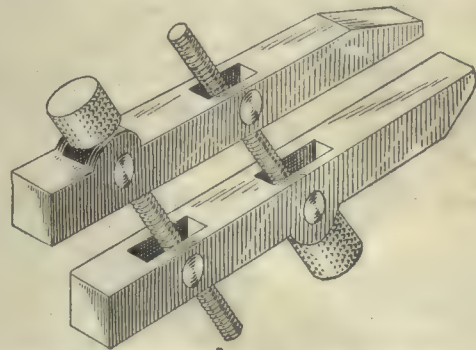
The statement that "the office force does not have to work nearly as hard as do the people in the factory" should be qualified. Some office work is harder than some factory work and vice versa. Class distinction is a matter of men—not office and factory. Is there no class distinction between the men in an insurance office or a banking house? Again, social intercourse is governed entirely by congeniality. Changing working hours will not change human nature. I do not, on such short consideration of the subject, claim that these points settle permanently in the negative the question of equalizing the working hours. They are presented, however, for consideration along with those set forth in the editorial.

H. D. MURPHY.

Jersey City, N. J.

From a Small-Shop Notebook

The "tool-makers' clamps" illustrated on page 1109, Vol. 44, of the *American Machinist* could be improved



IMPROVED FORM OF TOOL MAKERS' CLAMP

by making them as shown. This would make a better bearing surface for the heads of the clamping screws.

Quebec, Canada.

A. R. WHITTLE.

Standard-Size Holes--Why?

On page 1137, Vol. 44, there is an editorial under the heading, "Standard-Size Holes—Why?" The way this subject is put in the editorial makes it appear as if it would be easy to make the change and also very advantageous.

Standard-size holes are costly to produce. If we make shafts standard and have the holes changing, will not these holes cost as much or more to produce than stand-

ard-size holes? I give here some reasons why I think the change would not be at all desirable. More reamers would be required, more stock room in the tool stores to care for them, more limit gages for holes, and a smaller limit will have to be worked to than on standard-size holes. Fewer pieces will be reamed before they are under size, and there will be more scrap reamers.

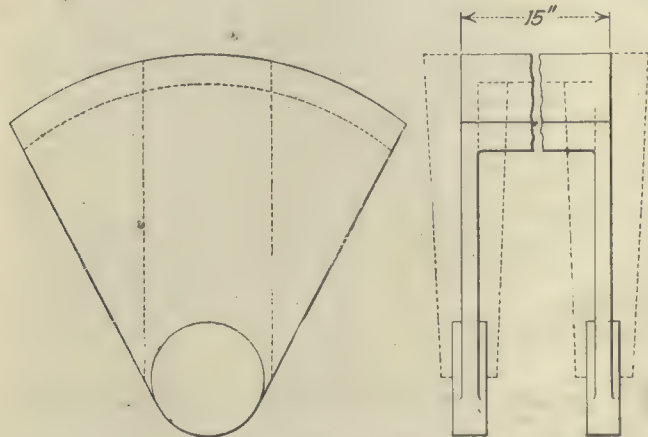
I should say that in the case of a drive fit being behind a running fit, it would be best to alter the size on the drawing. I have had no experience with such conditions. Some special jobs where this requirement is needed would be interesting.

J. H. DAVIS.

Wembley, England.

How Would You Produce This Casting?

Replying to M. E. Duggan's query, page 318, I would make the pattern to mold in a two-part flask by use of core prints from the 3-in. boss up to the top of the



THE PATTERN

pattern, as shown by dotted lines in the illustration herewith. To have a good job the cores must fit the prints, and the twelve castings could be made without loss in the day's work.

C. K. ROGERS.

Salem, Mass.

What Has the Metric System To Offer?

Occasionally an advocate of the metric system of measurements, when urging its advantages over our present English system, will admit that its adoption would necessitate changing some of the standards now in use. Just what standards do they propose to change, and what will they give us in place of those to which we are accustomed?

By far the largest amount of material used in this country for manufacturing and engineering purposes is listed in dimensions that are nominal, not actual; that are short when spoken, easy to write and memorize, that have been established by actual thread requirements, and that are thoroughly understood by those who use them. When we are asked to adopt a foreign system of measurement that will either substitute odd decimal dimensions for our present even fractions, or change our stock sizes of material to bring them to even metric dimensions, we want to know what these changes would look like.

Standard wrought pipe is listed in nominal sizes advancing by eighths, quarters, halves and inches, and in

standard, extra strong, XX, and hydraulic weights. Do metric countries use the same actual dimensions and weights of pipe as we do, or do they use standard sizes developed by themselves, and expressed in convenient metric dimensions?

Standard oil-well casing runs from $4\frac{1}{4}$ in. to $15\frac{1}{2}$ in. nominal sizes, and some single sizes are made in five different weights. There are also a number of special sizes and weights, and every one of these sizes was made to fill the needs of some oil field. Will these sizes, weights and threads be retained and expressed in odd metric equivalents, or will they be supplanted by the even metric sizes which I presume metric countries are now using?

Merchant bar steel in rounds, squares and flats is one of the largest items of material entering into our home manufactures. The sizes run in sixteenths, eighths and quarters, are firmly established in the minds of seller and buyer, and are the determining factor in fixing sizes of much machine work. Do metric countries buy and use this material in our English sizes, or do they have a metric schedule of sizes that covers as wide a range as ours, and is as easily learned and memorized by those who are not mathematicians?

The same question applies to structural steel, sizes of which are usually expressed with one or two dimensions, and the weight per foot. Is there a metric standard ready to replace the English?

Then how about turned or drawn shafting $\frac{1}{8}$ in. to $4\frac{1}{8}$ in., manufacturers' black bolts and nuts $\frac{1}{4}$ in. to $1\frac{1}{2}$ in., plate and sheet iron and steel, wire and nails? Will metric measurements answer as well as English for all of these without changing present actual dimensions?

Then there is tin plate. What is the metric expression for 14x20-90 lb. tin?

How is lumber listed in metric countries, and what is the metric equivalent for 2x4-16? Or for our board foot?

The foregoing are only a small part of our materials that would be affected by a change from the English to the metric system, but I trust that the advocates of the latter will be able to show us some metric schedules of sizes in good working order that are better for our own use than the English system.

F. A. DEW.

Pomona, Calif.

Exact Angles for Lathe Centers

R. W. Greene's center troubles, described on page 298, remind me of an attempt to buy an accurate 60-deg. gage while residing in England some years ago. One gage was wanted, but three of a well-known American make were obtained—the extra two to help test the one. These gages being of sheet form—not conical—were tested against a straight-edge on a glass plate, so that light was freely admitted to show inaccuracy. No means was at hand to ascertain the amount of error, but it was so considerable that the gages were returned to the selling agent. The agent refunded the purchase price without comment.

It is plain that an error of 2 min. of arc is negligible in any center of ordinary dimensions. In a 60-deg. center 1 in. across, the error would be only about 0.0005 in. at the base.

WILLIAM S. ROWELL.

Wilksburg, Penn.

Editorials

Navy Yard Employees' Vacations

The Naval Appropriation Bill recently enacted contains a clause increasing the vacation with full pay for navy yard employees from fifteen days per annum to thirty days per annum. This bit of legislation, when examined in connection with certain other facts, appears nothing short of remarkable.

In the first place, with their fifteen days' vacation heretofore, navy yard employees have had seven national holidays and Saturday half-holidays during three summer months, making a total of twenty-nine days during the year for which they received pay for doing no work. This is a very large allowance—more than necessary. Yet the total holiday is now increased to forty-four days. When the fifty-two Sundays and the forty-four days off are deducted from the year's total of three hundred and sixty-five days, there remain but two hundred and sixty-nine days for work.

Of course, the navy yard work must go on. The places of employees who are on leave with pay must be filled. In a medium-sized navy yard, employing, say, two thousand workmen, approximately one hundred additional men must be employed, to make up for the time the two thousand lost on leave with pay. This means an increase in wages outlay of about 5 per cent., with no return. It was not even claimed by the proponents of this measure that this increase in vacation would raise the workers' efficiency. It was to be a plain gift from the Government.

An effort was made to hide the increase in overhead expense due to this gift by charging it to accounts apart from the cost of work accounts. The debate on this point makes amusing reading, showing how little is known in the halls of Congress about cost accounting. However, the Senate was finally set straight by a senator who pointed out that shipbuilders would claim that the cost of vacations belonged in the cost of work, so they might as well show it there.

For the second time the Appropriation Bill prohibits the use of a watch or other time-measuring device to ascertain the facts connected with the performance of manual labor, and also prohibits the payment of bonuses for efficient labor. These prohibitions, together with the increase of vacation time, operate to increase cost and delay construction.

Perhaps it was with a view to making up for this delay in construction that Congress included another provision, which authorizes the Secretary of the Navy to increase the total cost of ships, including armor and armament, as much as 20 per cent., in order to employ more than one shift of labor, overtime work, and to bring about the speedy delivery of material.

It is difficult, indeed, to reconcile the foregoing three provisions. But one thing is certain; the country must pay the bill, and the country, generally speaking, consists of people who do not work in navy yards.

Navy yards should be model plants; models not only in equipment, arrangement and quality of work, but in con-

tinentment and efficiency. They are notoriously less efficient, however, than private plants. If the workmen are allowed to learn how to become efficient, and are paid according to their attainment, they will increase their usefulness and their incomes. There is a sound principle of economics underlying the following statement by Senator Cummins, made during the debate:

They [navy yard employees] want to earn more money; they are entitled to earn more money and every hour that you permit them to enjoy the employment of the United States with pay and without work will in the end reduce their compensation, because there are forces stronger than any enactment of Congress which will finally determine what the Government of the United States will pay for the work it must do.

The Machine-Gun Controversy

The Army Appropriation Bill provides \$12,000,000 for procuring machine guns for the United States Army and the National Guard. Some of the newspapers of the country are printing long articles in regard to the Lewis machine gun and an alleged controversy between the inventor and the Ordnance Department of the United States Army. The complaint is that this gun has been rejected by our military authorities, although it is an American invention and is superior to the guns now adopted. It is further alleged that this gun is doing wonders in the hands of the British army in Europe. At the outset it is impossible to overlook the coincidence of the passing of the large appropriation for machine guns and the publicity in regard to the Lewis gun.

It is essential that all the sums spent for military and naval equipment should buy the best articles of which we have knowledge. Thus a matter of this kind deserves the most careful consideration before a final decision is reached. There is not the slightest question but that this course will be followed. Meanwhile, it is wise to have in mind as many of the facts in regard to what has previously happened as it is possible to obtain.

The *American Machinist* believes that there is no animus on the part of the Bureau of Ordnance at Washington toward Colonel Lewis and no prejudice against his gun. If there is animus in the controversy, it is the other way around.

The best available information is that Colonel Lewis holds only two patents on parts of his guns. These are for the air-cooling arrangement, which is similar in principle to the cooling device on the Franklin automobile engine, and one other minor feature. It is stated that the other patents covering the rest of the gun are held in names other than that of Colonel Lewis.

It appears that several years ago Colonel Lewis took up the matter of his gun with the Secretary of War, stipulating in his offer that the decision as to availability of the gun and the tests upon it should not be made by the Bureau of Ordnance nor by the Chief of the Bureau, General Crozier. Accordingly, the matter was referred to the Board of Ordnance and Fortification, of which General Crozier is one member. So far as the *American*

Machinist has discovered, this original offer is not now a matter of record.

It appears further that nothing was done in regard to the gun at that time. But in 1913 an invitation was sent out to all manufacturers of machine guns to participate in a test to be held at the Springfield arsenal. These tests were to be conducted by a board appointed by the Secretary of War and consisting of five officers, of whom one was an ordnance officer and the other four were line officers.

The nature of each trial was to consist, first, of a mechanical test to be followed by field-service tests on such guns as passed the first series successfully. Six machine guns were submitted, including a Lewis gun. On the second day of the mechanical test the Lewis gun was withdrawn by its maker, because it had broken down when shooting commenced. The test it had received before breakdown was so short as to be insufficient to show the board whether the failure was due to fault of design or of material. The board so reported. No other Lewis gun was submitted, and for this reason naturally the service test could not be made, for the gun had not qualified in the preliminary test.

Two guns, the Vickers and the Benet-Mercier, passed the mechanical test satisfactorily and were later submitted to exhaustive field-service tests. The latter showed that both guns were satisfactory and of a desirable type. (It is interesting to mention that at this time the total amount available for procuring machine guns was only \$100,000. Thus the possible business for any gun was not very great. It is further worth while to point out that the Bureau of Ordnance as a bureau had nothing whatsoever to do with this 1913 test.)

After this the Lewis gun was taken abroad and was successfully introduced to the British Government. A large number have since been purchased and are being used in the present war with alleged satisfactory results.

But to continue the history, in the spring of 1916 the War Department again appointed a board of officers, consisting of two line officers and one ordnance officer, to investigate machine guns. It was intended that these tests should be preliminary and not exhaustive. A Lewis gun was submitted for these tests to be compared with a Vickers and a Benet-Mercier (Hotchkiss) as well as a Colt. This board reported that in its opinion the Lewis gun was not as good as either the Vickers or the Benet-Mercier, and for that reason the board did not recommend a purchase of any large quantity of Lewis guns, a very natural thing under the circumstances.

The report was based on actual trials which showed that the Lewis gun had a greater number of malfunctions to its credit—or discredit—than either of the others. It is possible that the difference between American and British ammunition had something to do with this record. The American ammunition exerts a pressure of 48,000 lb. per sq.in., gives a velocity of 2,700 ft. per sec. and weighs 150 grains. The British ammunition exerts a pressure of 43,000 lb. per sq.in., gives a velocity of 2,440 ft. per sec. and weighs 174 grains. The test on the Lewis gun was made with British ammunition, and the result of the comparison did not indicate that the record would be as good with a gun constructed for use with American ammunition. It should be noticed that the Bureau of Ordnance had nothing to do officially with this report, having only one-third representation on the board.

When the Mexican trouble became acute, a number of machine guns were ordered in a hurry under an emergency purchasing order. It was found at that time by the Bureau of Ordnance that the only gun that could be obtained for immediate delivery was the Lewis gun, and accordingly 250 of these were purchased at once and 100 more a little later. It is important to call attention to the fact that these purchases were not made by the War Department itself, but by the Bureau of Ordnance on its own initiative and under no compulsion. This fact disposes completely of the charge of animus.

The attitude of the War Department is still further shown from its statement that it is perfectly willing to carry out further tests of the Lewis guns, at which representatives of the manufacturers could be present. It is stated that these offers have been declined on the ground that the company did not have the time to prepare a special gun and was unwilling to have a gun taken out of the shipment of the 350 that had previously been purchased and tested against a Vickers or Benet-Mercier gun that might have been specially prepared for such test.

The daily papers have made much of the so-called Plattsburg test conducted by General Wood. It appears that this trial was entirely informal, made without the authorization of the War Department and therefore unofficial. It appears further that only some 3,000 or 4,000 rounds were fired—a very small amount and insufficient to show the durability of the mechanism and parts.

The newspaper articles have conveyed the idea that the Lewis gun is directly comparable with the Vickers, that it is intended for identical kinds of service and that one should be adopted as a standard over the other. As a matter of fact, the Vickers gun weighs 70 lb., the Lewis gun 26 lb. Published accounts from Europe indicate that the Lewis gun is used in the first lines of the British army because it is adapted to mobility in attacks. On the other hand, the Vickers machine gun is likewise used by the British army, but in the reserve trenches. An attempt has been made in some of the newspaper comments to draw the inference from these facts that the Vickers is less desirable and has been relegated to the rear. The real reason for differences of position is merely the one of putting each gun where it is of the most service.

The belligerent nations of Europe require man-killing devices. There is no time to investigate and search for utmost refinements in these mechanisms. It is a case of taking the best that can be procured at the present time. As an army officer said, the British would undoubtedly buy large quantities of blowpipes, provided these would shoot darts that would kill.

From the foregoing summary the following facts seem to stand out clearly: The Lewis guns have had a fair trial by the War Department and thus far have failed to qualify. The Ordnance Bureau has no prejudices against the Lewis gun, no animus against its inventor and, what is more, the gun has never been offered to the Ordnance Bureau itself in any shape or form. The original offer excluded the Ordnance Bureau from the possibility of deciding on the merits of the Lewis gun. Further, the War Department stands ready today to make further competitive tests at which representatives of the manufacturers of the Lewis gun may be present.

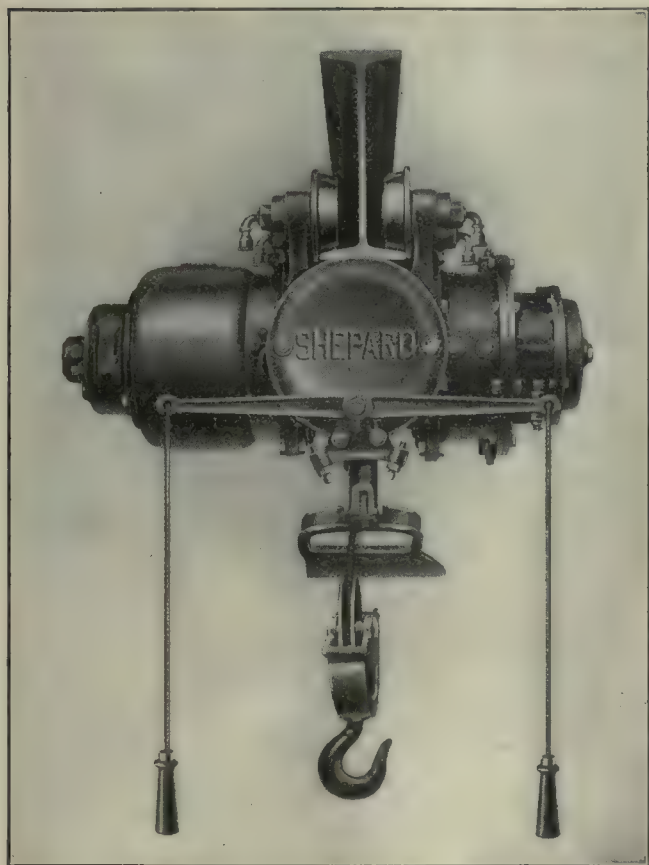
Meanwhile, the American people are interested in having the \$12,000,000 appropriated for machine guns spent to the greatest possible advantage.

Shop Equipment News

Electric Monorail Hoist

The type of electric hoist shown was designed to be especially adapted to machine-tool service and is made available in several sizes, for both direct and alternating current, by the Shepard Electric Crane and Hoist Co., Montour Falls, N. Y.

The aim has been to provide the same completeness in detail in the small type of hoist shown as is found desir-



ELECTRIC MONORAIL HOIST

Three sizes in capacities of 500, 1,000 and 2,000 lb.

able in the largest cranes. Anticipating the varied class of duty demanded in serving machine tools, and the consequent likelihood of overloading, an unusually high factor of safety has been allowed.

To simplify this small type of hoist, it has been equipped with a newly developed combination mechanical and electric brake. This brake automatically regulates its braking effect to the requirements of the load being lowered. When there is no load on the hook, the hoist lowers with the brake completely released, thereby reducing heating and wear.

In general, the construction is similar to the larger sizes that have been regularly produced by the manufacturers, introducing, however, a sectional construction. The hoist proper consists of four parts, or sections—namely, the winding mechanism (which is the center section), the motor end, the gear and brake end and the

controller. Each section is a complete unit by itself and may be employed in any one of a variety of combinations; the several sections are simply bolted together to form a complete machine.

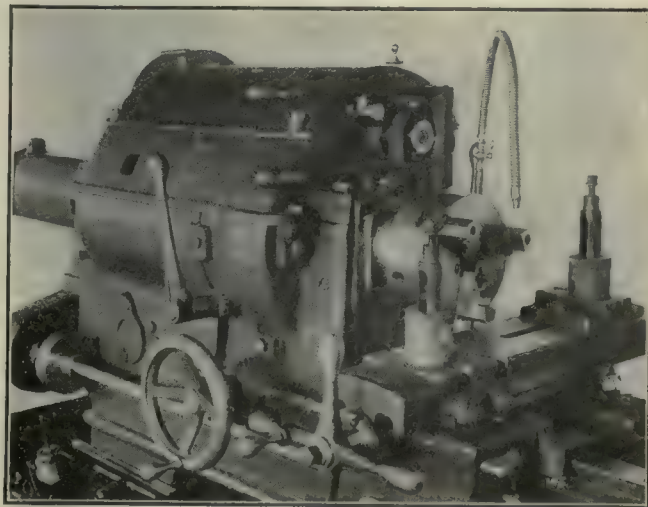
Although the type of hoist shown is now manufactured for a single speed control, a controller providing a large number of running speeds will soon be applied.

The hoist is provided with the standard "balanced drive," consisting of planetary gearing, regularly built by the manufacturer.

All-Geared Screw-Machine Head

The all-geared head shown is a recent development of the Foster Machine Co., Elkhart, Ind., designed to provide the advantages of instantly obtainable speed changes and increased pulling power, owing to the higher belt speed possible. The head is built on the unit principle, made so as to fit the standard Foster No. 5 screw machine.

The cone in the standard back-geared machine is substituted by a three-gear cluster mounted on a sleeve journaled on the spindle. This gear cluster is arranged to engage a triple sliding gear cluster mounted on a shaft directly above the spindle. This shaft is journaled in



ALL-GEARED SCREW-MACHINE HEAD

Diameter of chuck, $7\frac{1}{2}$ in.; swing over cutoff, $8\frac{1}{4}$ in.; pulley, 10 in. in diameter; width of belt, $2\frac{1}{2}$ in.; six speed changes, 34 to 466 r.p.m., in geometrical progression

bronze boxes carried by the main head casting. The means of operating the sliding gear cluster is a rod and a hand lever.

On the shaft are mounted two friction gears with the cone type friction, arranged to engage either of the gears. The purpose of this friction is to stop, start and reverse the machine, one of the gears being engaged by the reversing idler, mounted beneath the main driving pinion. The driving pinion is securely mounted on the pulley shaft journaled in bronze boxes held by the main head casting.

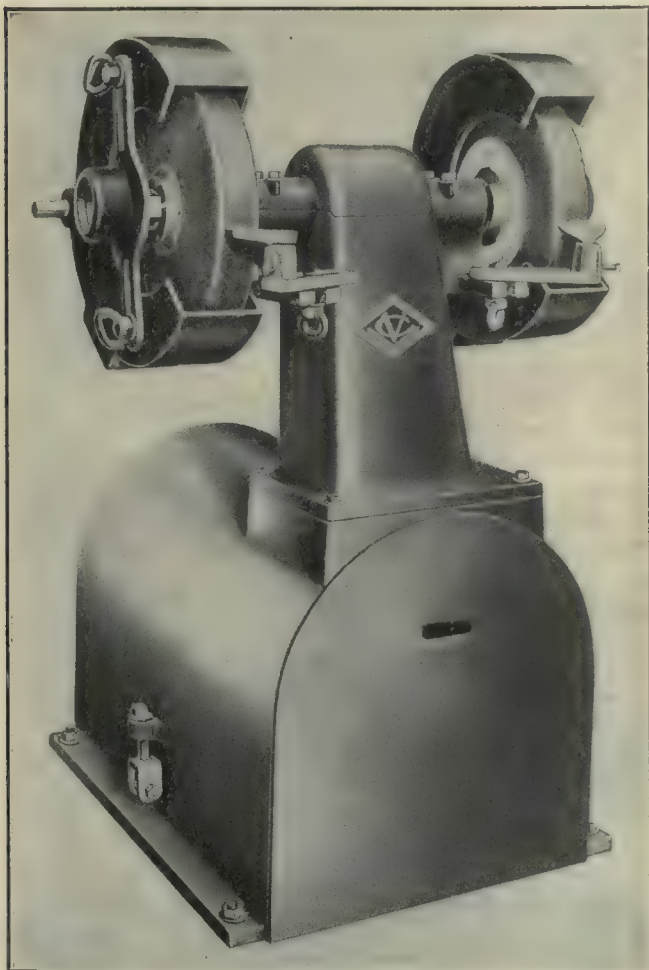
The three speed-changing levers are conveniently located; the vertical lever is for operating the friction clutch mounted on the spindle, this being the same as used in the cone-head type of machine.

✽

Inclosed Motor-Base Grinder and Buffer

The motor-driven self-contained grinder and buffer shown is a recent product of the Valley City Machine Works, Grand Rapids, Mich., and is made in two sizes.

In the application to the work, the motor is placed on a pivoted base at right angles to the grinder spindle, which



INCLOSED MOTOR-BASE GRINDER AND BUFFER
Capacity for wheels up to 18 in. in diameter and motors up to 5 hp.

it drives with a quarter-twist belt. The tension of the belt is varied by means of the adjustment screw, shown at the base of the machine. The belt-driven spindle construction is designed to cushion or absorb the shocks without danger to the motor, which is also kept free from dirt and grit in the base.

✽

Revolving Oilstone Grinder

The Oliver Machinery Co., Grand Rapids, Mich., is manufacturing a machine for quickly sharpening all kinds of edge tools and knives.

The frame is very rigid and cast in one piece. Two grades of oilstones are provided, one for rapid abrasion and the other for putting on a keen edge. Kerosene oil

is used on the wheels and is applied liberally. A special device prevents its being thrown off by centrifugal force. The two oilstones are carried on an upper arbor. Under and at right angles to this is another arbor, carrying an emery cone on one end for grinding long gouges and the like, and at the other end an emery wheel for dry grind-



REVOLVING OILSTONE GRINDER

Oilstones (2½-in. face by 10-in. diameter) run at 225 r.p.m.; emery wheel, 1-in. face by 10-in. diameter; emery cone, 4 in. in diameter, 5¼ in. long; knife-grinding attachment, two sizes, to grind knives 24 and 30 in. long; base, 25x25 in.; height of upper spindle, 37½ in.; height of lower spindle, 35 in.; height over oil receptacle, 45½ in.; single-arbor machine weighs about 800 lb.; double-arbor machine, three sizes weighing 825, 1,200 and 1,250 lb.; drive, either belt or motor for both types.

ing, there being four wheels on the machine. The tilting and universal tables, adjustable for face grinding, give plain straight surfaces as well as peripheral grinding. They are independent and allow the use of both oilstone wheels at the same time.

The tool holder has micrometer adjustment for small tools. It is easily put on or taken off. A knife-grinding attachment has a rigid knife bar equipped with dial and indicator, adjustable to any usual knife angle. Special care has been taken to make all parts as safe as possible. A single-arbor machine carrying only two oilstones is also made.

✽

Large Gun Planer

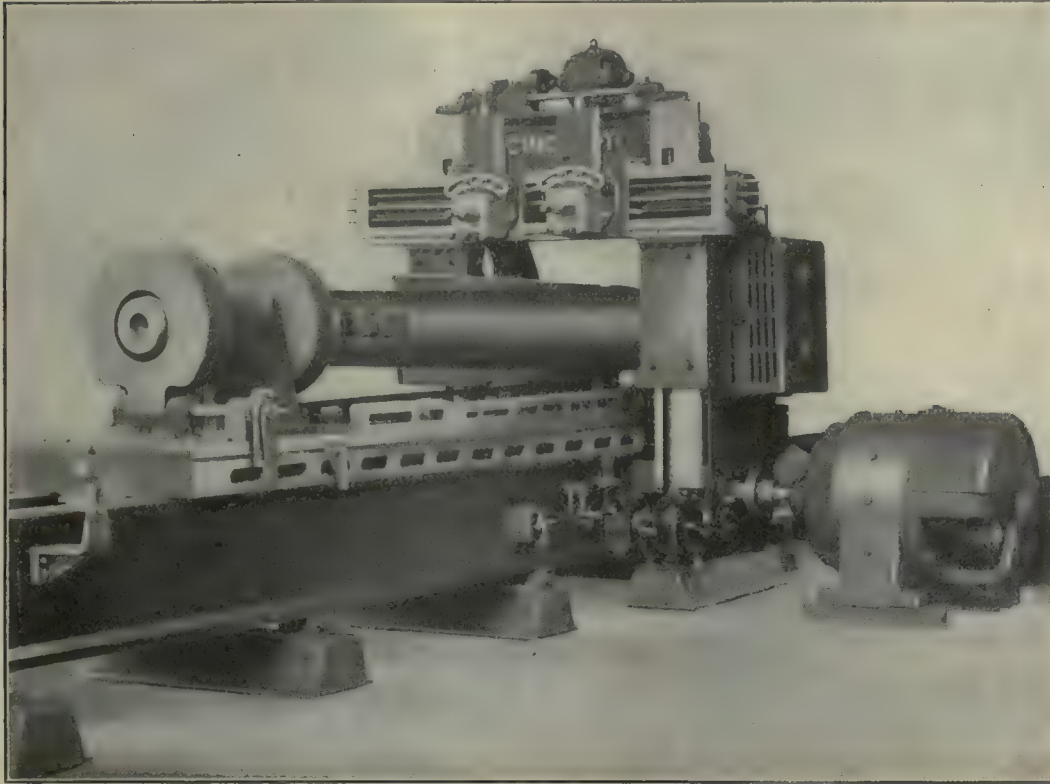
The illustration shows a planer equipped with special attachments for planing 9.2-in. howitzer guns. The planer is driven by a reversible motor drive coupled direct to the planer.

The guns are first turned on the outside wherever the projecting surfaces of the gun do not interfere; one end is also turned to fit the chuck, and a center is put into the opposite end. After this the gun is mounted between centers on the planer table and finished complete between the projecting surfaces that could not be turned. The rectangular recoil guides are also planed while mounted in this position on the planer.

The front center, or headstock, shown at the end of the table, is provided with a large expansion chuck that is a part of the spindle on which a large wormwheel is mounted on the opposite end. The worm that engages this large wheel is keyed to a shaft having a ratchet lever mounted on the outer end. This ratchet lever engages the

tappet fastened at the side of the bed at the end of each stroke and revolves the gun for the next cut.

The crossrail, which has a sliding fit on the housings, is supplied with two special brackets, which are bolted under the rail and are further held to the housing face by a clamp on both the outside and the inside of the housing face. A roller is mounted on each of these brackets at the lower end and projects over the side of the table to a cam



LARGE GUN PLANER 48x48x18 FT.

mounted on each side of the table. This cam has a contour corresponding exactly to the contour that is to be planed on the gun.

In operation this machine differs but little from the regular planer, except in the feed and taper attachment. The table is started on its cutting stroke in the regular way, and the crossrail instead of maintaining a fixed position is guided by the rollers over the cams on the table, causing the rail to rise and fall while the table passes under it, thereby providing the taper attachment. At the end of the return stroke the ratchet lever on the worm-shaft strikes the tappet at the side of the bed, causing the lever to pass through an arc, which produces a partial revolution of the worm, thereby revolving the gun an amount equal to the feed usually provided by the feed gears.

It will be noticed that the combination of these two motions—namely, the turning of the gun on centers at the end of each stroke and the raising and lowering of the crossrail while the table is in motion—causes the tool to plane both a circle and the taper on the outside of the gun.

In planing the straight rectangular projections on the gun the rail is raised a little clear of the cams and bolted fast to the housings, the same as in ordinary planing. The ratchet lever is also disengaged and the feed obtained through the regular feed gears on the end of the rail.

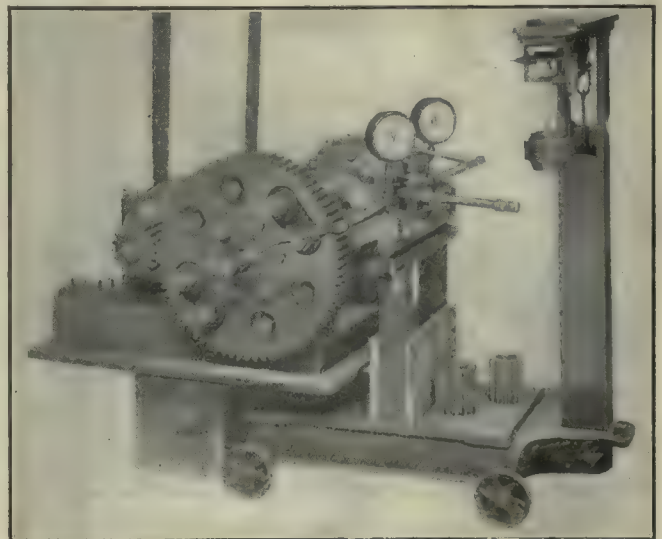
The machine is a recent addition to the line made by the Cincinnati Planer Co., Cincinnati, Ohio.

Gear-Testing Machine

The machine shown is the outgrowth or evolution of a previous machine, designed and built by Wilfred Lewis for the use of the American Society of Mechanical Engineers' Committee on Standards for Involute Gears, and is now available for the market through the Tabor Manufacturing Co., Philadelphia, Penn. The machine has

been made to combine the means for controlling and measuring the pressure on gear teeth in action, with a later construction designed to measure the power consumed. The former machine had a cast-iron frame or base, designed to rest upon a solid foundation. This construction has been taken bodily and mounted upon two horizontal axes, one of which coincides with the axis of the driving shaft while the other is a knife-edge resting upon portable platform scales, as shown. A stand has been introduced to encircle the driving shaft and carry a foot down through an opening in the main frame of

the machine. This foot rests upon a block of stone or concrete, represented in the photograph by a wooden box, and it will be understood that the shaft bearings are carried in this stand on ball bearings. On



GEAR-TESTING MACHINE

the other side of the machine the caps for the main bearings have been extended to carry the knife-edge, as shown. The weight of the whole machine is therefore

divided between these two supports at a certain distance apart, depending upon the size of the pinions used.

When driven in one direction the load on the scales is increased, and when driven in the other direction it is decreased by the driving torque, as measured by the arm of the couple between supports.

Fluid pressure is admitted to either side of the load piston through a three-way cock, and the pressure resulting on the gear teeth is shown by the gages attached. It will be seen that this pressure can be readily reversed while the gears are running, and with a suitable counter-shaft or motor attached to the driving shaft the direction of motion can also be reversed. With 80 lb. fluid pressure in the load cylinder the working load on the gear teeth becomes about 5,000 lb., and this is expected to break test-gear teeth in cast iron four per inch, 1-in. face, or thereabout, at some speed to be determined. The effects of various lubricants on the friction load can also be studied and the effects of wear at different speeds and loads.

When breaking loads are approached, the test gear can readily be inclosed by a frame attached to the flange around the main casting so that broken teeth will not be thrown off to endanger the operator. No danger of a general smash-up is, however, to be expected, because the remaining teeth will continue to mesh properly no matter how many may be broken.

The improvised foundation and the supporting stand on the scales, as shown, will be replaced by substantial substitutes in actual practice.

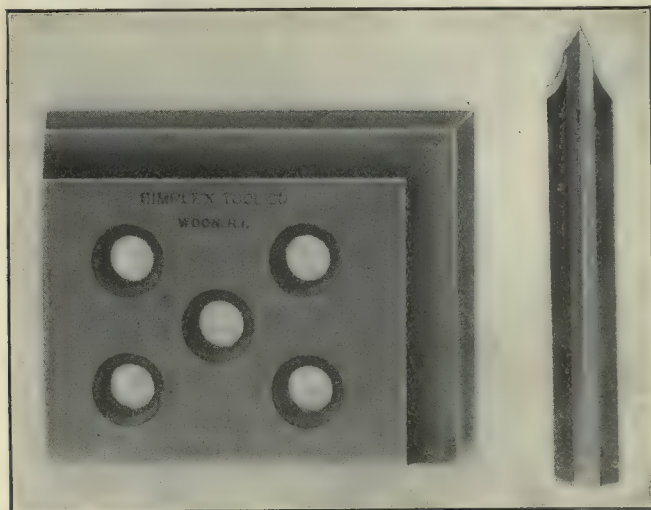
✽

Precision Square

The form of square shown is made of hardened tool steel ground accurately to a fine edge on two sides and flat on the opposite sides.

The fine edges in contact with the work are claimed to permit the detection of an error less than 0.0001 of an inch in the length of 3 in.

The holes in the sides are so arranged that they afford an efficient finger grip for every method of applying the



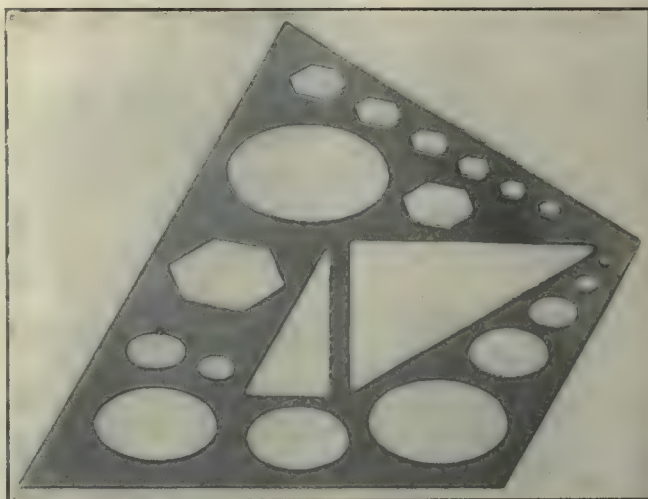
PRECISION SQUARE 3x2½x½ IN.

square to the work. This form of square is primarily intended to meet the requirements of tool and gage makers in its retention of accuracy without sacrificing sensitiveness and is a recent product of the Simplex Tool Co., Woonsocket, R. I.

Combination Drawing Tool

The combination drawing instrument shown was designed to save time in laying out hexagonal and other forms in the use of the isometric system.

The instrument can be handled quickly and covers a wider range than is accredited to it on first sight. It is



COMBINATION DRAWING INSTRUMENT

claimed that after using the instrument for a short time the ability to make freehand isometric sketches rapidly develops.

The instrument is a recent product of the Two Rivers Drawing Tools Co., Two Rivers, Wis.

✽

Spray Paint Gun

The spray paint gun shown was designed to be especially adapted for rapidly and evenly painting machines and metal parts of all kinds. It may be adjusted for spraying varnishes and lacquers as well as all classes of heavy paints.

The complete equipment consists of the paint gun proper, connected by a flexible hose to a portable unit combining in compact form the material container, pressure-control attachment and a pressure gage. After the portable control head has been adjusted to meet the conditions of air pressure, thickness of paint, etc., the operator has absolute control of the outfit by means of the trigger on the paint gun. The unit is furnished complete, ready for attachment by a single hose connection to the compressed-air supply.

It will be readily recognized that the spraying process will paint thoroughly corners or parts of structures that could not be easily reached with a brush.

There are but two adjustments—the round cap at the nose, which screws out or in, regulating the amount of material, and the knurled stem at the rear, which screws out or in to control the amount of air. These adjustments once made determine the proportion of air and material for any class of work. The control trigger acts on both air and material, regulating the amount sprayed—from nothing to the full amount for which the adjustments are set. The parts of the gun are nickel-plated, to insure good wearing qualities. The total weight of the gun is a little over 1 lb.

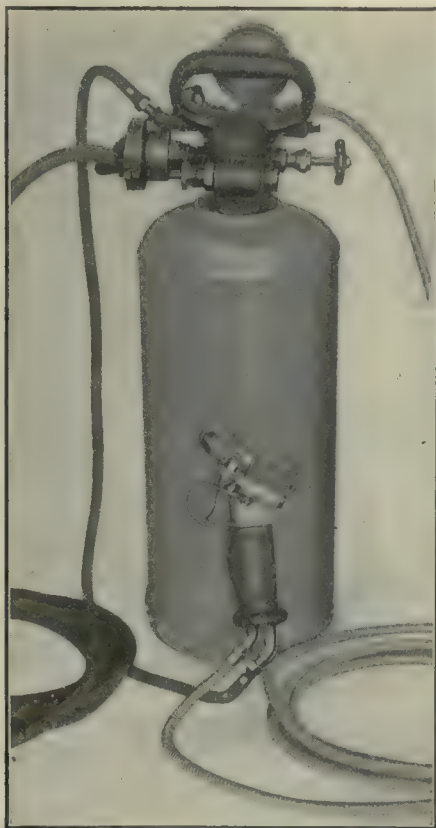
The control head comprises a pressure gage showing the air pressure on the main supply line, also on the

material in the pressure tank, and an adjustable reducing valve by which pressure on the material may be varied at will. The action of the gun is thus independent of the position of the tank, and any material may be fed to the gun at the most suitable pressure.

The adjustable reducing valve also permits using for the spray any pressure less than main-line pressure. This is essential where very high air-supply pressures are maintained.

A complete air filter and strainer is included. This insures a supply of dry, clean air. The filter may be readily inspected and cleaned without the use of tools.

For shop use, the control head and pressure container are not essential unless very heavy materials are used. Under such conditions the gun may be connected directly



PAINT-SPRAYING APPARATUS

to the air-pressure line, using an air regulator if the supply pressure is excessive or if air is not dry and clean. The material is placed in a tank suspended above the work and is supplied to the gun by gravity. A suitable material tank with block and tackle for suspension can be furnished with this type of equipment.

Connection with the air system is made by a rubber hose heavily braided, while a flexible metal hose is commonly chosen for delivering the paint to the gun. For special purposes, depending upon the nature of the paint used, other forms of hose can be furnished.

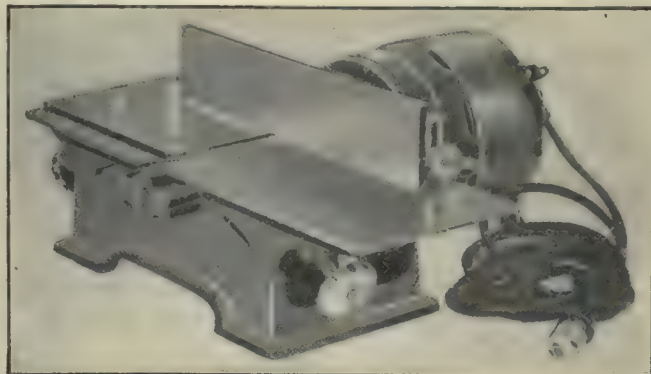
The device shown is a recent product of the Spray Engineering Co., Boston, Mass.

❧

Pattern Makers' Bench Planer

The machine here illustrated is a small powerful one, suitable for pattern makers or other woodworkers. It will take very heavy cuts in hard wood as well as soft,

and finish it so smooth that the knife marks do not show. It is provided with a safety guard, not shown. Connection to any light socket is easily made, no special wiring being



PATTERN MAKERS' BENCH PLANER

Width of knives, 4 in.; length of front table, 10 in.; length of rear table, 8 in.; speed of two-knife cutter head, 4,000 r.p.m.; speed of three-knife cutter head, 3,600 r.p.m.; weight with motor, 50 lb.

needed. The maker is J. D. Wallace, 527 Van Buren St., Chicago, Ill.

❧

Errors in Grinding Due to No Fault of the Operator

BY W. E. WICKSTROM

Among the many peculiar errors that occur in cylindrical grinding is one due to the varied depth of center holes, together with the fact that the centers of the machine are not in alignment.

Not long ago, my attention was called to a case where small cylinders were to be ground to a limit of 0.00025 in. on the diameter, with the understanding that the sides be parallel. Now the head and footstock centers not being in line it was necessary to swing the table to make up this difference. The center holes of the first four cylinders were of the same depth, about $\frac{1}{4}$ in., while the fifth cylinder had been centered $\frac{1}{2}$ in. deep.

Bearing in mind that the centers of the machine are not in line, one will readily see that the centers meet the holes unevenly and tend to throw the cylinder away from its state of parallelism with the wheel spindle, thereby causing a taper. The deeper the hole the greater the taper. The remedy is to make sure that the pieces are the same length and the center holes the same depth.

❧

Annealing Stampings Made of Sheet Steel

BY L. E. OLSEN

One of the reasons why steel has not replaced brass in small factories to a greater extent in making drawn shells, etc., where it is necessary to anneal the material between operations, is doubtless because it is much easier to anneal brass than steel. I have annealed steel successfully by placing it in a covered pot, heating it to the proper temperature and allowing it to cool gradually without removal from the pot. The air must be kept from the steel while it is heating in order to prevent oxidation of the surface, which if allowed to take place will, when a smooth bright surface is desired, increase the difficulty of finishing.

When there is not sufficient annealing to be done to make it profitable to employ this method, brass plating is resorted to, as oxidation does not occur when the brass surface is exposed to the air.

In cupping small steel shells $\frac{7}{8}$ in. in diameter and $\frac{3}{8}$ in. deep, made of 0.018-in. sheet steel, it is of course necessary to anneal them. After the cupping operations the shells should be tumbled until bright and afterward plated with brass. They can then be placed in an open pot, heated and allowed to cool, as the brass plate protects the surface from oxidation. Without plating, the same result can only be obtained by placing the shells in a sealed pot for annealing.

In shops equipped with a plating outfit this process gives a simple method of treating small steelwork, as tumbling and plating cost very little.

Master Pattern Makers Form an Association

Immediately prior to the meeting of foundrymen at Cleveland some inquiries had been made as to the feasibility of starting a technical association of master pattern makers. Over 200 names were obtained of those actively interested.

On Sept. 14 about 30 master pattern makers present at the Cleveland convention held a preliminary meeting and dinner at the Hotel Statler.

After a general discussion of the practical possibilities of such an organization, it was decided that an advisory committee should be appointed to consider the various matters incidental to an orderly and successful beginning. A tentative form of constitution was offered and will be critically considered by the advisory committee and also mailed to the entire list of names for constructive criticism and suggestion.

It is planned to hold an annual meeting at the same time and place as the American Foundrymen's Association.

The objects of the new organization, as outlined by the proposed constitution, are "the improvement of the art and practice of pattern making, to promote social intercourse among the members of the association, to provide for the exchange of technical experience, to encourage uniform standards in shop methods and in general to advance whatever shall tend to the dignity and reputation of pattern making and the well-being of members of the association."

Office headquarters have been opened at 206 Bellevue Court Building, Philadelphia, Penn.

Foundrymen's Convention at Cleveland

The American Foundrymen's Association and the American Institute of Metals held their conventions in Cleveland, Sept. 11 to 16. The usual accompanying exhibition was installed in the Wigmore Coliseum and Annex.

About the average number of foundry exhibits were shown, but the machine-tool displays were notable for their absence, many of the makers pleading too much business. Out of 149 exhibitors listed in the program less than 20 were those ordinarily classed as machine-tool builders.

The officers elected for the coming year by the American Foundrymen's Association were: President, J. P. Pero, of the Missouri Malleable Iron Co., East St. Louis, Mo.; vice-president, B. D. Fuller, of the Westinghouse Electric and Manufacturing Co., Pittsburgh, Penn.; secretary and treasurer, A. O. Backert, editor of *Foundry*, Cleveland.

The officers elected by the American Institute of Metals were: President, J. L. Jones, Pittsburgh; vice-president, George C. Stone, New York; secretary, William Corse, Buffalo.

Business Items

The Wagner Electric Manufacturing Co., St. Louis, Mo., announces the opening of a sales office and service station at 922 North Pennsylvania St., Indianapolis, Ind. The office will be in charge of Charles M. Welch.

Armstrong Bros. Tool Co., Chicago, Ill., has in course of erection two additions, one to provide increased drop-forging facilities and the other to be used as a finished-stock warehouse, shipping department and offices.

Krebs Manufacturing Co., 341 East Ohio St., Chicago, Ill., has been formed to engage in contract work. The firm consists of Charles E. Krebs, formerly superintendent of the Forsyth Co., Harvey, Ill.; Anton Brust, formerly foreman of the Krasberg Manufacturing Co., and Carl Blomquist, who was also connected with the Forsyth Co.

Trade Catalogs

Flexible Shaft. Stow Manufacturing Co., Binghamton, N. Y. Bulletin No. 102. Pp. 60. 6x9 in. Illustrated.

Electric Motors. Stow Manufacturing Co., Binghamton, N. Y. Bulletin No. 100. Pp. 20. 6x9 in. Illustrated.

Oil Hole Covers, Positive Lock Compression Grease Cups. W. A. & C. F. Tucker, Hartford, Conn. Catalog No. 5. Pp. 16. $3\frac{1}{2}$ x6 in. Illustrated.

Oxy-Acetylene Welding and Cutting Apparatus. The Alexander Milburn Co., 1418-28 W. Balti-

more St., Baltimore, Md. Catalog 24. Pp. 32. 8x10 $\frac{1}{2}$ in. Illustrated.

Portable Electric Tools. Stow Manufacturing Co., Binghamton, N. Y. Bulletin No. 101. Pp. 28. 6x9 in. This describes drills, grinders, screw-drivers and other portable electric tools.

Fuel Oil Appliances. W. S. Rockwell Co., 50 Church St., New York. Bulletin No. 31. Pp. 28. 8 $\frac{1}{2}$ x11 in. This contains considerable data on the handling and burning of fuel oil which ought to be useful to those interested in the subject.

Oxy-Acetylene Welding and Cutting Apparatus. Searchlight Co., 415 Karpen Building, Chicago, Ill. Catalog No. 12. Pp. 32. 6x9 in. Information on the welding and cutting of metals by the oxy-acetylene process is contained in this catalog.

Machinists' Small Tools. Brown & Sharpe Mfg. Co., Providence, R. I. Catalog No. 27. Pp. 376. 5x7 $\frac{1}{2}$ in. This shows the extensive line of small tools, cutters, screw machine tools, etc., made by this company and contains useful tables and suggestions in the application of such tools.

Machinists' Measuring Tools. J. T. Slocomb Co., Providence, R. I. Catalog No. 15. Pp. 127. 5x7 $\frac{1}{2}$ in. In addition to an illustrated description of the extensive line of measuring tools made by this company, the catalog contains useful tables for tool makers and considerable historical data on the development of the micrometer and some of its refined applications in the shop.

Forthcoming Meetings

National Machine Tool Builders' Association. Annual convention, Oct. 24-25, Hotel Astor, New York City. Charles E. Hildreth, general manager, Worcester, Mass.

American Society of Mechanical Engineers. Annual meeting, Dec. 5-8, Engineering Building, New York City. Calvin W. Rice, secretary, 29 West 39th St., New York City.

American Society of Mechanical Engineers. Monthly meeting, first Tuesday. Calvin W. Rice, secretary, 29 West 39th St., New York City.

Boston Branch National Metal Trades Association. Monthly meeting on first Wednesday of each month, Young's Hotel. W. W. Poole, secretary, 40 Central St., Boston, Mass.

Providence Association of Mechanical Engineers. Monthly meeting, fourth Wednesday of each month. J. A. Brooks, secretary, Brown University, Providence, R. I.

New England Foundrymen's Association. Regular meeting, second Wednesday of each month, Exchange Club, Boston, Mass. Fred F. Stockwell, 205 Broadway, Cambridgeport, Mass.

Engineers' Society of Western Pennsylvania. Monthly meeting, third Tuesday; section meeting, first Tuesday. Elmer K. Hiles, secretary, Oliver Building, Pittsburgh, Penn.

Rochester Society of Technical Draftsmen. Monthly meeting, last Thursday. O. L. Angevine, Jr., secretary, 857 Genesee St., Rochester, N. Y.

Superintendents' and Foremen's Club of Cleveland. Monthly meeting, third Saturday. Philip Frankel, secretary, 310 New England Building, Cleveland, Ohio.

Western Society of Engineers, Chicago, Ill. Regular meeting, first Wednesday evening of each month, excepting July and August. J. H. Warder, secretary, 1785 Monadnock Block, Chicago, Ill.

Philadelphia Foundrymen's Association. Meetings first Wednesday of each month. Manufacturers' Club, Philadelphia, Penn. Howard Evans, secretary, Pier 45 North, Philadelphia, Penn.

Technical League of America. Regular meeting, second Friday of each month. Oscar S. Teale, secretary, 35 Broadway, New York, N. Y.

The Evolution of the American Military Rifle

STAFF CORRESPONDENCE

SYNOPSIS—While a brief outline is given of early small-arm developments, the main interest centers around the American military rifle, and especially on the gun made in the Springfield armory, which is the oldest in the United States. It is from this arsenal that the present as well as most of the past army rifles take their name.

The actual date of the first hand firearm is uncertain, but its appearance was at about the same time as that of the breech-loading cannon, both being of large bore and invented close to the beginning of the fourteenth century. Artillery is known to have been used in European warfare as early as 1327.

The first real improvement seems to have been along the line of locks, after which a reduction of weight took an important part. The hand cannon of the early part of the fourteenth century was at first very crude, simply being fastened to a block of wood, and was too large to be fired from the shoulder. The vent, or touch-hole, was on the top of the barrel, and the first improvement of this model was a cover over the vent to keep the powder dry. The portable hand cannon immediately followed and was made from the middle to the end of the fourteenth century. This style

differs from the first in having some shape to the wood block, which is not unlike a stock, and it was capable of being shot by a strong man.

Beginning with this arm we find the vent placed on the right side and a pan added to hold the prime. A cover was also added, which was moved by hand. This gun is known to have been made as early as 1453 and possibly a little before that. It was fired by means of a match held in the hand.

The first lock seems to have been an S-shaped piece of metal, pivoted at the center, with the upper end slotted for the purpose of holding the match. The lower part was made large, like the lever of a crossbow, and so placed that the weight would keep the match raised above the pan of priming until the lower end, or "trigger," was pulled back, which action brought the match in contact with the priming and fired the piece.

Following this device came the more important form of matchlock, in which a spring was used in the lock, and it was also the first type to have a projecting open

powder pan. This contrivance was improved soon afterward by the addition of a cover. Owing to their simplicity and cheapness these matchlocks were used for over two hundred years and in practically the same form until the introduction of the wheel-lock, which was invented in Nuremberg, Germany, somewhere between 1509 and 1517. Sparks for igniting the powder were obtained from a piece of sulphurous pyrites against which a steel wheel, having projections, was revolved. This wheel was rotated by means of a ribbon spring of the clock-spring type. The steel wheel had to be wound up each time and was released by pulling the trigger.

The so-called musket, according to Boutelle, was first used in Italy about 1530 and in France and England about 1570. It was a large and heavy "arquebus." At that time it was the custom to name guns after animals or birds, as for example the "falcon" and its diminutive, "falconette." As the musket was the most important small arm at that time, the name of the smallest bird of prey was given to it, which was that of the male young of the sparrow hawk, or the musket. Rifling of gun

barrels, according to the same authority, was patented in England in 1635. Ancient bowmen had the idea when they arranged the feathers on the shafts of their arrows in a spiral so as to impart a rotary motion in flight. Rifling, however, was not popular in

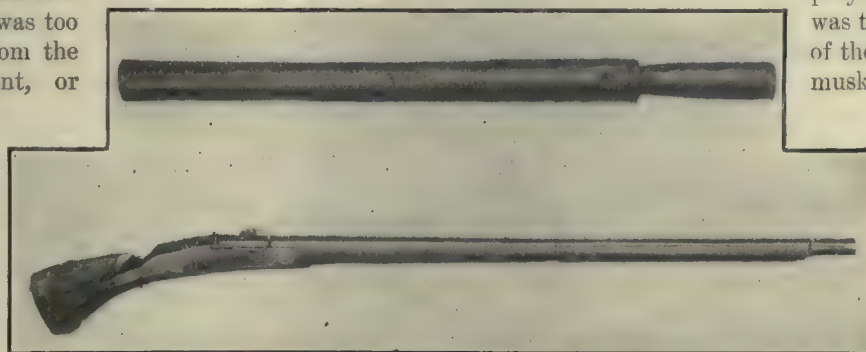


FIG. 1. PRIMITIVE CHINESE HAND CANNON

Length of barrel, 25½ in.; bore, about 1½ in.; diameter of muzzle, 2½ in.; diameter of breech, 2¾ in.

FIG. 2. VERY EARLY FORM OF MATCHLOCK

Supposed to be of the fifteenth century; length of barrel, 47½ in.; bore, about ¾ in.; diameter of muzzle, 1 in.; diameter of breech, 1¼ in. octagon; entire length, 61 in.; weight, about 11 lb.

military muskets until after the introduction of breech-loaders, since the rifling was apt to foul and clog and make loading at the muzzle difficult at critical times. For this reason, smooth bores long were the standard weapon of the armies.

The snaphaunce gun, says Boulette, derived its name from the pecking hen, and by the same authority is said to have been invented by poachers, who were too poor to buy wheel-locks and who did not dare use matchlocks for fear the light would betray their movements. In these guns the wheel was replaced by a hammer, which struck a piece of pyrites placed above the priming pan. This gun was the immediate forerunner of the flintlock and, according to Boutelle, was invented about 1508. The flintlock proper is said by Norton to have been invented about 1630 and appears to have been first made in France.

Since most of the guns used round lead balls, the bore, or gage, of the gun early became known by the size of hole which it was necessary to use for a certain size or weight of ball. The balls were classified by the num-



FIG. 3. UNITED STATES MUSKET, 1803

Flintlock; closely resembles French Charleville musket of 1763; made practically as in 1795 and following years at Springfield, Mass.; 71 cal.; diameter of breech, $2\frac{1}{8}$ in.; diameter of muzzle, $\frac{3}{8}$ in.; length of barrel, 42 in. (barrel of 1809 musket was 45 in. long); entire length, $56\frac{1}{2}$ in.; weight complete, 10 lb. 7 oz.; without bayonet, 9 lb. 11 oz.; made at Springfield

FIG. 4. UNITED STATES MUSKET, 1805

Flintlock; slight lock changes

FIG. 5. UNITED STATES MUSKET, 1821

Flintlock; altered later to percussion cap

FIG. 6. UNITED STATES MUSKET, 1825

Flintlock; blued barrel and darkened fittings; 69 cal.

FIG. 7. HALL BREECH-LOADER, 1831

Flintlock; paper cartridge; 54 cal.; diameter at breech, $1\frac{1}{4}$ in.; diameter at muzzle, $\frac{3}{8}$ in.; length of barrel, $32\frac{1}{2}$ in.; entire length, 52 in.; weight, 10 lb. 14 oz.; breech-block hinges at back and lifts up at front end; made at Harper's Ferry, Va.

FIG. 8. HALL BREECH-LOADER, 1839

Percussion lock; shown with breech-block raised for insertion of paper cartridge; otherwise same as Fig. 7

FIG. 9. UNITED STATES MUSKET, 1832

Flintlock; all brown; heavier powder pan; cal. 69

FIG. 10. ARTILLERY MUSKETOON, 1842

Percussion cap; new nipple seat; regular was practically the same, but had longer barrel; patterned after Charleville model of 1840; cal. 69

FIG. 11. SPRINGFIELD RIFLED MUSKET, 1855

Maynard primer; cal. 58; patch box in butt; rear sight; bulged nipple seat

FIG. 12. SPRINGFIELD RIFLED MUSKET, 1863

Percussion cap; cal. 58

FIG. 13. SPRINGFIELD BREECH-LOADING RIFLE, 1865

Allen alteration; breech-block hinge attached to top of barrel by short block and screws; has firing pin; used center-fire metallic cartridges; 58 cal.; diameter at breech-block, $1\frac{1}{4}$ in.; diameter at muzzle, $\frac{3}{8}$ in.; from muzzle to hinge of breech-block, 37 in.; from muzzle to stock, 40 in.; entire length, 56 in.; weight, 10 lb.

FIG. 14. SPRINGFIELD BREECH-LOADING RIFLE, 1865

Top of barrel cut away to show insertion of tube for reducing caliber from 58 to 50; small piece of paper has been slipped between barrel and lining tube to show better how tube was placed; this changed the gun to an 1866 model

FIG. 15. SPRINGFIELD BREECH-LOADING RIFLE, 1866

Regular model; longer hinge-block screwed to top of barrel, as old one tended to work loose; brown barrel

FIG. 16. SPRINGFIELD BREECH-LOADING RIFLE, 1870

Barrel screwed into receiver frame; different rear sight; shown with breech-block up; cal. 50; length of barrel, 36 in.; entire length, 52 in.

FIG. 17. REMINGTON MODEL BREECH-LOADER, 1870

Thumb-block action; patented May 3, 1864; 50 cal.; length of barrel, 36 in.; entire length, 52 in.

FIG. 18. WARD-BURTON MODEL BREECH-LOADER, 1871

Bolt action; patented Dec. 20, 1859; cal. 45; diameter at breech-block, $1\frac{1}{8}$ in.; diameter at muzzle, $\frac{3}{4}$ in.; length of barrel, 38 in.; entire length, 52 in.; weight, 9 lb. 6 oz.

FIG. 19. CHAFFEE-REECE BREECH-LOADING RIFLE, 1884

Bolt action; cal. 45; diameter at breech, $1\frac{1}{8}$ in.; diameter at muzzle, $\frac{3}{4}$ in.; length of barrel, 28 in.; entire length, $48\frac{1}{2}$ in.; weight, 9 lb. 13 oz.

FIG. 20. SPRINGFIELD BREECH-LOADING RIFLE, 1888

Rod bayonet (this is the 1884 regular model plus the rod bayonet); different rear sight; cal. 45

FIG. 21. UNITED STATES MAGAZINE RIFLE, 1892

Bolt-action modified Krag-Jorgensen; six shots—five in magazine and one in barrel; 30 cal.; wood-top barrel cover makes it easier to handle

FIG. 22. UNITED STATES MAGAZINE RIFLE, 1902

Side magazine removed; cal. 30; first type of present arm; rod bayonet; length of barrel, 31 in.; entire length, 50 in.; weight, 9 lb. 10 oz.

FIG. 23. UNITED STATES MAGAZINE CARBINE, 1899

Krag system; Buffington sight; cal. 30; wood top extends to front sight

FIG. 24. UNITED STATES MAGAZINE RIFLE, 1903 EXPERIMENTAL

Cal. 30; sight slightly changed; rod bayonet

FIG. 25. UNITED STATES MAGAZINE RIFLE, 1903 MODEL

Latest type with Maxim silencer; six shots—five in magazine and one in barrel; used as either single or magazine gun; sword bayonet; cal. 30; diameter of muzzle, 0.619 in.; diameter at breech, 1.14 in.; length of chamber and bore, 23.79 in.

FIG. 28. SPENCER CARBINE

Patented Mar. 6, 1860; lever-action vertical slide block; rim-fire cartridge; 52 cal.; length of barrel, $20\frac{1}{2}$ in.; entire length, $39\frac{1}{4}$ in.; weight, 9 lb. 5 oz.; 94,156 purchased 1861 to 1865



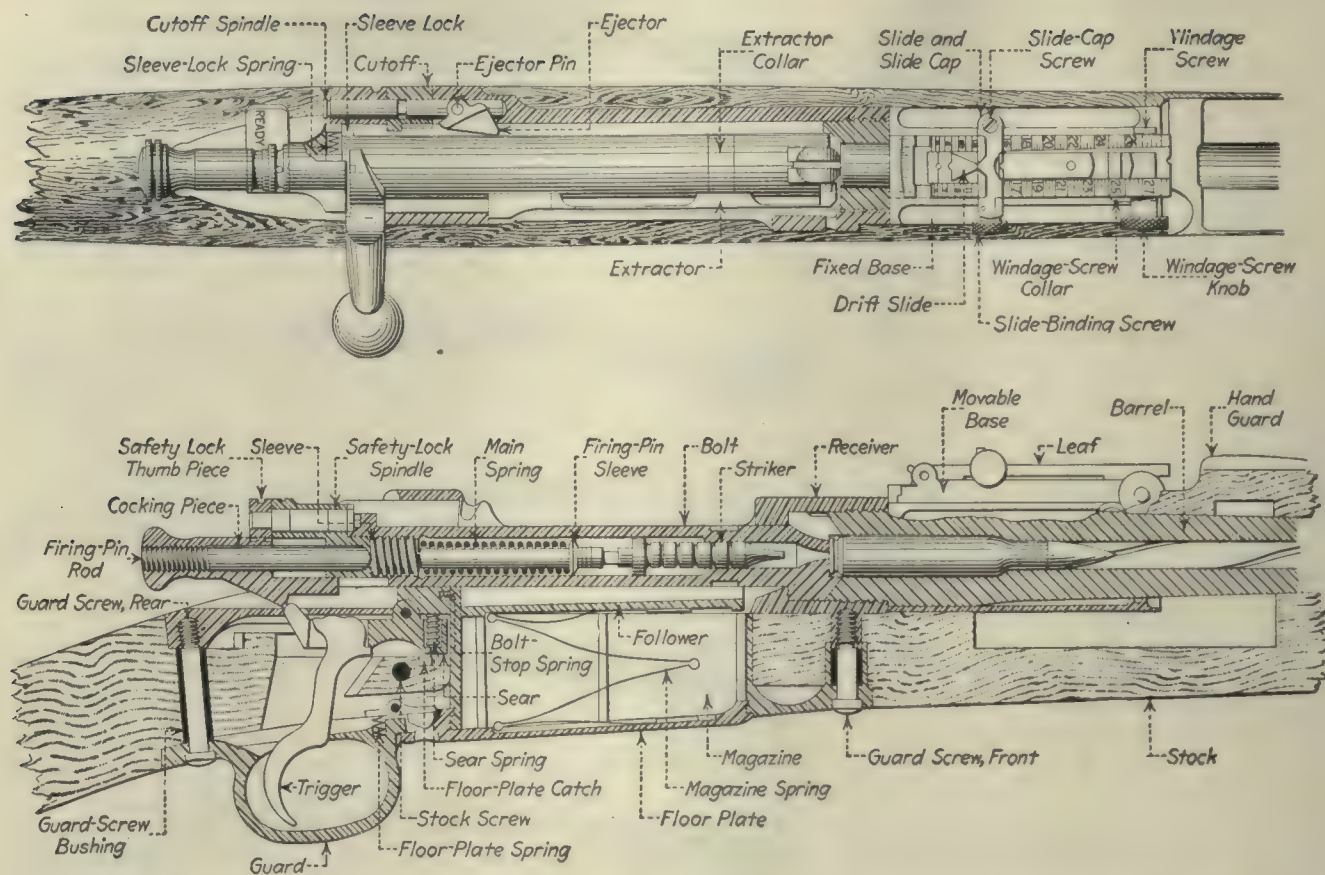


FIG. 26. SECTIONAL VIEW, BOLT AND MAGAZINE MECHANISM, U. S. MAGAZINE RIFLE, MODEL 1903

The bolt lever is shown projecting at the right in the top view. In operating the bolt, this lever is brought to a vertical position and pushed out or in. As the parts are shown, a cartridge is in place and the gun ready to fire, but the magazine is shown empty. Cartridges placed in the magazine are pushed upward to the feeding mechanism by means of the spring shown. The bolt moves backward and forward, as moved by the operator, and rotates in the well of the receiver. It carries a cartridge, either from the magazine or one placed by hand in front of it, into the chamber and supports its head when fired. The sleeve unites the parts of the bolt mechanism, and its rotation with the bolt is prevented by the lugs on its sides coming in contact with the receiver. The hook of the extractor engages in the groove of the cartridge case and retains the head of the latter in the countersink of the bolt until the case is ejected. The safety lock, when turned to the left, is inoperative. When turned to the right, which can only be done when the piece is cocked, the point of the spindle enters its notch in the bolt and locks the bolt; at the same time its cam forces the cocking piece slightly to the rear, out of contact with the sear, and locks the firing pin.

The bolt mechanism operates as follows: To open the bolt, raise the handle until it comes in contact with the left side of the receiver, and pull directly to the rear until the top locking lug strikes the cutoff.

Raising the handle rotates the bolt and separates the locking lugs from their locking shoulders in the receiver, with which they are brought in close contact by the powder pressure. This rotation causes the cocking cam of the bolt to force, the firing pin to the rear, drawing the point of the striker into the bolt, rotation of the firing pin being prevented by the lug on the cocking piece projecting through the slot in the sleeve into its groove in the receiver. As the sleeve remains longitudinally stationary with reference to the bolt, this rearward motion of the firing pin, and consequently of the striker, starts the compression of the mainspring, since the rear end of the latter bears against the front end of the barrel of the sleeve, and its front end against the rear end of the firing-pin sleeve. When the bolt strikes the receiver, the locking lugs have been disengaged; the firing pin has been forced to the rear until the sear notch of the cocking piece has passed the sear nose; the cocking piece has entered the cock notch in the rear end of the bolt; and the mainspring has been almost entirely compressed. During the rotation of the bolt a rear motion has been imparted to it by its extracting cam coming in contact with the extracting cam of the receiver, so that the cartridge will be started from the chamber. The bolt is then drawn directly to the rear, the parts being retained in position by the cocking-piece nose remaining in the cock notch remains longitudinally stationary with reference to the bolt.

To close the bolt, push the handle forward until the extracting cam on the bolt bears against the extracting cam on the receiver, thereby unlocking the sleeve from the bolt, and turn the handle down. As the handle is turned down, the cams of the locking lugs bear against the locking shoulders in the receiver, and the bolt is forced slightly forward into its closed position. As all movement of the firing pin is prevented

by the sear nose engaging the sear notch of the cocking piece, this forward movement of the bolt completes the compression of the mainspring, seats the cartridge in the chamber and, in single loading, forces the hook of the extractor into the groove of the cartridge case. In loading from the magazine the hook of the extractor, rounded at its lower edge, engages in the groove of the top cartridge as it rises from the magazine under the action of the follower and magazine spring. This brings the parts to the position shown, and the piece is ready to fire.

After firing, just before the bolt is drawn fully to the rear, the top locking lug strikes the heel of the ejector, throwing its point suddenly to the right in the lug slot. As the bolt moves fully to the rear, the rear end of the cartridge case strikes against the ejector point and is ejected slightly upward and to the right from the receiver. Double loading from the magazine is prevented by the extractor engaging the cartridge case as soon as it rises from the magazine and holding its head against the face of the bolt until it is ejected.

It will be noticed that in this system of bolt mechanism the compression of the mainspring, the seating of the cartridge in the chamber and the starting of the empty case from the chamber are entirely done by the action of cams. The piece may be cocked either by raising the bolt handle until it strikes the left side of the receiver and then immediately turning it down, or by pulling the cocking piece directly back. In firing, unless the bolt handle is turned fully down, the cam on the cocking piece will strike the cocking cam on the bolt, and the energy of the mainspring will be expended in closing the bolt instead of on the primer. This prevents the possibility of a cartridge being fired until the bolt is fully closed.

The magazine may be charged either by cartridges held in a clip, or one at a time. To fill, the cutoff is turned up so as to show "on." The bolt is then drawn fully to the rear, the cartridges are inserted from the top, and the bolt is again closed. The magazine chamber is made wider than a single cartridge, but not as wide as two, so that the cartridges lie in it staggered, three on one side and two on the other, when the magazine is full.

When the cutoff is turned down, the magazine is "off" and the bolt cannot be drawn fully back. Its front end, projecting over the rear end of the upper cartridge, holds it down in the magazine below the action of the bolt. The magazine mechanism then remains inoperative, and the gun can be used as a single-loader, the cartridges in the magazine being held in reserve. The gun can also be readily used as a single-loader with the magazine empty.

When the cutoff is turned up, the magazine is "on," and the bolt can be drawn fully to the rear, permitting the top cartridge to rise high enough to be caught by the bolt in its forward movement. As the bolt is closed, this cartridge is pushed forward into the chamber, being held up during its passage by the pressure of those below. The last one in the magazine is held up by the follower, the rib of which directs it into the chamber. In magazine fire, after the last cartridge has been fired and the bolt drawn fully back, the follower rises and holds the bolt open to show that the magazine is empty.

ber required to make a pound. Consequently, if it took eight or twelve balls to make a pound, the corresponding size of gun would be known as eight or twelve ball. This naturally merged into bore, as the maker bored the barrels to the size of the ball used. Caliber, as now understood in the United States, is measured by the size of the bore in decimal parts of an inch, 30-caliber meaning 0.30 in.

While the very early and perhaps some of the first guns made were of the breech-loading type, considerable trouble was experienced in making the breech tight enough to prevent the escape of gas, which in many cases was extremely dangerous to the operator. It was for this reason that it was not until the invention of cartridges that breech-loading became practical. However, there are numerous specimens of other breech-loading mechanisms in existence in various museums. One example especially, which may be found in the British Museum, was made by John Cookson in 1586. This gun was not only a breech-loader, but was a repeater. Powder sufficient for ten loads was carried loose in one magazine and ten bullets in another. A revolving-disk mechanism fed a charge of powder and one bullet to the barrel, from which they were discharged. This gun appears to be in perfect condition in spite of the danger that is at once evident to the reader—of the ignition reaching the powder magazine itself.

AN EARLY REPEATING BREECH-LOADER

Another single breech-loader appears to have been made some 30 years previous to the Cookson gun, and in the same year of 1550 a matchlock revolver was invented, which had a seven-chambered cylinder revolved by the action of the hammer. Six of the seven chambers were exposed in practically the same way as in the modern revolver with which we are all familiar. Two weapons known to have been made during the reign of Henry VIII were veritable Snider action rifles.

In 1664 Abraham Hall invented a gun: "Which hath a hole at the upper end of the breech to receive the charge, which hole is opened or stopped by a piece of iron or steel that lies along the side of the barrel and that is moved by a ready and easy motion."

Numerous other examples of early breech-loading portable firearms could be cited, but the foregoing is sufficient to give an idea of some of the early inventions.

On May 21, 1811, John H. Hall, of North Yarmouth, Maine, patented a breech-loading gun that was the first one of the kind manufactured in this country, with the possible exception of a few isolated cases. It was at first a flintlock and later a percussion-cap gun, using paper cartridges. Official records show that about 100 were issued to a company of riflemen in 1816. In 1836, Congress voted Mr. Hall a reward of \$10,000, based on \$1 per gun, which shows that 10,000 had been made up to that time. These guns were priced at \$20 each, and a number were used as late as the Civil War. There is no evidence of any foreign government having adopted a breech-loader previous to the invention of the Hall, so the United States must be credited with having been first in the field. It must not be understood, however, that this gun was ever officially adopted at any time for the entire United States Army. It was, however, used to a considerable extent in the Black Hawk and Seminole Wars, and also in the Mexican War; and while not generally known, quite a number were used in the Civil War.

Just how early paper cartridges were invented is uncertain, though in the year 1586 charges of powder and a bullet were placed together in a paper envelope or sack, the base of which was torn or bitten, and the powder poured into the barrel. The bullet was then rammed down on it. These cartridges were gradually improved in form, but did not carry their own means of ignition, being fired by matchlock, flintlock or percussion-lock mechanisms similar to those used for loose powder and ball. A cartridge carrying its own means of ignition is known to have been patented in 1827.

In the year 1836 Lefauchaux invented the pin-fire cartridge, which was made of thin brass and paper and had a pin projecting through the side which, on being struck, exploded a "cap" inside the shell. In this same year Greener, an Englishman, produced a very successful elongated bullet that would expand and fill the rifling grooves when fired, thus conserving the energy of the gas. Several others had tried the same scheme, but his appears to have been the earliest successful one.

The needle gun cartridge was invented by Deyse in 1838 and adopted by the Prussians in 1841. It had a conical bullet, with a wad at the base, behind which was a charge of powder in a lubricated paper case. The detonator was placed in the wad and was fired by means of a needle that was thrust through a perforation in the base, through the powder and into the "cap."

Percussion itself dates back to 1807 and is credited to the Rev. John Forsyth. It was first used in the form of powder ignited by means of a punch—hence the name of "punch-lock." Later, ignition was used in the shape of pills and gave the name of pill-lock to the type of arms to which it was applied. The copper percussion cap was invented in 1818 and is generally credited to Joseph Egg, of England.

In America the first metal cartridges appear to have been fired from percussion locks by means of a perforation in the base of the cartridge, which allowed the flame of the priming to ignite the charge. Probably the rim-fire cartridge closely followed. A center-fire cartridge was patented by Smith & Wesson in 1854. They also obtained patents on an improved rim-fire cartridge in 1860. It was the development of the metal cartridges that made possible the successful use of breech-loaders, as the expansion of the metal shell by the explosion for the first time produced an effectual seal for the prevention of the escape of gas at the breech.

ORIGIN OF THE AMERICAN ARMY MUSKET

The original model for the first musket made by the United States Government was the French model of 1763, which was largely furnished by the French Government during the American Revolution. This style was known as the Charleville musket, and it was copied in almost exact detail. The subsequent models brought out by the French were also closely followed for many years. The model of 1763 is especially noted as having been mentioned in the contracts of 1798. A model of 1797 was sent over from France by the American ambassador as an example of fine workmanship, and on the recommendation of Eli Whitney the improvements were later adopted in the United States guns. From the beginning of Government gun manufacture in the United States until the Krag system was adopted in 1892 the lines of the old Charleville musket are plainly visible. A few interpola-

tions were introduced to a limited extent, notably the Remington in 1870, the bolt-action Ward-Burton in 1871 and the Chaffee-Reece bolt-action in 1884. None of these were ever universally adopted for the regular

Declaration of Independence steps were taken looking toward the establishment of an ammunition factory, but it was not until after the close of the Revolution that anything which could be called a Government small arm



FIG. 29. SHARP'S CARBINE

Patented Sept. 12, 1848, and Oct. 5, 1852; lever-action vertical sliding block; first ones used percussion caps and paper cartridges; cal. 50 and 52; length of barrel, 22 in.; total length, 39 in.; weight, 8 lb.; 80,512 purchased during Civil War

FIG. 30. MAYNARD CARBINE

Patented May 27, 1851, and Dec. 6, 1859; tip-up barrel; lever action; percussion cap; 50 cal.; length of barrel, 20 in.; total length, 36¾ in.; weight, 6 lb.; 20,002 purchased during Civil War

FIG. 31. BURNSIDE CARBINE

Patented May 25, 1856; percussion cap; flaring metal cartridge with small hole in butt end; lever-action tilting breech-block into which cartridges were placed butt end first; cal. 53.5; weight, 7 lb.; 55,567 purchased

FIG. 32. COLT REVOLVER REPEATER

5-shot; percussion caps; patented Nov. 24, 1857; cal. 56; length of barrel, 26 in.; total length, 44 in.; weight, 9 lb. 3 oz.

FIG. 33. CARBINE MADE BY B. KITT-RIDGE & CO., CINCINNATI, OHIO

Rim-fire cartridges; 40 cal.; dated Oct. 25, 1859; tip-up barrel striker on hammer

FIG. 34. SMITH CARBINE

Patented June 23, 1857; percussion; top lever, tip-up barrel action; cal. 50; barrel, 21½ in.; total length, 39 in.; weight, 7 lb. 15 oz.; 30,062 purchased during Civil War

FIG. 35. JOSLYN CARBINE

Patented Oct. 8, 1861; rim-fire cartridge; firing pin; breech-block hinged at side; 53 cal.; weight, 7 lb. 3 oz.; 11,261 purchased

FIG. 36. REMINGTON CARBINE

Patented Dec. 28, 1863; thumb hinged block at breech; 44 cal.; weight, 5 lb. 4 oz.; 20,000 purchased

FIG. 37. GALLAGHER CARBINE

Patented July 17, 1860; percussion cap; tip-up barrel; 51 cal.; 22-in. barrel; weight, 7 lb. 8 oz.; 22,728 bought

FIG. 38. STARR CARBINE

Patented Sept. 14, 1858; firing pin; lever-action vertical sliding breech-block; 52 cal.; weight, 7 lb. 9 oz.; 25,603 bought

army, though the Remington was issued in large numbers to militia in a number of the states.

The beginning of the manufacture of the Charleville pattern guns is pretty clearly traced. Soon after the

was manufactured. In 1776 General Washington ordered Col. David Manson, of Boston, to establish a laboratory for making all kinds of ammunition. Brookfield, Mass., and then Hartford, Conn., were suggested, but for sev-

eral reasons were not selected. The final decision was centered on Springfield, Mass., and early records show that work was begun on this laboratory in April, 1778. After the Revolutionary War was over, all the employees were discharged and the buildings left in charge of a storekeeper.

In April, 1794, Congress authorized the establishment of two armories, one at Harper's Ferry, Va., and the other at Springfield, Mass. The manufacture of small arms began at Springfield in 1795 with 40 men, and 245 muskets were turned out the first year. There is no record of any small arms being produced at Harper's Ferry previous to 1801. In 1810 the output at Springfield was 9,700 muskets and 602 carbines. At this arsenal in 1819 the cost of labor per musket was \$6.57, which together with the cost of the material brought the total cost to \$12.40 each. The output of this arsenal continued from

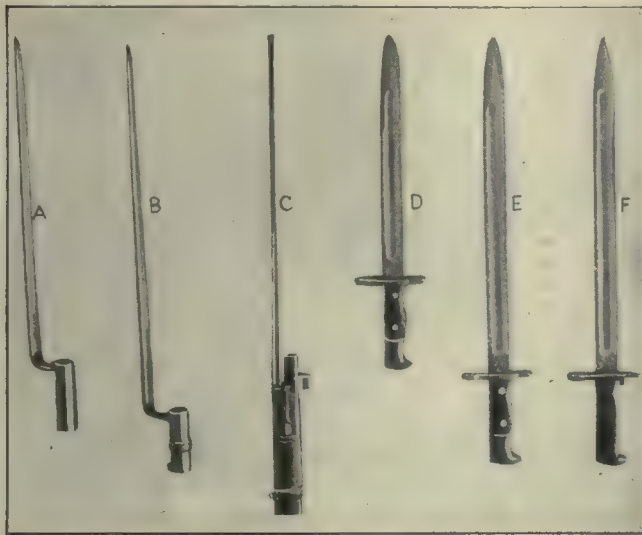


FIG. 27. TYPES OF BAYONETS ON UNITED STATES ARMY MUSKETS AND RIFLES

A, bayonet 1803, hollow ground point, 16 in. long, $\frac{3}{8}$ in. at widest part of blade; B, bayonet 1865, hollow ground blade, 18 in. long, $\frac{3}{8}$ in. wide at widest part of blade, $\frac{3}{8}$ in. thick at base of blade; C, rod bayonet 1888, when out projects 15 in. from end of barrel, rod is $\frac{3}{8}$ in. in diameter with triangular point; D, Krag bayonet 1892, 11 $\frac{3}{4}$ in. long, $\frac{3}{8}$ in. thick at base; E, bayonet 1905, 16 in. long, 1 $\frac{1}{4}$ in. at base of blade, handle 4 $\frac{1}{2}$ in. long; F, bayonet 1906, slight changes in handle and catch

1811 to average about 1,000 per month. Twelve thousand muskets and 250 rifles were produced in 1819. This average was not materially changed until 1862, when it jumped to 102,410, and to 276,200 in 1864. The cost per gun the latter year was \$10.69. In 1865 the output dropped to 195,341, and the cost rose to \$14.12 each.

Besides the Government armories established, Congress in 1808 enacted a law for the annual payment from the United States Treasury of \$200,000 for six private armories established that year. From among the more prominent gun makers were selected Asa Waters, Sutton (now Millbury), Mass.; Simeon North, Middletown, Conn.; Nathan Starr, Middletown, Conn.; Eli Whitney, Whitneyville (near New Haven), Conn.; Henry Deringer, Philadelphia, Penn.; and Lemuel Pomeroy, Pittsfield, Mass. Contracts were issued to these firms for a term of years, which were renewed from time to time until 1840. These private armories were regarded as permanent, having been recognized by the Government as a part of the United States industrial preparedness measures for the insurance of a supply of arms.

The six private armories assured, the Government proceeded to issue contracts for arms to supply the militia. From June 30 to Nov. 13, 1808, nineteen contracts were made; the total number of arms delivered by these nineteen firms to December, 1812, was 53,660.

In 1841 and 1842 the number of private armories was seven, with an output as follows: Pomeroy, 1,200 muskets; Whitney, 1,500 muskets; Starr, 1,200 rifles, Deringer, 1,200 rifles; Waters, 3,000 pistols; Johnston, 3,000 pistols; North, 2,000 Hall's carbines. These made a total of 13,100 annually. In 1845 the last of these contracts expired, and the whole system was broken up without notice.

Starting at the beginning, the strictly Government muskets and rifles were made as follows. The changes indicated can be easily traced by reference to the various illustrations, shown and described separately:

French Charleville musket, model 1763; pattern only.

Flintlock musket, smooth bore, 1795 to 1822; minor changes; bore reduced from 71 or more to 69 cal.

Musket altered to percussion, model 1822; cal. 69.

Musket, percussion; new nipple seat or boss; model 1842; cal. 69; patterned after French Charleville, model 1840.

Springfield rifled musket, model 1855; Maynard primer; cal. 58.

Springfield rifled musket, models 1861, 1863, 1864; different mountings.

Springfield breech-loading rifle; model 1865; Allen alteration; cal. 58.

Springfield breech-loading rifle, model 1866; cal. 50.

Springfield breech-loading rifle, models 1868 and 1870; cal. 50.

Springfield breech-loading rifle, model 1873; cal. 45.

Springfield breech-loading rifle, model 1884; cal. 45; rod bayonet.

United States magazine rifle, model 1892; cal. 30; Krag-Jorgensen system.

United States magazine rifle, models 1896 and 1898; Krag system.

United States magazine rifle, model 1903; cal. 30.

Briefly reviewing the various changes and interpolations that took place from time to time, only minor alterations were made in the muskets manufactured from 1795 until 1822, when the percussion system was adopted to supersede the flintlocks. Many flintlocks were altered later, so that frequently models of earlier years are encountered in museums, having the percussion system of ignition. A large number of the old flintlocks were allowed to accumulate at the various arsenals until in 1850 and 1851 a great many were changed to percussion. It was during this period that the Hall breech-loader was used to some extent, and many are to be found of both systems.

The model of 1842 shows a new nipple seat or boss, bulging out from the side of the barrel and an integral part of it. The next change of importance was the reduction of the bore from 69 to 58 caliber and the adoption of the Maynard primer, which was done in 1855. The Maynard primer consisted of a flat tape with an explosive mixture, or caps, at intervals. This tape was wound over a small drum, and the caps were fed one at a time up over the nipple. The action of the hammer, as it was cocked, brought a cap into position; and as it descended, it cut off a piece of the tape and a cap. This did away with the necessity of putting a cap on the nipple at each loading, as it was taken care of automatically as long as the priming tape lasted, when it was easily replaced. This system was later abandoned and return was made to the percussion caps. With this exception, few changes other than in the mountings were made for years, the essential parts remaining standard.

Very few breech-loading arms except the Hall were tried by the Government previous to the Civil War. Among the principal ones were the Sharps, Burnside and Spencer, of which a few were issued to troops between 1845 and 1860. Some Maynards were also issued. The general opinion of the army boards of this time was that the breech-loader was not perfected enough for general adoption. At the outbreak of the Civil War the Government found itself unable to furnish its troops with arms, so they were purchased both here and abroad. None of these weapons, however, seem to have influenced the subsequent Government models to any noticeable extent. Since these guns had so little bearing on the regular army models and were so numerous, only a few of the better known ones are shown in the illustrations.

In 1865 the Government adopted its first official breech-loader. This was known as the Allen alteration and consisted mainly in crossmilling a section out of the top of the rear end of the barrel and fitting on a hinged breech-block. This block is plainly shown in the illustration for that year. The model of 1866 was very similar, but the caliber was reduced to 50, which was taken care of in the guns already made by inserting a rifled tube in the barrel to reduce it to the required size. Practically no change was made in the models of 1868 and 1870, except that in 1870 the barrel was made to screw into the receiver frame. It was also in this year that the Remington breech-loader was used to a limited extent. This was followed the next year by another brief experiment in the form of the Ward-Burton bolt-action rifle, which was one of the earliest of this type.

The model of 1873 had the caliber reduced to 45. Some of the officers' models of this year also were fitted with a three-cornered rod bayonet. Of course, it must be borne in mind that all through these periods numerous carbines for mounted troops, artillery, officers or others were made, but had no bearing on the main issue. All sorts of weapons were also being constantly tried out by the ordnance boards in the search for something better, but through it all the old lines of the original Charleville musket proved the more practical.

The Springfield model of 1884 carried the rod bayonet as its principal change. This was a round pointed rod that was carried in the rifle about like the old ramrod and could be pulled out a certain distance, when a catch would hold it until released and pushed back again. This year also saw the introduction of another experiment in the Chaffee-Reece bolt-action rifle, of which only a few hundred were manufactured and issued for regular service.

The next change is a radical one, the caliber being reduced to 30 and a magazine rifle of the modified Krag-Jorgensen type being adopted after extensive competitive tests. It is not necessary to describe this model in detail, though it continued in use with slight alterations until the adoption of the present model of 1903, the action and details of the latest type of which are described elsewhere. This last rifle contains many of the best features of both the Krag and the Mauser systems, and in its present form is considered by army men to be one of the best and hardest shooting rifles used by any army. The big advantage of the bolt action is that it lends itself so easily to either magazine or hand loading.

During the entire period of rifle evolution the bayonets varied but little, except as they were made to conform to the different sizes of barrels. Some special designs were

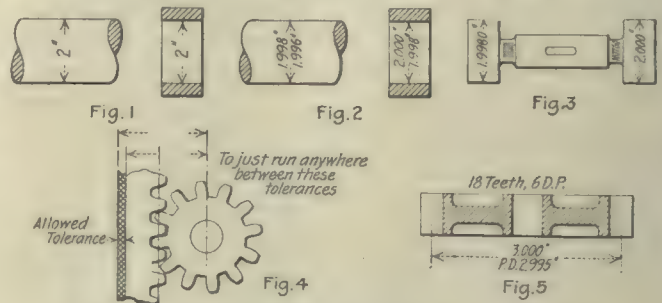
introduced for different branches of the service, but three principal types only were used by the regular army, as shown by the illustrations.

Inspecting High-Grade Gears

BY JOHN YOUNGER*

It is a comparatively short time since shafts and bushings were marked on the blueprint to the normal size rather than the actual expected size. The "man in the shop" was expected to turn or bore his own clearances, and the drawings had the appearance of Fig. 1.

The "man in the shop" did not prove equal to the job, and the drafting room gradually took on the responsi-



VARIOUS METHODS OF INDICATING SIZE AND WORKING TOLERANCES

bility of giving him accurate sizes. Simultaneously they gave him the working tolerances as well as the clearances, so that a drawing now looked like Fig. 2.

The gage makers did their part and designed two gage plugs (Fig. 3) for the one hole. One plug went in, the other did not. Sometimes similar caliper gages were made for the shaft. Sometimes micrometers were used.

The system was gradually extended to surfaces, screw threads, forced fits, depth, height and width measurements. The "man in the shop" was not given a chance—*except in gears.*

A draftsman draws two shafts exactly 3 in. center distance. He draws two gears each marked plainly P.D. 3 in. and expects them to mesh quietly together. They won't.

The "man in the shop" either makes the centers out "a little" or he cuts the pitch diameters "a little" less. Sometimes he measures that "little" by a thing he calls backlash—that is, the thickness of feeler he can just get in tangential to the curved surfaces of two tooth faces.

It is obviously impossible for him to measure backlash on every tooth, especially if the gear is case-hardened and of slightly varying shape. He must form a general conclusion based on approximate feel or really instinctive knowledge. It is this "rule of thumb" intuitive or instinctive knowledge that differentiates the good gear inspector from the poor.

To repeat, working clearances were once measured this way between shaft and bearing, till the supply of good men ran out. A 0.002-in. clearance felt to some men like 0.015 in. and vice versa. No man could estimate "shake" or backlash correctly *all* the time.

It is not easy to measure pitch diameter accurately, but it can be done. A nominal 3-in. P.D. can be actually cut 3.002 in. in one blank and 3.005 in. in another. These blanks can be retained as masters, and acceptable gears should mesh tightly with the 3.005 in. and run around

*Chief Engineer, Pierce-Arrow Motor Truck Department

freely with the 3.002 in. If this accuracy be too great the tight or "not go" might be made as much as 3.010 in. and the free gear as little as 3 in. Clearances and tolerances in gears may be a matter of taste just as much as they are in shafts and holes.

Perhaps better still a hardened rack can be made and very accurately ground on the teeth and on the back: its pitch line accurately measured to the back, and all gears run with it between the two allowed center distances. The rack could slide in ways across the gear teeth as indicated in Fig. 4.

A gear under suspicion could be run with the master in a few seconds. One high tooth alone will show up instantly and cause rejection. With slight experience eccentricity can readily be detected. Nothing is left to the emotions of the inspector. It either runs or does not run.

Drawings could be dimensioned in accordance with what they are. A gear drawing would look like Fig. 5.



The Temperature of Chips

By E. THAULOW*

The heating of metal chips is due to the energy lost by the cutting action through "internal friction" in the material of the chip and external friction in the chip, the piece of work and the cutting tool. A part of that heat is conducted away from the cutting point through the material of the piece of work and the cutting tool; but at a cutting speed high enough, the greater part remains in the chip and gives it the well known coloring, as mentioned in the last article of Mr. Herbert (Vol. 44, page 501). Some time ago, when I tried unsuccessfully to get blue chips by cutting mild steel, I developed a mathematical formula for the relation between the cutting pressure and the temperature of the chips. I think this formula may be of interest to some *American Machinist* readers.

If the cutting pressure in kilograms per square millimeter is p , the area of the chip in square millimeters a , and the cutting speed in meters per minute v , then the energy used by the cutting action will be pav kilogram-meters per minute. As the unit of heat corresponds to 427 kilogram-meters, the heat generated will be $\frac{pav}{427}$ calories.¹ Suppose finally that the part used to heat up the chips is proportioned to the total heat generated by n , then the heat per minute H_1 available for heating the chips will be determined by:

$$H_1 = n \frac{pav}{427} \text{ calories} \quad (1)$$

The volume of chips cut per minute is av cubic centimeters. Taking a specific gravity g in kilograms per centimeter and a specific heat h in calories per kilogram, the heat H_2 required to heat up the chips to the temperature T above the temperature of the room is determined by:

$$H_2 = avghT \quad (2)$$

By actual cutting we get $H_1 = H_2$.
Hence

$$T = n \frac{p}{427 \times gh} \quad (3)$$

The formula shows that except in the value of n the cutting speed and the chip area do not affect the temperature of the chip.

For steel we have $g = \frac{7 \times 8}{1,000}$ and $h = 0.115$. Substituting these values in formula (3) we get:

$$T = 2.62 np \quad (4)$$

The value of n depends on the cutting speed, partly also on the area and the shape of the chip, and is supposed to be about $\frac{3}{4}$ in., the practical use of high-speed steel tools in roughing steel. As a maximum never reached we get $n = 1$. Substituting these values for n , formula (4) becomes:

$$T = 1.97p \quad (5)$$

and as a maximum

$$T = 2.62p \quad (6)$$

In cutting medium steel, using a cutting angle of about 70 deg. and an area of cut of about 5 sq.mm. (0.008 sq.in.), the value of p is about 1.75 kg. per sq.mm. Hence $T = 344$ deg. C. (650 deg. F.), as a maximum $T = 458$ deg. C. (850 deg. F.). For larger chip areas the temperatures are still less, and high temperatures such as glowing temperatures by cutting ordinary material of construction are beyond physical possibility, unless there is something wrong in the cutting action, as the breakdown of the cutting edge.

The foregoing considerations threw some light upon the behavior of different materials for cutting tools. For tools of carbon steel the temperature of the chip may be much higher than the breakdown temperatures of the tool steel. Therefore, it is necessary to employ a slow cutting speed and a small chip area, so that the heat generated can be conducted for a considerable part through the piece of work and the tool itself; that is, the factor n must be small. For tools of high-speed steel the effect is opposite. Here the chip temperature is lower than the breakdown temperature of the tool, and the chip acts as a cooling medium.

Besides this, the difference of temperature between the tool and the piece of work may be much higher than in carbon steel, and the latter will also act as a still stronger cooling medium on the edge. This in connection with the poor heat conduction of high-speed steel will preserve the hardness of the edge longer than the remainder of the cutting side of the tool. In cutting tough materials where the chip remains in contact with the cutting side of the tool for a longer time, this fact explains the well known phenomenon of the wear of the tool behind the cutting edge, while the latter is left nearly untouched.



Removing Counterbore Teat from a Hole

By H. P. JOHNSON

While counterboring a $\frac{1}{16}$ -in. hole $\frac{1}{2}$ in. deep the pilot on the counterbore roughed up and twisted off flush with the bottom of the hole. The piece being counterbored could not be heated as this would spring it. An old drill, the size of the body of the counterbore, was procured, and the center was ground out with a thin wheel the size of the pilot. The drill thus ground acted as a hollow mill. After running the drill in the center slot all that remained was to take a pair of tweezers and pick the broken teat out.

*Professor, The Royal Technical College, Copenhagen, Denmark.

¹1 calorie = 3.087.77 ft.-lb. = 3.97 B.t.u.

Tools for Pump and Lathe Parts

By ROBERT MAWSON

SYNOPSIS—In this illustrated jig and fixture data page are shown tools for machining elements used on pumps and lathes. The different items include weight, speeds, feeds and time required for the various operations. With such information, the article should prove helpful for similar work in many shops.

The special tools, jigs and fixtures shown herewith are found in the equipment for machining the parts of a steam

pump and turret lathe in a New England shop. The tools are not elaborate, yet they are producing work of an interchangeable nature at a good rate of speed. It will be observed that the same fixture base serves for both the milling and the drilling operations in machining the back arm.

A milling fixture to machine two parts which are held by one strap and the jig for the same piece are shown; when machining the lathe carriage, the boring fixture is made with a finished surface to suit the part to be machined, which is securely held in place with a wedge.

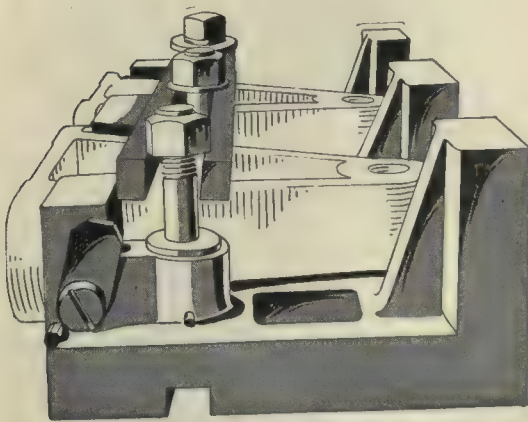


FIG. 2

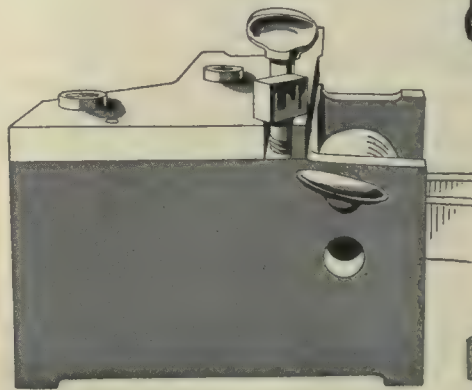


FIG. 4

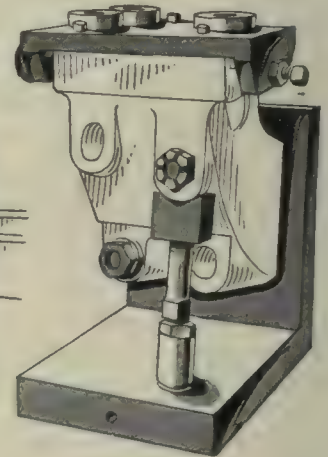


FIG. 6

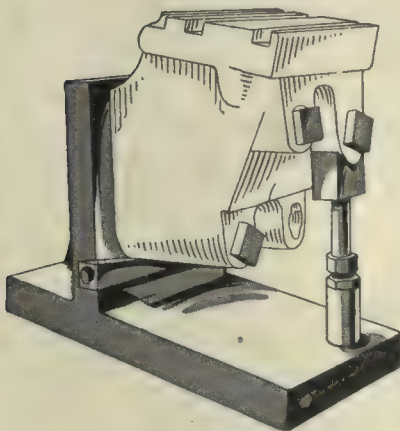


FIG. 7

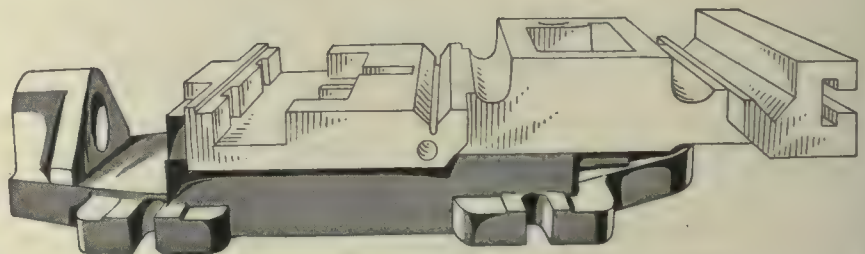


FIG. 9

TOOLS USED IN MACHINING PUMP AND LATHE PARTS, WITH WORK SHOWN IN POSITION

FIGS. 2 AND 2-A

Operation—Milling pump pedestal, Fig. 1. The rough casting is located against pads at the end of the fixture, and an open strap is slid under the nuts on the bolts. The nuts are then tightened, holding the casting securely.

Surface Machined—Base, using a $3\frac{1}{2}$ -in. end mill operating at 96 r.p.m. with a feed of 0.1 in. per revolution.

FIGS. 4 AND 4-A

Operation—Drilling lathe countershaft hanger tie-rod, Fig. 3. The rough casting is located in two V-blocks and forced against a stop pin with a setscrew. A thumb-screw is then tightened on the piece to hold it securely.

Holes Machined—Two $\frac{49}{64}$ -in. and one $\frac{41}{64}$ -in. drilled.

FIGS. 6 AND 6-A

Operation—Drilling lathe back-arm block, Fig. 5. The milled casting is placed in the sub-base fixture and held with two bolts. The jig is then slid on, the upper surface being located against an adjustable setscrew by a thumb-screw.

Holes Machined—Two $\frac{59}{64}$ -in. and six $\frac{1}{4}$ -in. drilled. The former holes are afterward tapped with 1-in. U.S.S. threads.

FIGS. 7 AND 7-A

Operation—Milling lathe back-arm tool block, Fig. 5. The casting is located in the sub-base fixture in a manner similar to that described for the drilling operation.

Surfaces Machined—Slots in the base, using three 5-in. cutters operating at 53 r.p.m. with a feed of 0.18 in. per revolution.

FIGS. 9 AND 9-A

Operation—Boring lathe carriage, Fig. 8. The casting is located against a stop pin. A wedge is driven into the machined surface of the fixture and the part to hold the carriage in position. The fixture is located on the boring machine with keys and held in place by bolts fitting in the slots of the fixture ears.

Surface Machined—One 2-in. bored hole through two sections of the casting.

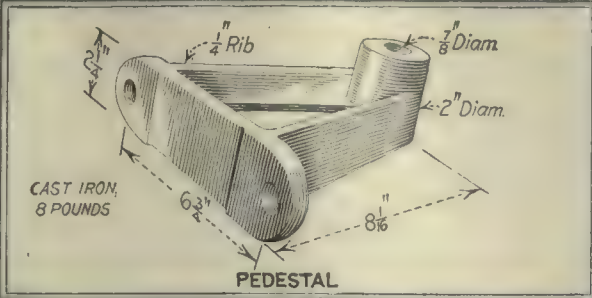


FIG 1

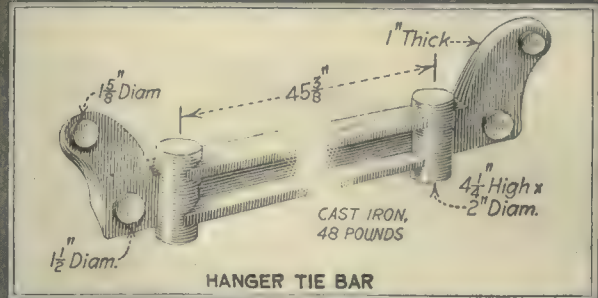
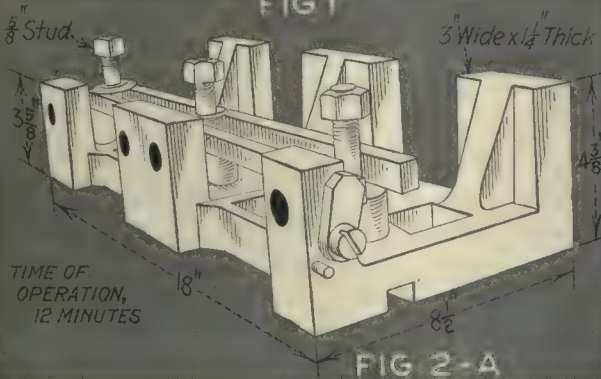


FIG 3

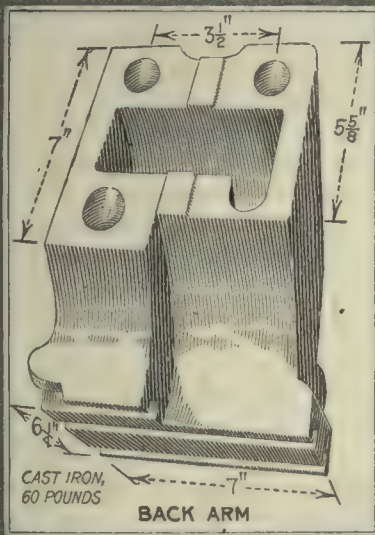
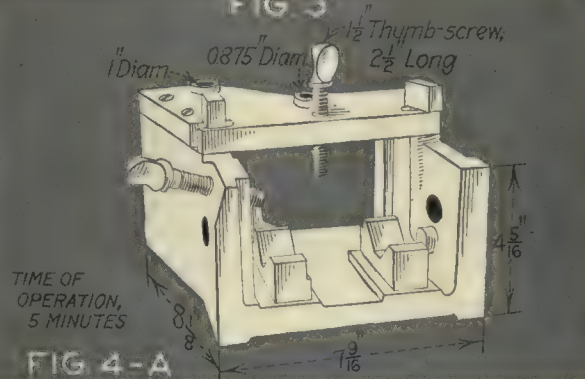


FIG 5

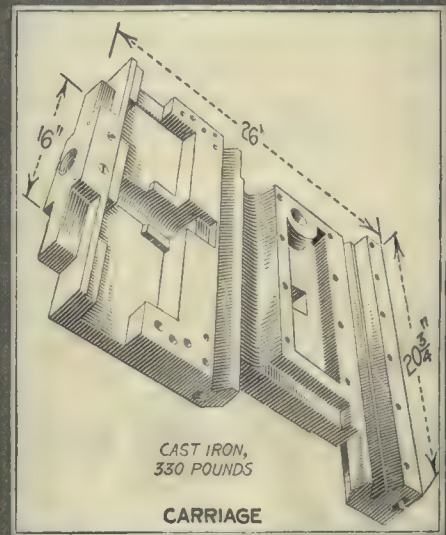
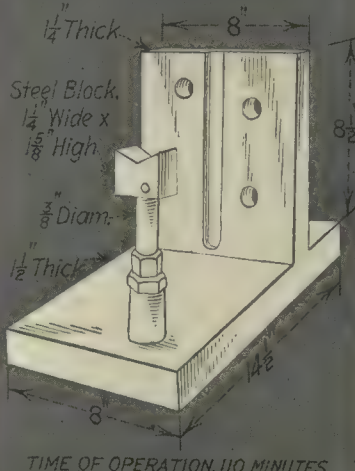
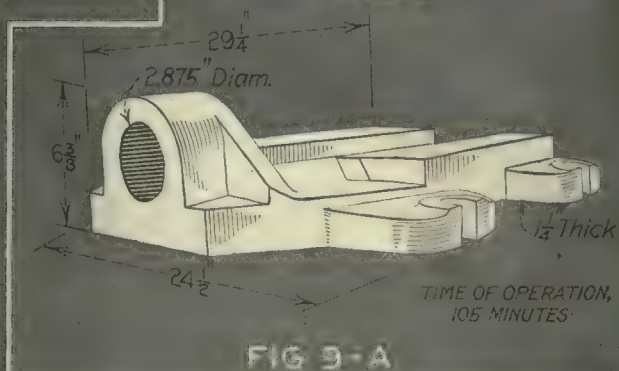
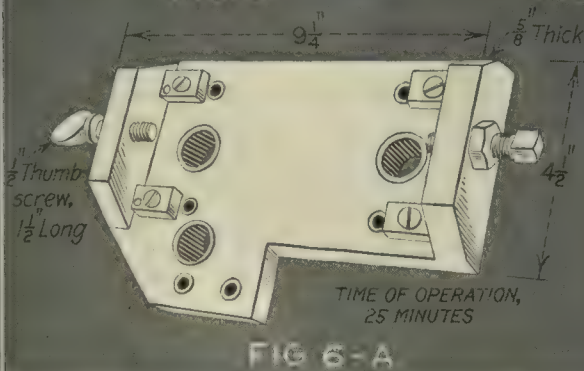


FIG 8



ALL BUSHINGS USED FOR GUIDING TOOLS ARE BLACKENED OR HEAVILY RULED. ALL JIG AND FIXTURE BODIES ARE CAST IRON. STRAPS AND FASTENINGS, MACHINERY STEEL, GUIDE BUSHINGS ARE TOOL STEEL, HARDENED AND GROUND

Encouraging the Manufacture of Steel in Japan

By a JAPANESE ENGINEER

Herewith is given a summary of the report of a Steel Committee appointed by the Japanese Government in May, 1916, to investigate the steel situation. Its members included high authorities in Japan—steel makers, steel consumers (private and Government), professors, mining engineers, dockyard directors, etc. Some of the figures differ from our last report. They were probably obtained from a more reliable source.

Though the Government has already investigated the iron beds in Japan and there is probability of finding new beds in the future, it is quite evident that there is not sufficient ore in our country to satisfy the increasing home demands of iron and steel. Therefore it is necessary to secure a supply from abroad. The Government has studied the iron beds in the neighboring countries to some extent, but this work is not finished. The following steps are to be taken to encourage the production of iron ore at home:

1. The Government will give technical assistance to private enterprise, such as boring, mining, planning, etc.
2. A special reduced price will be fixed for transportation of iron ore.
3. Special facilities will be provided for supplying charcoal to be used in iron furnaces.
4. The Government steelworks will investigate and try the experiment of producing iron from inferior ore, as well as from sand iron ore.

The use of sulphide iron ore for producing iron will also be encouraged, and the first, second and fourth of the items above will be applied to this kind of ore. The Government will investigate the plants of important iron mines when a great quantity of ore is required in case of emergency. It will study the Skatani mine, and steps will be taken to start the works there.

There is not sufficient suitable coal in Japan for making coke for the iron furnaces, so the Government steelworks will endeavor to use inferior kinds of coal for its own furnaces. It will determine the possibilities of near-by countries as sources of iron ore, mangan ore and special ore necessary for certain steels. This will be done immediately. Coal fields in near-by countries suitable for producing cokes for iron furnaces will be investigated. Assistance will be given to private enterprises in importing iron ore and all kinds of raw material necessary for ironworks, and those private firms that produce metals or alloys necessary for special steel will be aided.

VARIETIES OF IRON AND STEEL PRODUCTS

The home consumption of pig iron has been as follows:

Average yearly consumption, 1906 to 1910.....	124,007 tons
Average yearly consumption, 1911 to 1916.....	200,228 tons
Increase	61.5 per cent.

The probable consumption of pig iron in the future is estimated as follows, in tons:

1918.....	360,900	1925.....	617,500
1920.....	430,000	1928.....	743,000
1923.....	533,600		

The home consumption of steel has been as follows:

Average yearly consumption, 1906 to 1910.....	472,487 tons
Average yearly consumption, 1911 to 1916.....	691,884 tons
Increase	46.5 per cent.

The above figures do not include importations of ships, engines, railway wagons, locomotives, etc. These are esti-

mated at 92,000 tons per year, as the average from 1912 to 1914.

The probable consumption of steel in the future is estimated, in tons, as:

1918.....	1,113,000	1925.....	1,786,000
1920.....	1,295,000	1928.....	2,112,000
1923.....	1,568,000		

The annual production of Japan and neighboring countries follows:

	Pig Iron, in Tons			
	Home	Chosen*	Manchuria†	China‡
1915	345,600	.....	30,000	200,000
1916	491,000	.....	35,000	200,000
1917	539,900	.....	70,000	200,000
1918	541,500	100,000	230,000	480,000
After 1919 ...	541,500	100,000	230,000	480,000
After 1922 ...	611,500	100,000	230,000	480,000
	Steel, in Tons			
	Home	Chosen*	Manchuria†	China‡
1915	405,100	.....	.....	50,000
1916	569,600	.....	.....	50,000
1917	686,000	.....	.....	60,000
1918	765,000	.....	.....	60,000
After 1919 ...	770,000	.....	120,000	60,000
After 1922 ...	1,090,000	.....	120,000	60,000

Besides the above figures, there is a yearly production of wrought iron of 1,000 tons at present.

*Chosen indicates the production at Kenjiho. †Manchuria means Honkeiko and Anzantenm. ‡China means Dai-ya and Han-yang. Honkeiko and Dai-ya do not produce any steel.

We cannot get good ore suitable for acid steel in Japan, but all other varieties of steel are as good as those of foreign manufacture. The cost of manufacturing pig iron is not higher than that in foreign countries. The greatest difficulties are the lack of capital, heavy taxes and miscellaneous shop expense. The committee believes there will be great prosperity for these manufacturing works in Japan, if the Government makes a special policy in their favor. The same conclusion also applies to steel manufacture.

The committee strongly advises the Government that mutual intimate consultation and coöperation of Government and private steelworks, instead of competition between them, is highly desirable.

STEPS TO ENCOURAGE IRON AND STEEL MANUFACTURE

To encourage the manufacture of iron and steel the following steps are recommended by the committee:

1. Works producing pig iron of more than 35,000 tons per annum shall receive the right to buy the land by force, if necessary (just as the land necessary for railroad or Government use is acquired—buying the land at an appraised value instead of at abnormally high cost, or buying though the owner declines to sell).
2. Steel makers can buy or contract to hire Government land for long periods.
3. Steelworks established to produce more than 35,000 tons of steel or pig iron per annum shall be exempt from any kind of taxes for 10 years from the commencement of the work.
4. Special subsidies for encouraging works producing pig iron containing a low amount of phosphorus shall be granted.
5. No taxes shall be charged on iron and steel imported from Chosen.
6. Special protection shall be paid to iron and steel products manufactured in foreign lands under Japanese capital.
7. Government steelworks shall constantly prosecute research and experiments that might benefit private steel makers.
8. Government steelworks must keep in mind means for producing skilled engineers and foremen, etc., so as to be able to supply them to private firms if required.

Installing Task-and-Bonus Work in Typewriter Plants

BY L. P. ALFORD

SYNOPSIS—The principles and a few of the practical reasons that have brought success in installing task-and-bonus work in the plants of the Remington Typewriter Co. This work has been done during the introduction of scientific management and with the counsel and advice of H. L. Gantt.

Three preceding articles, published on pages 457, 497 and 537, have briefly sketched the results of the installation of scientific management in the four principal plants of the Remington Typewriter Co., have outlined the attitude of the management toward the employees and have given the principles of storekeeping, timekeeping and production control. This last article on general features of the management as now organized deals with task-and-bonus work. It is the purpose to give a few of the principles, together with some of the basic reasons that have contributed to success in its installation.

A few of the figures given in the first article showing the general results and savings that have come from the introduction of the new methods will bear repetition here, for task work and bonus has been one of the important factors in bringing the benefits. About one-fifth of the operations in the Remington plant at Ilion, N. Y., are now on a task-and-bonus basis. Many jobs are also on this same basis in the other three factories, though not as many in the aggregate. The average increase of production per unit of time on these 5,000 tasks is 65 per cent. The saving of labor expense on these same 5,000 jobs is about 18 per cent. The increase in wages earned by the workmen employed on these 5,000 jobs is 23 per cent. In addition to these savings, there are many other items of operating expense that have been eliminated or reduced and show through the decrease of manufacturing costs.

OBJECT OF TASK WORK WITH A BONUS

The object of task work with a bonus is to insure the regular accomplishment of the full amount of work that can be done by a trained workman with proper equipment and under proper conditions. To secure this result it is necessary that every operation shall be studied to find out the best method of doing it with the equipment available, or to determine what other equipment it may be necessary to acquire.

The method and equipment having been decided upon, the next step is to establish the rate of production that, all things considered, is the most economical. It is on this rate of production that the task is based. The health and happiness of the workmen enter as factors in setting this rate, for it is obviously uneconomical to have any employees overworked or overstrained. Thus a task system that does not consider these features of well-being is wrong in principle and must fail. A successful system must be scientific, human and be operated with fairness.

The function of task-and-bonus work can only be fulfilled by obtaining the coöperation of the workmen. Such

coöperation is a most important factor in the economy of manufacture. It can best be developed by rewarding the individual worker according to his just deserts. It is this that task work with a bonus seeks to do. It endeavors to obtain the coöperation of the workman by inducing him to work at a rate and in a manner which scientific investigation shows to be the best for all concerned, and then rewards him adequately for the efforts that he puts forth.

Thus one of the basic ideas in task work is the setting up of an equitable bargain between the company and each employee. The company asks for a definite minimum output, which investigation has shown to be fair considering all of the working conditions. In return for this it offers the workman a guaranteed hourly rate over and above that which he regularly receives. This increase is great enough to induce him to do the minimum amount of work specified in the manner and time specified. This amount of work is called the "task." If a workman accomplishes his task, he is paid at his regular hourly rate for the time allowed for the task plus a percentage of that time. The compensation is thus equivalent to a piecework rate. The workman has all the advantage of daywork if he is unskilled, and of piecework if he is skilled.

A task is set in such a manner that a good workman is enabled to accomplish it every day, and the time allowed is liberal enough so that he will not be penalized by failure because of small and unusual delays which cannot be specifically provided for. Every failure to make bonus is investigated as promptly as possible after the work is done, and the conditions that caused it are at once corrected.

A study of task work in the Remington plants discloses this fact: That task work cannot be successfully established until the management has sufficient production control to insure that the proper conditions for the specified output can always be maintained. This means that there must exist proper methods of purchasing material, storekeeping, timekeeping, planning and scheduling, before task work is begun. If this foundation is not laid, conditions are likely to arise which will bring a loss of bonus for causes over which the workman has no control. Such a condition is fundamentally opposed to the basic idea of any proper system of task work.

CONDITIONS THAT MUST BE MAINTAINED

In order that the functions of task-and-bonus work may be successfully performed, the following conditions must be established and maintained:

1. The workman must have a constant supply of work ahead.
2. Proper instructions must be furnished as to what is to be done and how it is to be done.
3. An accurate record must be kept of the amount of work done and the time it has taken to do it.

The storekeeping and timekeeping systems care for items 1 and 2. The proper instructions required by 2 can only be supplied from research information accumu-

lated by the engineering office. Thus the duties of the task-setting division of this office, in order that this function may be properly performed, are as follows: Routing, analysis, study tabulation, utilization, classification, training and charting. It is impossible in such an article as this to do more than outline what each one of these duties includes.

Routing—This is a determination and recording of what manufacturing operations should be performed and in what order; that is, it is supplying the information for the master route card from the best information available.

Analysis—This comprehends a splitting up of the operations on the master route card into their elementary parts, with instructions for performing each one according to the best knowledge available.

Study—This is a determination of the best time needed to perform each elementary part of each operation in the best manner that can be devised.

Tabulation—This is collecting and tabulating all kinds of data that are or may be useful for task setting.

Utilization—This comprehends making use of the observed and tabulated data when determining the best methods and proper time for performing the various operations. It also includes writing the task reports and making out instruction cards.

Classification—This is a determination of the class to which the work belongs.

Training—This item is one of the most important of all, for it concerns the training of the workmen to do the work in accordance with the instructions.

Charting—This includes the planning and establishing of proper charts on which to record the daily performance of the task workers and the comparison of their performance with the task required.

THE LEADERSHIP OF THE TASK SETTER

As the purpose of the task-and-bonus work is to establish and maintain the active coöperation of the workmen, at the same time giving them an adequate reward for their efforts, and as it involves a training of these men in the methods prescribed, it follows that an important responsibility rests upon the men who do the teaching. These men are the task setters. Their principal duty is first to learn something of value themselves and then teach it to others.

However, the task setters' duties in this particular apply only to new work, for these men are under the control of the engineering office. After a task has once been set, demonstrated and one or more employees trained to perform it, it is the duty of the foreman to teach additional employees who are subsequently given this same task. This latter duty comes under the manufacturing office, for it is routine work.

In order that task setting may be done successfully, it is of great importance that the good will of the workmen be gained. Apparently there has been unusual success in this direction in the plants of the Remington Co. Such results can only be obtained by selecting for task setters men who are honest, above board, and who can inspire confidence in others. It must be remembered that the workman's opinion of a task setter is based upon what the latter does and says in the shop. Thus he must gain his end by kind, persistent persuasion, rather than by arbitrary methods.

In order to show some of the things that intelligent research brings to light, a number of isolated facts recorded in connection with the task-and-bonus study in the automatic screw-machine department at the Iliion plant are given below. These are introduced to emphasize the things that occur in an unorganized, unstudied shop department.

A study of 11 Brown & Sharpe No. 00 automatic screw machines over a period of eight weeks showed that the "irregular legitimate stoppage" amounted to 40.8 per cent. of the "regular legitimate stoppage." It also showed that the "interference" amounted to 55 per cent. of the "total legitimate stoppage."

During the eight weeks' investigation the above machines that were making screws were running from 74 to 86 per cent. of the total time. Those working on sleeves were running from 63 to 87 per cent. of the total time. The average for the machines on screws was 82.8 per cent. and for those on sleeves 70.1 per cent.

In eliminating the illegitimate stoppages a number of minor changes were made in the machines and tools. Some of these were:

It was found that the chuck fastener for the bearing attachment was turned at right angles to its proper position on all the machines. This was remedied, thus keeping the sleeve in the chuck from catching and causing the safety pin to break.

It was also found that the diameter of the pin for loosening the chuck of the burring attachment was too small. This allowed the pick-up arm to go down with the piece in the chuck, and the result was again a broken safety pin. This was remedied by providing a pin with an enlarged head, so that the loosening pin of the chuck could not fail to meet it. An excessive drill breakage was caused by the chips binding around the drill and forming a nest, thus preventing the oil from reaching the drill. This was overcome by means of a tapered drill bushing which caused the chips to slide down its side in a direction away from the drill. At the same time new oil spouts delivering a heavier flow of oil were put on the machines. This latter feature had a marked effect in reducing drill breakage.

Safety pins were also broken at times on account of chips from the forming tools wrapping around the sleeve and not allowing it to enter the bushing of the burring attachment. This caused it to catch and break the pin. This was overcome by the introduction of a stripper, which consisted of a piece of spring-tempered steel bent over the forming tool in such a manner that it scraped the chips off the piece as they were cut.

Another battery of 14 Brown & Sharpe No. 00 automatic screw machines were engaged in turning the shanks of the type blanks. These shanks are tapered and must be very accurate. While studying their operation, it was discovered that at times the type blanks would stick in the magazine and not feed. This was remedied by widening the magazines out somewhat and placing a heavy weight on the feeding rod. The guide plate on the magazine holder was also too wide, and this at times allowed a blank to turn at a slight angle and thus strike against the chuck instead of entering the opening. This caused a high breakage of feeding forks, about 16 per day for 14 machines. This difficulty was overcome by making the slot in the guide plate narrower and tapered, so that the type could not possibly miss the chuck opening.

This brought the fork consumption down to two or three per day for the battery of machines and eliminated one of the causes of time waste.

Two other changes were made on this job. One hollow mill was done away with and its time of operation saved by combining its work with that of the pointing tool. This saved about 45 per cent. of the total time of the operation. Furthermore, high-speed steel was substituted for carbon steel in these mills, and this, of course, permitted higher speeds and faster feeds. The speeds of the box tool were also changed, so that it started its cut at a high rate and ended at a low one. The result of this was that the time of operation of the box tool was reduced sufficiently to keep the shank of the type from heating and breaking off—a difficulty that had previously existed.

An interesting situation developed in regard to the study of a line of four No. 51 Acme automatic screw machines. These were all engaged on making the same screw. On the first day after the task was set, the machines were kept going constantly, but it was found that the production was about 2,000 screws short of what was set. An examination of the chips taken from the machines brought to light nearly 4,000 screws. These chips had been thrown away without careful examination. Going through the machine, it was discovered that the pan used for catching the work was too small and would quickly fill up and overflow into the chip pan below. A larger work-pan was substituted, closely watched and never allowed to fill up completely. Also, the chips were examined daily. It is interesting to mention that this job on these machines ran for about nine months with practically no bonus loss to the operator.

At the end of the first 16 months of task-and-bonus work in the automatic screw-machine department, the following results had been obtained:

On 169 tasks the average production was 179.3 per cent. of the old production under piecework.

On 208 tasks the average labor cost was 59.6 per cent. of the old labor cost under piecework.

For 12 operators the average wages were 138 per cent. of the old wages under piecework.

When considering these gains, the reader must remember that before the task-and-bonus work was started the automatic department was a good example of the usual shop organization. It was systematically handled and the piecework prices had been intelligently set.

The Feeler Gage and Its Use

BY GUSTAVE A. REMACLE

The mechanic, once he has learned to make use of the feeler gage, would not care to be without one. These instruments cost but a trifle, and the reason that all machinists and tool makers do not possess one may be laid to the fact that they do not realize the many uses to which it may be put. Just a few of these applications are mentioned in the following article.

In Fig. 1 is shown the simplest application of this tool—measuring a small slot directly with one or more blades. If one or more blades are to be used, they should be measured with the micrometer. If three blades, 0.007, 0.008 and 0.009 in. respectively, are placed together, they may not measure exactly 0.024 in., as they may be kinked or dirt may exist between them; but when tested with a micrometer the operator is sure of the exact dimension.

At A in Fig. 2 is shown the application of two blades for measuring the slot in a gage, while at B several are used in conjunction with a ground parallel to determine the width of a larger slot. These blades are hardly to be relied on for measuring a gage when finishing, but are used when milling the opening and later when grinding, to determine the progress of the operation.

I have removed the blades from the holder, finding that I can use them more conveniently when they are separate.

In Fig. 3 is shown how a step upon a piece may be measured if there is no other convenient way of doing so. The step may be gaged very accurately by this method if

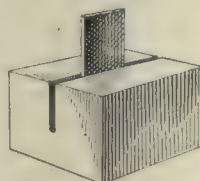


FIG. 1

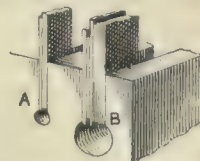


FIG. 2

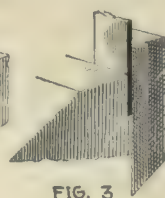


FIG. 3

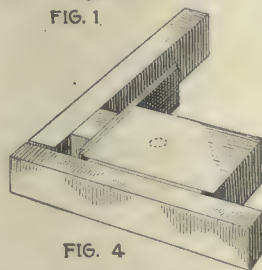


FIG. 4

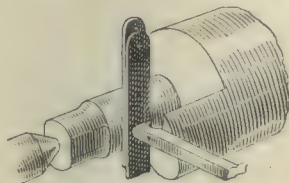


FIG. 6



FIG. 5

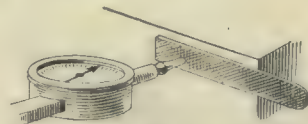


FIG. 7

VARIOUS APPLICATIONS OF FEELER GAGES

the straight-edge can be applied as shown, the operator feeling with the blade. If the job is of such form that the straight-edge cannot be used, the operator can place the blade in position and determine with the aid of a magnifying glass which blade is the same width as the step.

In Fig. 4 is shown how the blades may be used when a master plate is to be accurately shifted. By clamping parallels against the sides of the plate and applying the blades as indicated the plate may be shifted to a certain definite point.

A mechanic was given the task of making the plunger for a dashpot, one of the requirements being that the plunger be a certain number of thousandths less in diameter than the hole in the pot. As he had no micrometer or other instrument which would register the dimensions of these parts in thousandths, he was at a loss to know how he could obtain the desired result with plain calipers. I lent him my feeler gage and told him how to use it. With the aid of the inside caliper the outside caliper was easily set to the dimensions of the pot. Using a blade equal in size to the difference between the hole in the pot and the desired size of the plunger, and applying it as shown in Fig. 5, the mechanic easily machined the plunger to the proper dimension.

In the making of a number of spiral facing tools, such as shown in Fig. 6, I found the feeler gage indispensable. It was required that I cut a number of angular grooves

on the face of these cutters, the first groove to be a certain distance from the mandrel. The rest of the grooves were supposed to be spaced equally. Owing to the helical surface upon which these grooves were to be cut there seemed to be no other good method of properly locating these grooves other than that which I shall describe. It may be well to say that the graduated dials on the lathe on account of their inaccuracy were useless.

The distances between the tool and the mandrel for each of the different cuts were carefully calculated and noted, and the blades were applied as shown in Fig. 6.

Various bodies or parts of machines may be moved and the distance traveled measured, as shown in Fig. 7. If it is desired to move the carriage of the lathe say 0.023 in., a test indicator should be placed so that the point rests at right angles to the side of the carriage. A 0.023-in. feeler-gage blade should be placed as shown, the indicator being adjusted so that it registers zero. By removing the blade and advancing the carriage until the indicator again registers zero we know that the carriage has been advanced 0.023 in. Of course the feeler blade may be dispensed with if the indicator accurately measures in thousandths.

Lack of Adequate Clamping Devices in Toolrooms

BY HERBERT M. DARLING

We are constantly hearing a cry for greater efficiency and lower costs of production. This call extends to the toolroom as well as to the production departments of the modern shop. One important detail, however, seems to escape the eye of the management in many plants. While the production workers are well supplied, the tool makers are often obliged to get along with a most insufficient equipment of clamping devices, such as bolts, straps, clamps, etc.

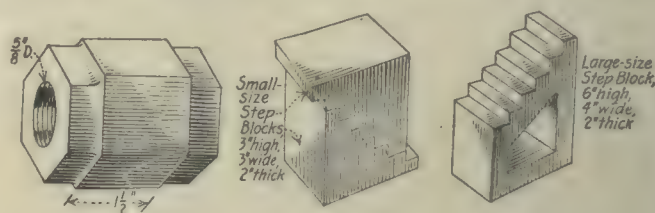
In most toolrooms it takes twice as long as it should to set up a job, if it is in any way complicated, principally owing to the fact that the workman has to search the whole department to get enough bolts, straps, blocking or clamps. This condition does not apply to any one shop, but seems to be general. In my experience in about twenty shops through New England and the Middle West I have found only two that provided their men with an adequate supply. And I might say that these two were the only shops I have found where any competent person is directly responsible for the condition or care of such clamping devices or where there are proper storage facilities. In most shops it seems the usual thing for bolts and straps to be left lying about the floor, benches and elsewhere until the helper takes a notion to pick them up and throw them all into a rough box beneath the bench, or some equally inaccessible place.

In a large shop I believe the best plan is to furnish a number of bins or racks, with each one marked for its respective size of bolt, strap or clamp. This set of racks may be in the toolroom, where the men can help themselves without the bother of tool-crib checks. But the men must be made to understand that they must return the articles to the rack after using. In addition to this, some competent person should be responsible for the condition and care of the equipment.

In the small shop one of the handiest devices I have seen is a truck about 30 in. high and 30 in. wide by 50 in. long. The top is divided into pockets for various

sizes of bolts, nuts, washers, etc. The lower part is similarly divided for straps and blocking, and on each end is a rack, in which to hang long bolts. This truck may be wheeled about the room to different machines and greatly facilitates setting up jobs.

The saving of time effected will soon pay for the installation of some system of storage and care, especially for bolts and nuts. Frequently the threads of bolts and nuts become stripped, or "bugged up." I know one shop that had a mixture of $\frac{5}{8}$ -in. U. S. S. and sharp V-bolts in the milling job. This caused a hopeless mix-up and a constant flow of "cuss words." In another shop (which by the way employs 7,000 men and covers 60 acres) one of the experimental rooms had a lot of $\frac{1}{2}$ -in. carriage bolts for clamping purposes. After a number of weeks a few $\frac{5}{8}$ -in. T-bolts were supplied. Numerous other instances could be cited to show that more thought should



FIGS. 1 AND 2. COUPLING AND STEP BLOCKING

be given to the selection and care of bolts. A valuable but little used article is a coupling, Fig. 1, that will make two short bolts into one long one.

Another thing lacking in many shops is blocking to go under machinists' straps. The men generally have to resort to all sorts of makeshifts—odd pieces of iron and blocks of wood. I know of one big shop where the favorite scheme is to pack up with milling cutters stood on end. By making cheap wooden patterns, two different sizes of step blocks, Fig. 2, could be provided in sufficient quantities at small expense.

As for the straps—I often wonder where all the good forged straps go that I see advertised in the *American Machinist*. In many places the strap is an odd piece of cold-rolled stock, with a bolt hole drilled in it. In addition to straight straps, the modern shop should have forged U-straps, gooseneck straps and other special shapes that may suggest themselves.

We must come to the conclusion that far too little attention is being paid to this matter. Superintendents or managers should not think that the shop is well provided for, merely because the shop foreman occasionally puts in a requisition for bolts, nuts or washers. The chances are that a lot of tool makers at 50c. an hour are spending a half-hour a day hunting for means to clamp their work. This wasted time would soon pay for the systematic storage and care of such tools.

In Soldering Electrical Apparatus. a writer in "Power" points out that nothing but a rosin flux should be used, as it is free from injurious acids and is a fair insulator. It can be applied in lump or powdered form, or as a paste by dissolving it in alcohol. There are several handy combinations of rosin-solder on the market, such as a slender tube of solder filled with rosin so that in use the flux is applied as the solder is melted and applied. Prepared soldering pastes and fluids may be bought, all of which are more or less satisfactory and convenient to use. A strong acid solution can be made by dissolving scraps of sheet zinc in muriatic acid, a little at a time to avoid generating too much heat, taking care not to inhale the acid fumes.

Precision Work in Manufacturing Aeroplane-Motor Parts

By FRED H. COLVIN

SYNOPSIS—The severe demands made on aeroplane motor make their manufacture a much more exacting problem than many realize. The limits of weight and the continual demand for maximum power are two difficult factors that enter into the construction of connecting-rods and valves. This article describes a few methods used in the making of such parts.

The combination requirement of light weight and maximum power continued for long periods makes the motor problem for the aeroplane one of considerable difficulty. Bearings must all be fitted closely and yet it is impossible

Some of the methods used to insure that the two bearings in the connecting-rod are perfectly parallel are shown in Figs. 1 and 2, these representing the practice of the Thomas Aërmotor Co., Ithaca, N. Y.

The connecting-rod is of forged steel of I-section and finished all over. The ends are rough-bored, the large end lined with its special bearing metal, and the rod is then ready to have the two holes lined up with each other. This is being done for the present in the small lathe shown in Fig. 1, the head stop of which is raised by the large cast block shown. The tool post is raised in a similar manner in order to carry the electrically driven grinder shown in position at *Z*. The plate *X* is mounted on the base plate, and a suitable counterweight is clamped in position as shown, so that the work may revolve smoothly.

The connecting-rod bearing *A* is clamped against the lower end of the plate by the strap *B* at the connecting-rod end. The piston-pin end of the rod is located against the hardened stop *C* and clamped against it by the strap *E*, while the screws *DD* locate it centrally from each side.

When the small end of the rod has been properly located, this being tested by an indicator to insure the hole being true with the lathe spindle, the grinding machine is put to work and the hole ground to the proper size.

After the hole has been ground to size, a piston pin is put in position for locating the small end of the rod in the boring fixture shown in Fig. 2. The pin *A* is located

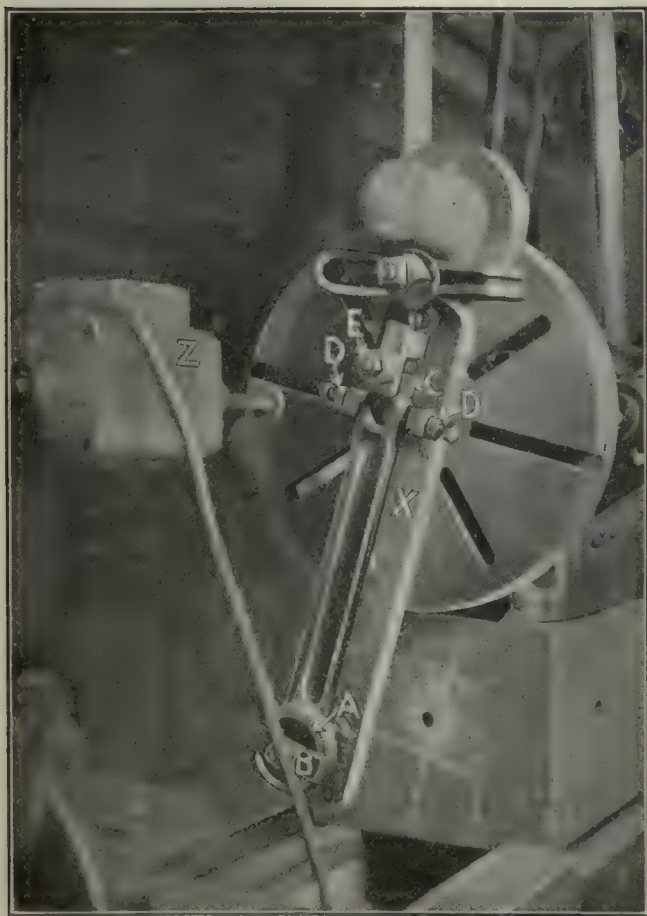


FIG. 1. GRINDING PISTON-PIN HOLE

to send out a new motor with the bearings nearly as stiff as in an automobile, in which the motor soon wears itself to a good bearing. This can readily be done by driving the car slowly and easily while the "wearing-in" process is taking place. In the case of the aeroplane, however, it is necessary to have practically constant motive power, and this must be kept fairly close to the maximum in most cases, effectually preventing any wearing-in while the motor is being used, and necessitating careful fitting when the motor is finally set up for actual duty.

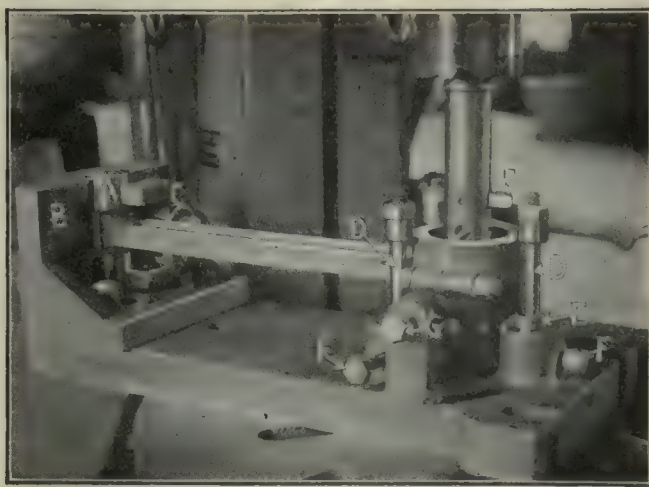


FIG. 2. FINISHING CONNECTING-ROD BEARING

in a V-groove cut in the block *B*, and is held in position by the forked clamp *C*.

This practically allows the large end of the rod to float. The three shouldered studs *D* form floating stops which are brought up into contact with the lower side of the rod end by means of the shoulders *E*. After these studs have been moved into contact with the rod, they are fastened by the screws *F*, so that they then become solid locating shoulders. Sidewise adjustment is secured by means of screws on each side, one being shown at *G*. This prevents any springing of the rod in clamping.

The large end of the rod is then ready to be finish-bored, with the assurance that this bore will be parallel to that of the small end carrying the piston pin. A single pointed cutter is used for this finish-boring. After it is

Fig. 5. Here the pusher *A* is supported in the block *B* and adjusted by the small screw *C*. It is held between the parts *DD*, the whole arrangement being mounted in the frame *E*. The handle *F* allows the movable part of

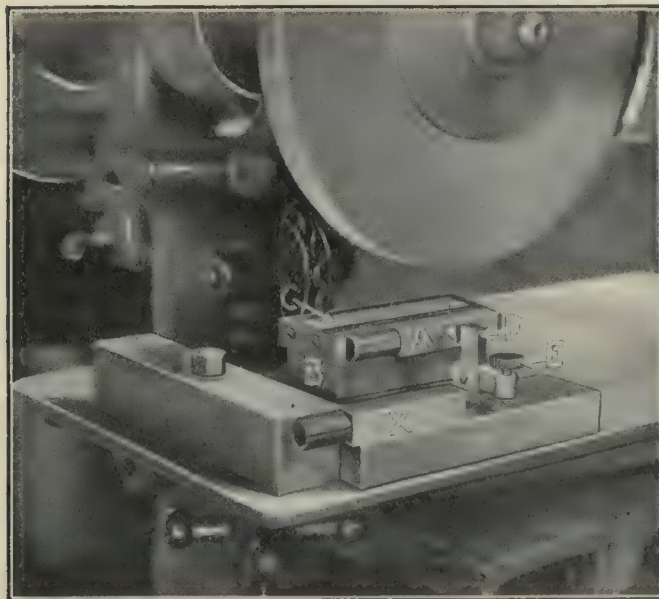


FIG. 3. GRINDING VALVE PUSHERS

bored, this cutter is removed and a facing cutter put in place, as shown at *H*. Sweeping the face of the rod bearing in this way assures its being square with the bore.

This would seem to be unnecessarily precise work on connecting-rod bearings, but the makers feel that it pays, in order to insure a smooth-running and long-lived motor.

GRINDING VALVE PUSH RODS

A neat little device is used for finish-grinding the push rod or pushers which operate the valve. These pushers are made from square stocks and have one end turned round as shown at *A*, Fig. 3. They are rough-ground and come to the small hand surface grinder shown, for finishing. Figs. 3 and 4 give a good idea of the grinding fixture in which the pushers are mounted. It consists primarily of a block *B* that has a suitable ledge in front to receive the square edge of the pusher, and a 90-deg. V-groove in the top as at *C*.

The pusher is held in place for the grinding of the sides by the clamp *D*, Fig. 3. This is a small bell crank that has a sharp front end and an adjusting screw *E* at the back for forcing the pusher into position against the shoulder in the fixture block. This point clamps the piece nearer the upper side, and as the bearing is at the lower opposite corner, tends to force the pusher down into position so that it will be uniformly seated at all times. The holder carrying the pusher is then moved under the grinding wheel until the desired size has been obtained.

REMOVING SHARP CORNERS

After the four sides have been ground to the desired size, the pusher is laid in the V-groove, as shown in Fig. 4, and the sharp corners removed by passing it under the grinding wheel. There is no specific size for this, the object being simply to remove the extremely sharp edge. The same letters are used in Figs. 3 and 4.

The rounded end of the push rods, coming in contact with the raising cam, is ground in the fixture shown in

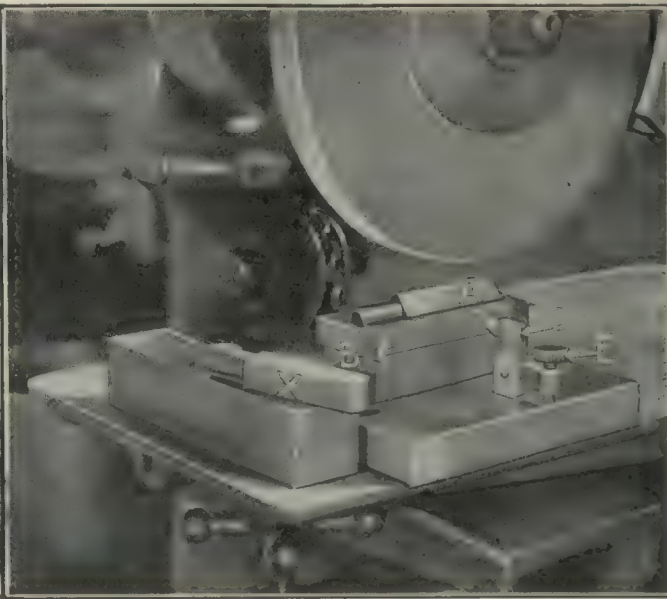


FIG. 4. GRINDING THE CORNERS



FIG. 5. A SIMPLE AND EFFECTIVE GRINDING FIXTURE FOR FINISHING THE RADIUS

the device to be brought under the wheel, so as to grind the correct radius on the end of the pusher. It is a simple device and works so efficiently as to merit more general adoption.



The Tensile Strength of Test Pieces taken from steel and iron sheets in the direction of rolling is greater than that of test pieces taken at right angles to the direction of rolling. In general, the reverse of this is true with test pieces taken from rolled brass. Further, the greater the reduction of the brass sheet by rolling the greater the comparative strength of the test piece taken across the grain.

Old-Time Tools and Mechanics in a New England Shop--II

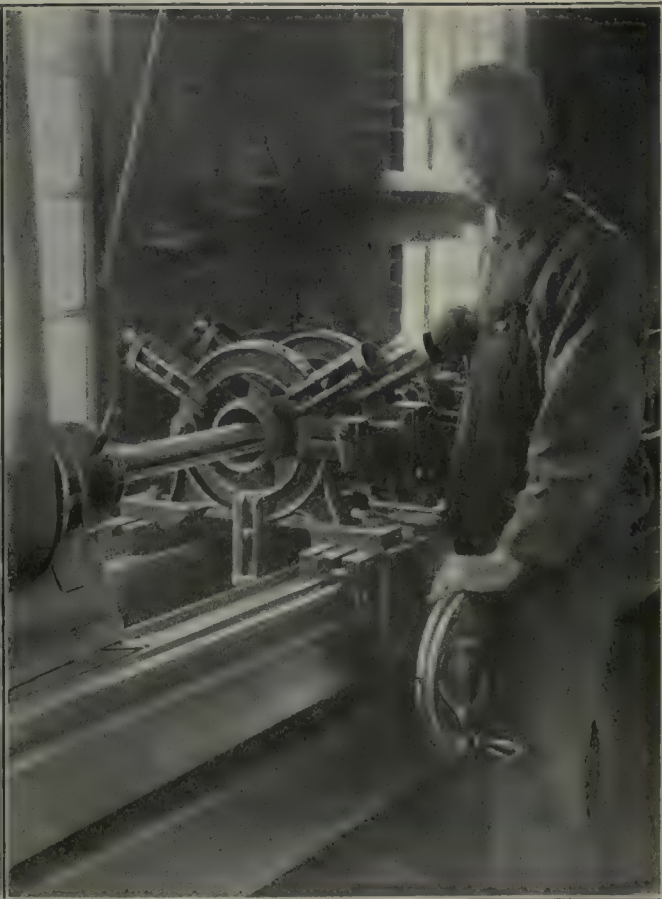
By FRANK A. STANLEY

SYNOPSIS—Some details are given here of the careers of a number of mechanics in various departments, who have been in the organization 45, 50 or more years, in most cases losing no time whatsoever from illness, accident or for vacations. The pattern maker has been 46 years in his department, and he has in constant service a wood-working machine that dates back 40 years before his own period at the shop.

It is interesting in connection with the previous description of machine tools dating back nearly a century to be able to present a brief sketch of certain personalities that have played an important part in the hand-

personally, as a part of their own experience, pretty much all the history of the development of machine tools in this country. This means also that their experience has been contemporary with the development of many other lines of machine manufacture too numerous in detail to cover here. Such articles as modern guns and rifles, the steam locomotive as we now know it, the present-day steam-power line and the complete line of electrical apparatus, the steel-hulled steamship, textile and shoe machinery and hosts of other things, many of which go back only 40 or 50 years, are recent institutions as compared with certain developments taking place during the lifetime of these individuals.

At the Douglas shops, Middletown, Conn., there are at least five men now actively engaged in machine opera-



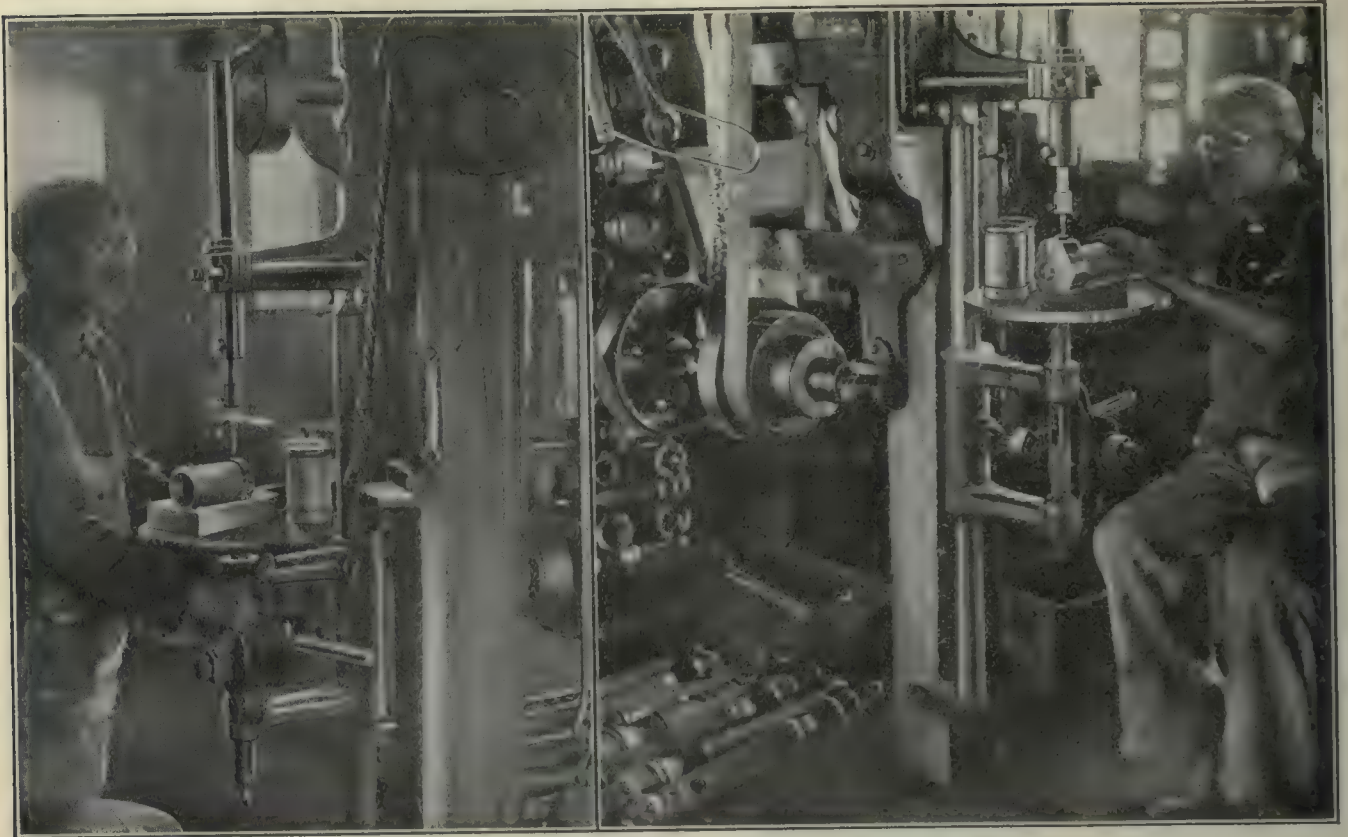
FIGS. 5 AND 6. TWO MACHINISTS WITH A RECORD OF OVER 50 YEARS EACH IN THE DOUGLAS PLANT

ling of the routine work through the shops. New England, of all sections of the country, has been the original home of the machinist and other shop artisans. Although our most highly developed factories, employing today thousands of workmen, seem to have on their rolls comparatively few men who are getting up toward the 65- and 70-year period of age and are still actively engaged in shop operations, nevertheless there are notable exceptions.

Some of these old-time mechanics who are still employed at the bench or in machine operations can recall

tions who have had in the neighborhood of 50 years or more of practically continuous service with the company and who are apparently good for a number of years more.

The man standing at the old lathe, Fig. 1, is Henry F. Raynor, foreman of the brass-finishing department, who came to this shop in 1873, over 43 years ago, to serve his apprenticeship. He has been employed at the plant ever since in some capacity or other as a machinist or a department foreman. While his period of service of nearly 45 years seems a long one for active



FIGS. 7 AND 8. CHARACTERISTIC DRILL-PRESS WORK

work upon the part of a mechanic, it is actually only about half the period during which the lathes shown have been used in the same shop with satisfactory results.

Another workman with almost exactly the same period of activity in the shop is Frank S. Hull, shown by the lathe in Fig. 4. Mr. Hull has been connected with the machinist trade for over 50 years, but his service with the Douglas company is only 44 years. Mr. Hull served his apprenticeship with the old Pelton company, which made hollow ware in Middletown many years back. Later he worked at the Finklie & Lyon sewing-machine works in the same town, so that while he has put in over a half-century in the machine business, it has practically all been in the Middletown district. It is usually more or less risky to undertake to bestow upon individuals titles based upon seniority in service or

upon some similar qualifications, owing to the impossibility of establishing each and every detail of the facts when it is necessary to search back for a half-century or more for data. I feel entirely safe, how-

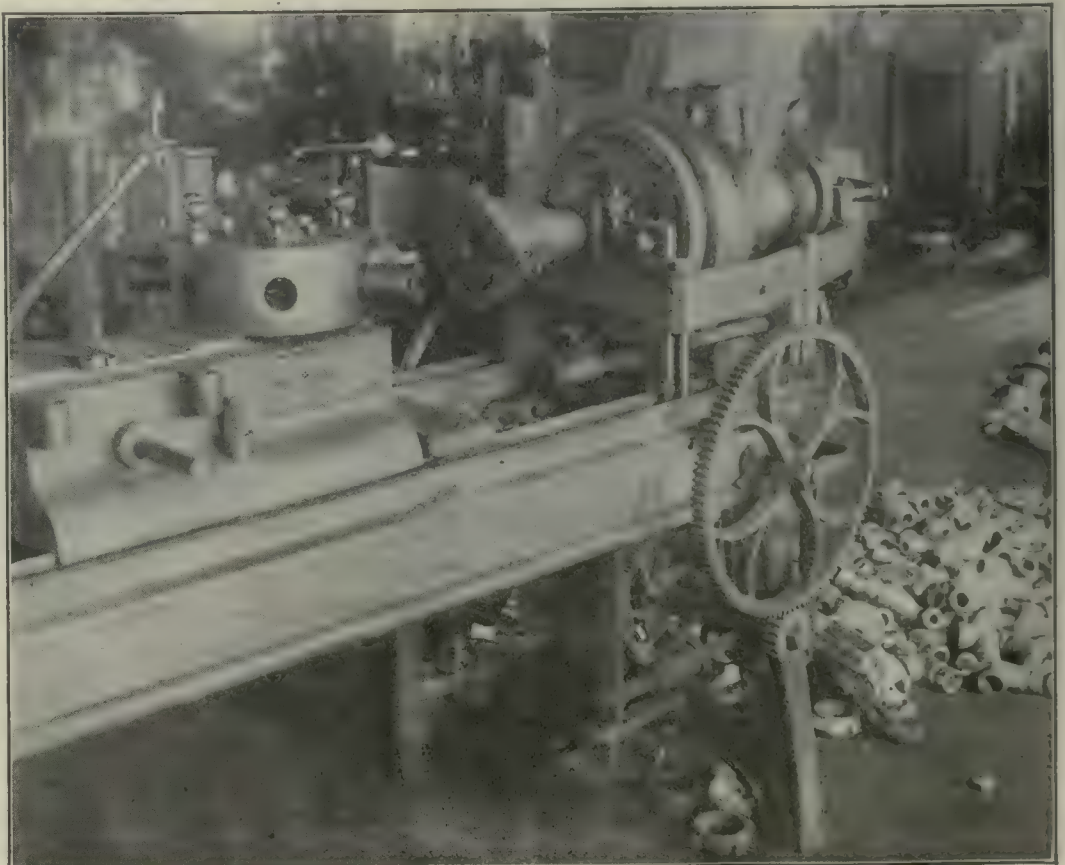


FIG. 9. A PATTERN LATHE, ONE END OF WHICH WAS BUILT IN 1832

ever, in calling the two men shown at work in Figs. 5 and 6 the associate deans of the machinist trade in Middletown, as each of these gentlemen has had a little over 50 years' experience at his vocation.

Frank A. Simons, operating the brass-finishing lathe seen in Fig. 5, served his apprenticeship in this shop and in a period of service of over 50 years has lost only four weeks' time all told. He has never taken a vacation and has never been absent from the plant, other than for the four weeks mentioned, except for a portion of a day or so once in a great while, waiting for cast-

It hardly needs pointing out that the lathe on which Mr. Hedges was working at the time this photograph was taken is not one of the old-time group especially illustrated herewith, but is a typical lathe of fairly recent design, here used for boring out pump cylinders.

The old-time drill press in Figs. 7 and 8 serves for putting oil holes in boxes, drilling small holes in pump bodies, bases, etc., and is operated by a German machinist, Louis Siegel, who, though born abroad, is an American citizen. Mr. Siegel has had only 36 years' experience on this kind of work with this company; hence

he may be considered quite a junior in point of service, although he has rounded out a period of nearly three-score years and ten, most of which has been spent in the Middletown district. Few comments are necessary regarding the drilling apparatus. It consists of the usual form of old-time post drill, with head bolted to a stiff wooden upright, and a table carried on a saddle adjustable up and down to suit the height of the work and the travel of the drill spindle. The driving pulleys and shaft are carried by brackets attached to the rear of the post or column, and the free side of the post is utilized to mount a sheave wheel over which passes a rope attached at one end of



FIG. 10. OLD ENGINE LATHE FITTED UP FOR TURRET WORK

ings or other material to come to his department for finishing. His only period of lay-off—the four weeks mentioned—should be explained as having been due to a lame knee (not a shop injury), requiring confinement in the hospital. Aside from this he has never missed a day from illness nor taken a day's time for the pursuit of pleasure or personal business.

The fourth machinist of the group whose portraits are included in this article is S. W. Hedges, now occupied as machinist for over half a century, who has had a little more variety in his shop life, although almost all of 50 years have been devoted to the manufacture of pump parts in this plant. He did, however, as a boy, work for the Remington Arms Co., at Ilion, N. Y., shortly after the time when that firm started to develop the typewriter. About this time E. Remington, proprietor of the plant, sublet a contract for carbines for the Turkish Government to the Savage Arms Co., then located in Middletown, and young Hedges returned to his native town to work on this job. Shortly after, he entered the employ of the Douglas company, where he has remained ever since.

the work table; at the other is a counterweight for balancing the table, to admit of easy control.

Turning now to other departments than the one in which these five men are employed, Fig. 9 illustrates a turret lathe built up by applying a special saddle, slide and turret to one of the old-time engine lathes constructed in this plant many years ago. As this is a rear view of the lathe, it gives a more thorough idea of the feed gearing than can be had from the somewhat indistinct photographs in Figs. 1 to 4. It also shows clearly the driving connection for the feed screw (the latter having been removed while the carriage is in use) and the open end socket for it, shown directly beneath the special chuck on the spindle.

The character of the work handled on this lathe will be obvious upon inspection of some of the parts lying upon the floor, although these are only a small portion of the great variety of castings finished on this and similar machines. The work-holding fixture is really a form of two-jawed chuck in which one jaw constitutes a part of the chuck body, while the other or loose jaw is so connected with the swinging yoke or strap which locks

the chuck for operation that when the latter is released the chuck jaw may be opened. The work is then dropped in place, the swinging clamp turned back into position, the setscrew tightened and the work firmly gripped for operation. This type of work-holding fixture or special chuck is used for many different castings, as only slight modification is necessary in the pattern or in the cast body itself, to adapt it to any special job coming along in large enough quantities to justify ending on the turret lathe.

AN OLD PATTERN LATHE

The last illustration in this group, Fig. 10, shows an old-time pattern makers' lathe, actually built on the premises in 1832. As a matter of fact, this is a double-ended lathe, and only the right-hand portion of the machine was constructed as long ago as the date given. At that time the machine had no metal ways, consisting merely of two heavy timbers mounted upon suitable supports and carrying the headstock and tailstock upon a flat upper base. In 1863 this lathe was rebuilt, and flat metal ways or shears were attached to the upper faces of the wooden bed, these being flat strips of wrought iron $\frac{3}{4}$ in. thick by $2\frac{1}{4}$ in. in width. At the same time the bed was made longer (it was originally only about two-thirds of the present length), and the other head and tailstock, shown at the left-hand end, were added. A new headstock was built with a black-walnut cone, a material common enough in the sixties, but as many manufacturers are now discovering, exceedingly rare at the present moment when such enormous quantities are required for gunstocks.

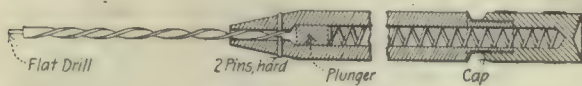
In connection with this pattern-shop illustration it may be mentioned that the machine department of this plant has no monopoly of the men with many years of local experience of a mechanical nature. There are one or two still engaged in the foundry who can boast of about a half-century of actual work at molding pumps in this plant. The pattern maker, Henry P. Bliss, who has been here since 1870 (46 years), came here as an apprentice boy and has made pump patterns ever since.

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A Spotting Tool

By F. J. DITTMAR

The accompanying illustration shows a tool designed to take the place of a prick-punch in laying out accurate work. It is often desirable to limit variations of drilled holes to say 0.002 in. or so. In prick-punching intersecting lines of a piece of work that has been laid out, the mark is seldom correct. With this little tool, which is light and sensitive, one can feel the cutting point strike



SPOTTING TOOL

first one line then the line intersecting. If held fairly vertical and pushed downward rapidly, the little flat drill at its end will cut a mark, not merely produce an indentation. Its correctness is easily determined with a magnifying glass. There will be no burr, nor a confusing rim of displaced metal to misguide the workman. The point is easily kept sharp with an oilstone.

Support for Crankshafts While Scraping

By P. G. LITTLE

In scraping bearings and fitting connecting-rods to crankshafts it is desirable that the pins be accessible and the work the correct height. The illustration shows a support for this purpose that is used by a concern making a great number of automobile motors. It will be seen that the support is fastened to the workbench so that all tools, etc., are at hand.

A cast-iron bracket A is drilled to suit the holes in the crankshaft flange and attached to a 2-in. tube that



SUPPORT FOR CRANKSHAFT

is fitted to a base fastened to the floor. The crankshaft is connected to the bracket by bolts or pins. At the front end of the crankshaft and fastened to the bench is a clamp that is made as shown in the sketch.

It will be found that the foregoing method is a far quicker and better one than fitting the connecting-rods to the crankshaft after it is in place in the crank case.

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Surfacing Thin Gages

By J. B. MURPHY

A week or so ago one of the men had a number of thin, flat gages to surface on the No. 2 Brown & Sharpe surface grinder, using a magnetic chuck. It seems he had a great deal of trouble, owing to the gages "buckling"—rising up in the middle. He finally tried placing two sheets of paper under the work, on the face of the magnetic chuck, and obtained very satisfactory results.

The gages were about 4 in. long, probably an inch wide, and about $\frac{1}{16}$ in. thick. There was something like 0.010 in. to be removed. As all the gages were required of the same thickness, it became imperative to find a remedy for "buckling," lest a gage be ground too thin in an effort to take out kinks and buckles. By way of experiment, I afterward tried wetting a cost card and placing it under a piece of thin gage stock on the grinder. This also seemed to give good results. Still, I have not tried it far enough yet to wish to go on record with a positive statement. These little "kinks," though, often point the way to bigger things.

Metal-Working Machines in the Scandinavian Markets

By LUDWIG W. SCHMIDT

SYNOPSIS—A brief review of the industrial conditions in Denmark, Norway and Sweden, with especial reference to the markets for machine tools.

The industrial life of northern Europe has undergone many changes during the last few years. The new conditions do not date back merely to the beginning of the war, but were noticed much earlier. They are the result of the rapid expansion of the European markets—England, Germany and Russia particularly. This expansion has made it possible for the northern European countries to take up manufacturing on a larger scale than before. While they have all been considerable importers of all kinds of merchandise, they have now begun to export on a large scale. Their export, however, is not in every case the same. While Sweden and Norway are showing an increase in the export of manufactured goods, Denmark, which is less developed industrially than the two other Scandinavian countries, has mainly exported foodstuffs. Germany and England have been her best customers. This predominance in the production of foodstuffs, however, has enabled her northern neighbors to export articles of manufacture to Denmark. In fact, both Sweden and Norway have found a good market in Denmark in consequence of the cheap export facilities offered in both cases by the short sea route.

While, therefore, the market of Denmark for metal-working machines and machine tools has always been small, at least before the war, the Norwegian and Swedish markets have been very active. This activity was much increased when the war broke out. American export statistics have shown that both those countries and also Denmark have increased their orders for metal-working machines in an astonishing way. While it is not unlikely that a part of the machine tools shipped via Norway, Denmark and Sweden may have finally reached Germany or Russia, it is a fact that the consumption of such machines has increased in the countries mentioned.

THE SCANDINAVIAN INDUSTRIAL FIELD

It is hardly possible to divide the economic field of northern Europe into political units, as there is a close interdependency, especially between Norway and Sweden. Commercial agents frequently cover both markets, and the class of business done is practically the same in both countries. This statement also applies more or less to Denmark. The business in American machine tools in the Scandinavian market is generally not very much different from that in most of the other European markets. Where there exists a highly developed metal industry, there must be a certain demand for high-class machine tools. The Scandinavian manufacturers have well realized the advantages offered by the American machines, even if the American maker as a rule has not been able to compete in price.

Before the war American machine tools were something of a luxury. Agents had to persuade manufacturers to pay the higher prices, and the superiority of the American

model had to be shown before an order could be secured. The war has changed this attitude. Scandinavian manufacturers keen to execute the orders coming to them either from their own markets or from abroad had to expand. They had to enlarge their producing capacity, and this necessity entailed the increase of their machine-tool equipment. For a while there was a possibility of securing English and German machines. A good many of those possibly were in stock, and it is a fact that German machine tools of the heavier type were still exported into Sweden and Norway for quite a while after the outbreak of the war. This business has now come to a standstill. An industrial exhibition held shortly before the war brought a good many orders to continental builders, who seem to have executed them. Later, when that supply dried up, only American machine tools were left. The influx of such machines has been large and has considerably changed the machine-tool equipment of the country in favor of American designs. The higher price was paid less unwillingly than before the war. Also, the more severe conditions of the American makers were met more readily.

CREDIT CONDITIONS OF THE SCANDINAVIAN MARKETS

English and German firms were fairly lenient with their sales conditions before the war. Since then this situation has altered, provided any business has been done at all. In former times machine tools could be got with four and even six months' credit terms. The latter, however, was not the general rule. Importers and machinery dealers very often had to meet the convenience of their less well-to-do customers. Smaller machinery users were accustomed to get machines on the installment plan, and the importer had to carry part of the risk. The usual way to transact this sort of business was for the importer to pay a certain part in cash and give the manufacturer notes for the rest. Importers as a rule demanded credits of from 60 to 90 days. An allowance of 2½ per cent. was made for 30 days' payment. Special cash rates also were given.

At present, credit conditions are more or less unsettled. Importers and manufacturers in those countries have done their best to keep up a system suitable to the interests of the trade, but the American makers, having plenty of orders on hand, have so far not been inclined to make more than the most necessary concessions. If the business is to be retained in the hands of American manufacturers, it will be absolutely necessary, after the war, to meet the demands of the market with regard to credit facilities. This most likely will entail the reform of the present banking facilities and the employment in American banks of men having a good understanding and personal knowledge of the market.

It has been pointed out that Denmark is not a large market for machine tools of the more expensive kind. Business has been brisk during the last few years, but exceptional circumstances have brought about exceptional results. Generally speaking, the Danish metal industry is not a large one. Many men are employed in it, but

a great percentage of them are small artisans doing repair work only. Further, there are plenty of wagon builders, lock makers, etc., who have a local custom and earn a good living, but can hardly be considered prospective buyers of first-class American machine tools. There is, however, a possibility that Denmark might become after the war an excellent market for hand tools. This is a line of export that is not developed as thoroughly by the American manufacturers as should be the case. Denmark buys in peace times also American agricultural machines. The replacement of parts of those machines and the repair of European agricultural implements and machines make necessary well-equipped repair shops. The difference between the American repair shop and that in Denmark, however, is that human labor plays so considerable a part in the latter. Before the war England and Germany were taking care of that business very well. The sales of American machine tools in Denmark have been averaging during the years before the war about \$60,000. The increase in orders during the last two years can hardly be regarded as a guidance for further business.

While the commercial and industrial activity of Sweden is possibly more pronounced than that of Norway, the latter country has made great progress during recent years. This progress had to be made in the face of heavy competition from outside, which is felt by all the Scandinavian countries in the same degree. All these markets are suffering somewhat from growing pains. Their commercial and industrial apparatus has developed more quickly than they could follow. As an example, the case of a Danish firm building railroad equipment may be mentioned. This concern complained about foreign competition. To meet the situation and to keep this important business in the country, Parliament decreed that for a period of 15 years 80 per cent. of all railroad material should be bought in Denmark.

METAL-WORKING PLANTS IN NORWAY

Norway has not carried this policy so far. A protective tariff, however, gives sufficient help to the Norwegian manufacturer. Also in Norway there is a strong national sentiment. The result of all this is that Norway has been able to build up in a short time a large industry. In 1914 there existed in Norway 853 plants connected with the iron and machinery trade, having together nearly 30,000 workmen. This industry is greatest around three points. The most prominent is Christiania, with well above 200 plants and about 8,000 workmen. The second is Trondjem, with about 50 plants and nearly 2,000 workmen; and finally Bergen, with somewhat over 100 plants, but mostly of a smaller size. Christiania and Bergen have a number of shipbuilding yards, of which the most important ones are situated in the first-mentioned city.

The awakening of the national spirit in the Scandinavian industries has much benefited the importation of metal-working machines and machine tools. An extension of orders for the iron and metal industries naturally must bring also an increase in the necessary equipment. American manufacturers therefore will watch with interest any development in this direction. This predominance of the national sentiment in the Norwegian market, however, also has certain disadvantages. While the two northern Scandinavian nations have many things in common, differences in the national languages which in former

years were not so marked, make it now necessary for the manufacturer to send catalogs printed in Swedish and Norwegian.

The Swedish metal industry is very powerful for the size of the country. According to recent domestic statistics the Swedish machine shops produce railway material and cars of a value of about \$4,000,000 yearly; electrical machinery, \$8,000,000; other motors, \$5,000,000; pulp and paper machinery, \$1,000,000; agricultural machines, \$4,000,000; and dairy machines, \$4,000,000. The total, including others not mentioned, is about \$35,000,000. The iron and steel exports have reached \$20,000,000.

The Swedish shipbuilding industry is fitted out only for building vessels of medium and small size. It is, however, very busy, and there is no reason why it should not become important. The end of the war undoubtedly will bring a large demand for new ships, and in this case the northern European countries will receive their share of the large orders for new bottoms which will come into the market. Rumors about the formation of new companies to take care of this business and the extension of older concerns have been frequently afloat, but nothing definite seems to have materialized as yet. Both Sweden and Norway have done a considerable part of the carrier trade of the world during the war and will continue to do so, possibly taking care again of the routes more outside the course of the international liners. Such a development naturally would bring a large demand for machine tools for use in shipyards.

The outlook for Swedish agricultural machinery seems to be very good. This industry, especially represented by a concern making cream separators that sell over the world, realizes the advantages of specialty manufacturing.

Of course, there is no doubt that the end of the war will bring an increased competition in the machine-tool business. Germany will do everything possible to regain the market she has lost, and with England is well equipped to take care of the Scandinavian trade.

American firms wishing to do a large business in these markets will be well advised to employ native agents in preference to special representatives. While the latter during occasional visits may do much to help the interests of their principals, both by studying the market and by closing actual sales prepared by local agents, only the native house as a rule has that personal influence with the buyers which is necessary to build up a trade. Several foreign concerns working in this market have obtained good results for their foreign principals, who include some in the United States. Their success, however, is frequently based on their wisdom in employing managers of Scandinavian birth.

Manganese for Hardening Aluminum Castings was made the subject of a paper presented at the last meeting of the Institute of Metals, and it was pointed out that various combinations containing manganese with or without copper and with a minimum aluminum content of 95 per cent. have been used in foundry practice for the past two years with gratifying results, the use of manganese in relatively small quantities hardening the alloy without destroying its ductility, as in the case of copper or zinc. The paper stated that alloys of aluminum containing manganese have been found to work very freely in cold rolling or hot forging. The same type of ingot molds is used in preparing aluminum for forgings as for brass forging ingots. In making drop forgings from aluminum a little preliminary forging is desirable. The ingot can be cut or dropped and forged to approximate shape at a temperature from 1,150 to 1,200 deg. F., after which it can be finished in the dies.

Plant of Honolulu Iron Works

SPECIAL CORRESPONDENCE

SYNOPSIS—Machine shops in distant places of necessity adapt themselves to the needs of their surroundings. So it is not surprising to find a Hawaiian shop building and repairing sugar-making machinery. This article tells a little about one such shop.

The Hawaiian Islands, lying 2,200 mi. southwest of San Francisco, have long been one of the principal cane-sugar producing sections of the world. Of the present industries on the island, sugar is by far the most important, although the manufacture of fertilizers and the production of rice and coffee, and the raising of pine-

In the early days of white settlers on the islands, Honolulu Harbor became the principal rendezvous for the whaling fleets of the Pacific Ocean, and with the establishment of steamship lines between America and the Orient, Honolulu became the principal port of call for steamers sailing east and west. With this increase in ocean travel, and with improvement in lines of communication between the various islands in the group, marine repair work became important. Much of this work is attended to by the Honolulu Iron Works, which is situated close to the waterfront.

The first shop of the company was erected nearly three-quarters of a century ago. Some interior views of the present plant are shown in the illustrations, Figs. 1 to 4.



FIG. 1. MAIN MACHINE SHOP OF THE HONOLULU IRON WORKS

apples, bananas and certain other fruits are carried on.

Coincident with the growth of the sugar industry, there has been a marked increase on the islands of machine and foundry work, to keep pace with the demand for mechanical equipment adapted to the crushing of cane and the manufacture of sugar.

Situated as it is in the midst of this important industry, the Honolulu Iron Works Co., established in 1852, has experienced a constant development and growth, until today it employs about 600 workmen in its principal plant at Honolulu. It also maintains a branch factory at Hilo. These shops manufacture complete lines of equipment for sugar factories and, in addition to the machinery built by them for sugar mills on the Hawaiian Islands, ship machinery to all parts of the world.

A view showing the greater portion of one of the main shops is given in Fig. 1, which conveys an excellent idea of the size of this section of the plant and illustrates some of the heavy tools. It also shows the heavy character of the work turned out, and in conjunction with other views presented in Figs. 2, 3 and 4, illustrates some of the equipment used in sugar factories, particularly in the line of crushing apparatus for cane.

In Fig. 1, the heavy lathe is shown set up for turning and grooving crushing rolls. This machine is kept constantly at this kind of work.

One of the big overhead traveling cranes is seen in Fig. 3. This shows the handling of a crushing roll ready for placing in the machine that is being erected along the right-hand side of the building. Fig. 2 shows the

same machine in process of erection, but with fewer rolls in place than in Fig. 3. Both of these engravings bring out clearly the heavy character of sugar-mill housings, and show the big broad-faced, coarse-pitch gearing for driving the rolls. These views further illustrate the variety of operations on boring mills, slotters and drilling machines near the left-hand bay of the main shop.

The foundry occupies a building of approximately the same dimensions as the machine shop. A good general view of the equipment is given in Fig. 5. This foundry produces all of the castings furnished in the establishment and turns out a big line of special work for all purposes relating to sugar machinery and other industries of the Hawaiian Islands and faraway countries of the world.



FIG. 2. SUGAR-MILL MACHINERY UNDER ERECTION ON SHOP FLOOR



FIG. 3. SUGAR-CANE CRUSHING TRAIN WITH ROLLS IN PLACE



FIG. 4. A VARIETY OF SMALL MACHINE TOOLS IN THE SIDE BAY

In all of the interior views referred to, a number of big pipe sections and connecting members are seen lying about on the shop floor.

The bay, illustrated by Fig. 4, is fitted up with smaller machine tools, and the nature of the work generally handled in this department is pretty well represented. This view, like the ones preceding it, shows the general feature of shop construction, including the heavy girder columns along the main bay for supporting the crane rails, the lattice columns and girders at the side with the angle-roof trusses and the corrugated roofing. A system of suspension for lineshaft and countershaft hangers is clearly shown, as is also the method of belting from line to countershaft and from counter to machine spindle.

Like the machine shop, the foundry is equipped with massive overhead cranes, and the big ladles can be readily transported to any part of the building for pouring molds wherever set up. This foundry casts flywheels running up to 18 or 20 ft. in diameter and weighing 25 or 30 tons each, and pours big sugar-mill and engine housings and bedplates and turns out pump beds and cylinders of almost any capacity.

A view in the forge shop, showing the big steam hammers in the center of the building and the small forges along the sides, is presented in Fig. 6. Each of the hammers is served with a long-armed jib crane equipped with convenient trolley and hoisting apparatus. The furnaces for heating heavy work are not seen in this



FIG. 5. GENERAL VIEW OF FOUNDRY OF THE HONOLULU IRON WORKS



FIG. 6. A FORGE SHOP, SHOWING STEAM HAMMERS AND FORGES

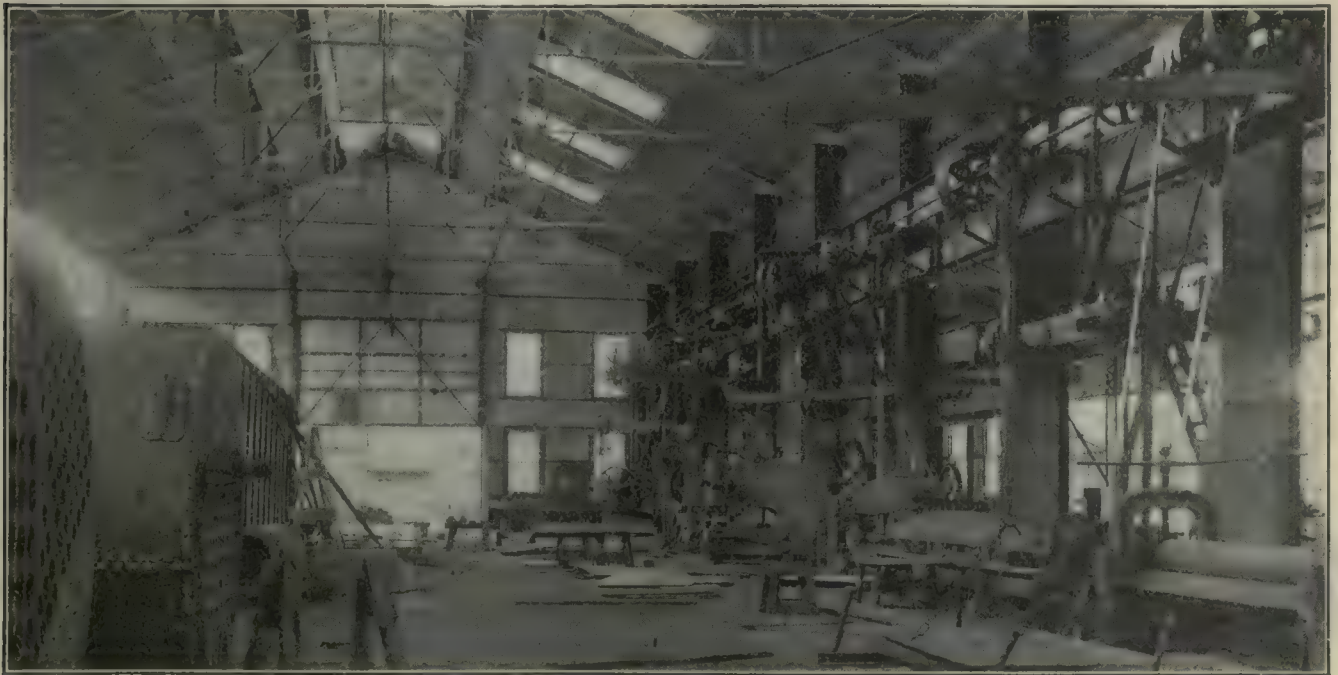


FIG. 7. BOILER SHOP AND A PART OF ITS EQUIPMENT



FIG. 8. VACUUM PAN 13 FT. IN DIAMETER

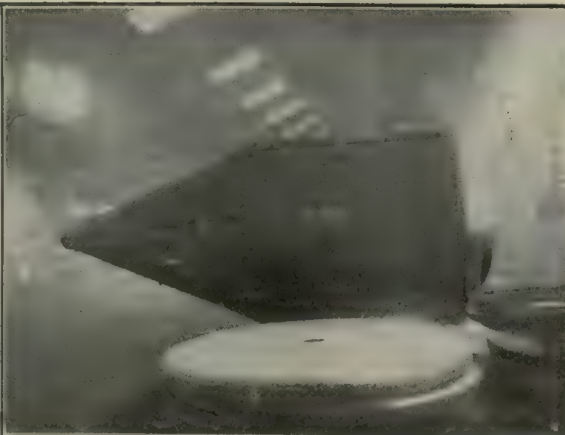


FIG. 9. HUGE CONICAL SETTLING TANK WITH SECTIONAL CYLINDRICAL BANDS

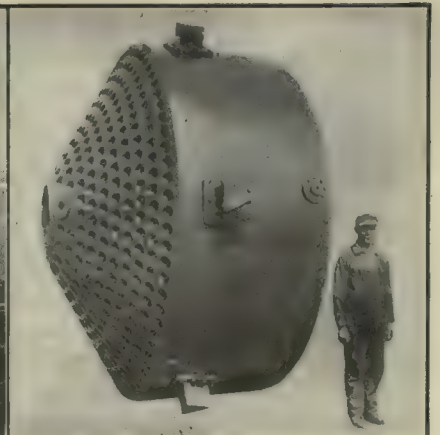


FIG. 10. 13-FT. CALANDRA FOR VACUUM PAN

view. The marine work forms an important part of the operations attended to here, and the equipment is heavy enough to take care of shafts, stern-frames, rudder parts and other ship-repair jobs, in addition to the regular line of forgings required for cane-sugar machinery.

THE BOILER SHOP AND ITS EQUIPMENT

A view of the boiler shop is seen in Fig. 7. Like the other buildings in the plant, this shop is of corrugated metal with big skylights overhead and large window areas in the side and end walls. Climatic conditions in Hawaii make it possible to keep the great doors and windows open almost all the year round. So far as practicable, shop buildings are erected with a view of admitting air from all directions, so that much of the work is carried on under conditions similar to working out of doors, except that the roofing provides shade and protection against rain.

This shop builds boilers of various types and sizes and turns out big tanks of special shape as required at the mills, such as the immense cylinders required for cylindrical and conical tanks used in the sugar industry. The general nature of the equipment, the overhead crane service, the lineshaft-drive method of rigging cranes and hoist require no explanation.

Some of the apparatus made in this shop is shown in Figs. 8, 9 and 10. Fig. 8 illustrates a 13-ft. vacuum pan in process of erection. Fig. 9 shows a big settling tank with a cylindrical body for half of its length, the remainder being in the form of a cone. Such tanks are made in large numbers and its general proportions will be seen upon comparison with the equipment near-by. At the bottom of the structure there are two cone-shaped members 13 ft. in diameter, with a great number of tubular openings in the conical lower surface and the necessary bosses to form a seat for the pipe connections. The shells of these cone-shaped members are made in sections with flanges, as indicated, to receive the plates which hold the parts together. In erecting such apparatus, jacks are placed underneath the cone to support the structure and it is then built up as a single unit on the shop floor. The method of attaching the upright angle bars and connecting the sectional cylindrical bands is clearly represented.

Fig. 10 shows a conical member with a workman standing alongside and gives a definite idea of the true proportions of this big piece of apparatus, which is known as a calandra.

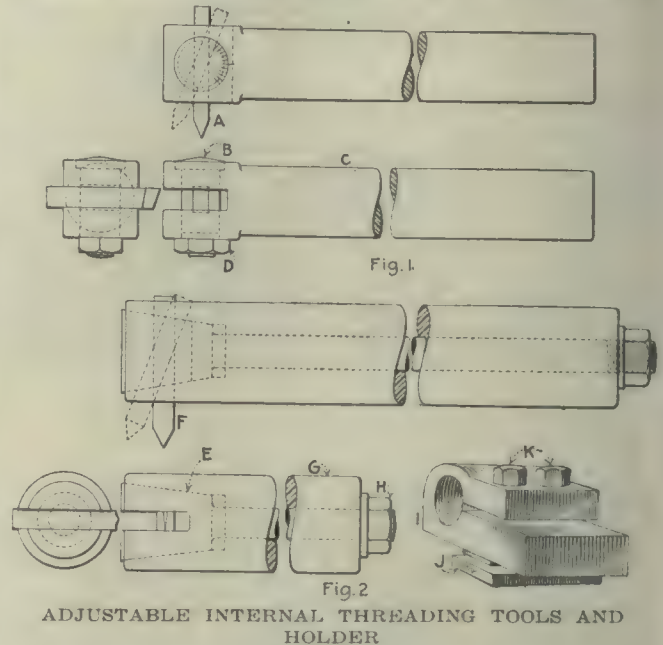
Internal Threading Tools

By W. BURR BENNETT

Two very satisfactory tools for cutting internal threads are shown in Figs. 1 and 2. Each consists of a case-hardened and ground machine-steel bar, of proper length, with a small inserted bit of tool steel. They are for use in a lathe, and a holder for each is shown at *I* in Fig. 2. This holder is in the form of a clamp and is made with a tongue that fits in the tool-post slot on the carriage. A plate *J* serves as a nut for the cap screws *K*. When the bar is in place and these screws are tightened, the whole is rigidly secured. The cap screws *K* have a clearance hole through the holder.

In Fig. 1 the inserted tool *A* is fitted in a slot in the stud *B* so that when the nut *D* is loosened the tool can be swung through a 90-deg. arc and its movement can

be read from the graduations on the head of the stud. This also serves as a means of setting the tool to a predetermined angle. When the nut is tightened the tool is clamped in the bar *C* and is ready for use. In Fig. 2 the tool *F*, which is held in the slot of the taper collet *E*,



has considerable horizontal adjustment when the nut *H* is loosened. The slot in the collet registers with the slot in the bar *G*, and the tool, passing through both, keeps the collet from rotating when the nut is tightened.

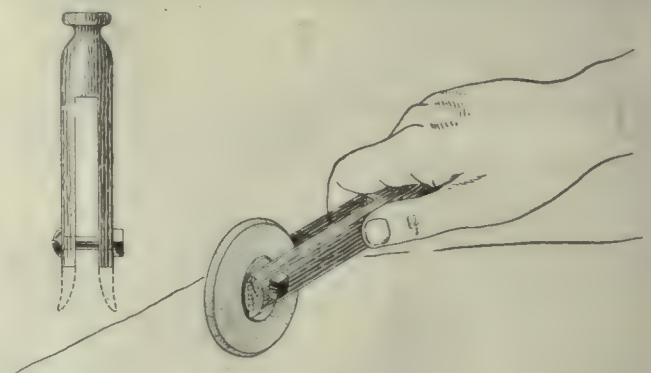
An Erasing Kink

By ERNEST A. ANDREWS, JR.

Every draftsman is familiar with the irksome labor involved in erasing ink lines on tracings. It is especially hard when using a circular eraser.

The illustration shows a kink that will help considerably to reduce the tired effect on the fingers because of gripping the thin eraser and rubbing at the same time.

Take an ordinary wooden clothespin and after cutting away the flared portion at the end drill a hole large



CIRCULAR-ERASER GRIPPING DEVICE

enough for a $\frac{6}{32}$ button-head screw through both lips of the pin. Insert the circular eraser in the slot of the pin, push the $\frac{6}{32}$ button-head screw through the pin and the eraser, screw on the nut and the eraser is ready for business.

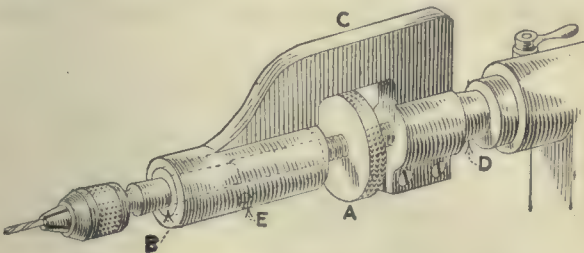
Letters from Practical Men

Method of Mounting Detail and Operation Sheets

The Becker Milling Machine Co., Hyde Park, Mass., has adopted an interesting method in its drawing-room system. Quite a number of firms employ operation sheets to control the work when manufacturing various elements. The common practice is to mount these element details and operation sheets on separate cardboards and shellac them. They are then sent out to the shop for use by the workmen. The Becker company has introduced a better method. It mounts the detail on one side and the operation sheet on the reverse side. By this procedure the danger of losing either sheet is lessened, and the cost and number of boards are also reduced.

New York City. A. TOWLER.

withdraw the drill in a sure though delicate manner. When the drill requires lubrication (a critical point when drilling with a small drill), vibration can be easily felt, through the touch of the operator's fingers on the screw A. A keyway is milled along the part B, which is a good sliding fit in the part C. A small screw E acts as a key



SENSITIVE DRILLING ATTACHMENT

Sensitive Drilling Attachment for the Bench Lathe

The accompanying illustration shows an excellent attachment for use in drilling small holes in the bench lathe. Ordinarily when drilling very small holes many drills are broken, owing to the lack of a delicate means of advancing the drill into the work. Push-spindle tailstocks are sometimes used for such drilling; but while these are sensitive enough, they lack the firm, steady push of the screw.

In the attachment shown the screw A has a right- and left-hand thread that enables the operator to advance or

and prevents the part B from turning. This attachment fits the tail spindle of the bench lathe and should be made carefully if it is to do good work.

Newark, N. J. A. G. ACKMER.

English and Metric Drill Table

Finding need in the shop and drawing room for the accompanying comparison table, I think that some of your readers may also be interested in it. The table is helpful where both the metric and the English standards of measurement are used.

New York City.

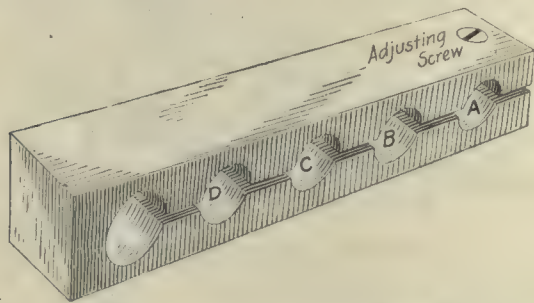
COMPARISON TABLE OF NUMBER, LETTER AND MILLIMETER DRILLS

Number and Letter Drill			Number and Letter Drill		
No. Drill	Mm. Drill	Decimal Equivalent	No. Drill	Mm. Drill	Decimal Equivalent
1	5.7	0.228	23	3.9	0.154
2	5.6	0.2244	24	3.8	0.1535
3	5.5	0.221	25	3.7	0.152
4	5.4	0.2205	26	3.6	0.1496
5	5.3	0.2165	27	3.5	0.1495
6	5.2	0.213	28	3.4	0.147
7	5.1	0.2126	29	3.3	0.1457
8	5.0	0.209	30	3.2	0.144
9	4.9	0.2087	31	3.1	0.1417
10	4.8	0.2055	32	3.0	0.1405
11	4.7	0.2047	33	2.9	0.1378
12	4.6	0.204	34	2.8	0.136
13	4.5	0.201	35	2.7	0.1339
14	4.4	0.2008	36	2.6	0.1299
15	4.3	0.199	37	2.5	0.1285
16	4.2	0.1969	38	2.4	0.1259
17	4.1	0.196	39	2.3	0.1221
18	4.0	0.1935	40	2.2	0.120
19	3.9	0.1929	41	2.1	0.1181
20	3.8	0.191	42	2.0	0.116
21	3.7	0.189	43	1.9	0.1142
22	3.6	0.1889	44	1.8	0.113
		0.185			0.111
		0.185			0.1102
		0.182			0.110
		0.1811			0.1065
		0.180			0.1063
		0.1772			0.104
		0.177			0.1024
		0.1732			0.1015
		0.173			0.0995
		0.1695			0.0984
		0.1693			0.098
		0.166			0.096
		0.1654			0.0945
		0.1614			0.0935
		0.161			0.0906
		0.159			0.089
		0.1575			0.0866
		0.157			0.086

Adjustable Step Lap for Plug Gages

Generally, a lap is made with one lapping hole in a round or rectangular piece of stock. Having at one time 100 plug gages to make, 0.308 in. in diameter, I made two laps out of a rectangular piece of gray iron $\frac{3}{8} \times \frac{5}{8} \times 3$ in. long, drilling and reaming four holes 0.308 in. in diameter, with an adjusting screw at the end to take up wear as needed.

These holes became a series of steps in sizes retaining the difference in their wear when lapping—that is, the lap when started is adjusted to the end hole A. The lap is used at this hole until it refuses to cut. The plug gage is then entered into hole B without distributing the ad-



STEP LAP FOR PLUG GAGES

justment. This hole is used up, and the plug gage is passed to holes C and D, which have less to cut, but are progressively smaller.

As the holes were all one size to start with and as the plug gage becomes smaller at each hole, there is less wear on the lap as the plug is passed from hole to hole. The holes retain about the same proportions and save measuring for sizes very often, when rough-lapping the plugs to within 0.0001 in. of finish size. As a finishing lap for size, it will be a surprise in the few trial measurements required with the micrometer or ring gage.

There is a tendency among workmen to use an excessive rotary speed when lapping a plug or ring. A speed that will make the work just comfortably warm to the hand is about right. Speed above this rate has a tendency to bake the oil and abrasive, which is a detriment to smooth and fast cutting.

C. A. MACREADY.

Springfield, Mass.

A Plea for Signed Help Wanted Advertisements

When are manufacturers going to advertise for help over their names? Surely no firm should be ashamed of the fact that it is hiring men.

In one instance that came under my notice, I sympathized with a tool maker who answered such an advertisement. Unknowingly he wrote to a firm where he had once been employed while rather wanting in experience. The foreman showed the letter to at least one of the men in the shop and soon the news was spread. The man who wrote this letter never for a moment thought that it was going to the shop in question, otherwise he would not have written it. Neither did he think that his former shopmates would be privileged to enjoy a laugh at a communication that he considered confidential.

That affair went a long way toward curing me of writing to I don't know whom. While I regret that

I am deprived of the mail as a medium of applying for a position, the circumstances force me to resort to the method of making application in person; for then, I know to whom I am talking. When a tool maker seeks a position, he is really a salesman desiring to sell his services. He prefers to pick his prospective buyers, naturally choosing someone who may buy his wares. But when he answers an advertisement and does not know to whom he is writing, he is not to be compared with the salesman but rather with the peddler who roams the streets yelling his wares to any and all that may be within hearing.

Perhaps there is some just reason for firms advertising in this manner, but the fact that there are concerns that do not hesitate to reveal their names in their help wanted advertisements leads me to believe that they can all do so if they wish.

R. A. CHARLES.

Newark, N. J.

Decimal Thickness Table for Sheet Copper

Sheet copper is always designated, not by its thickness, but by the weight in ounces of a square foot. I am a designer in a metal-ware factory, where more or less copper is used. Orders always come through stating, "Use ——— oz. copper to make the following articles."

THICKNESS OF COPPER FROM 3 TO 253 OZ. PER SQ.FT.			
Oz. per Sq.Ft.	Decimal Thickness, In.	Oz. per Sq.Ft.	Decimal Thickness, In.
3	0.004	64	0.083
4	0.005	70	0.095
6	0.008	81	0.109
8	0.010	89	0.120
10	0.013	100	0.134
12	0.016	110	0.148
14	0.018	123	0.165
16	0.022	134	0.180
18	0.025	151	0.203
20	0.028	164	0.220
24	0.032	177	0.238
32	0.042	193	0.259
40	0.049	211	0.284
48	0.065	223	0.300
56	0.072	253	0.340

Formerly we had to go to the stockroom for a sample and measure it for thickness, so that we could make the correct allowances on our tools. To obviate this necessity, we compiled the accompanying table from sheet copper in stock.

H. B. KELLAM.

Buffalo, N. Y.

Feeler Gages

Thickness or feeler blades are usually made to fold down in a steel handle much like an ordinary pocket knife. Feelers are commonly used in connection with standard-gage blocks for setting tools. This arrangement of having the blades held together is inconvenient, because all the blades have to be opened up before the right one is found. It is also clumsy.

A more convenient method is to disconnect the blades and arrange them in a row in a folder made for this purpose, where each blade is plainly seen and the one wanted is quickly obtainable. The blades can be easily removed from the steel handle.

The folder is made from any stiff material such as duck or canvas and has two strips sewed across its length to serve as pockets. When not in use, it can be folded up and tied.

J. E. COOLEY.

Hartford, Conn.

Discussion of Previous Question

Why Not Same Hours for Office, Drawing Room and Shop?

There are some points on which I must disagree with the opinions given on page 125, Vol. 45. While it is true that the office man, in many cases, gets a vacation with pay and is on a salaried basis, it should not be forgotten that the same man, in nearly all cases, works free when overtime is required; and in some places this is by no means a small item.

Under heading No. 3, your manufacturer makes the statement that "the office force does not have to work nearly as hard as do the people in the factory."

I should like to know on what basis he measured work. Does he think that a man can only get tired by using his muscles?

A large portion of the shop man's work is cut out for him, while a considerable portion of the designer's and estimator's work requires concentrated mental effort.

Conversation, whistling, singing or moving about is a relief to the average workman and in the case of the shop man can do little harm in the noise of the shop. In the drawing room, however, these things are strictly prohibited or frowned on for the reason that the man who indulges in them takes his mind, more or less, from his work and also annoys his fellow worker, with a resulting lack in efficiency for all within hearing.

It has been usual for mill workers in the steel industry to work 12 to 14 hr. per day and six to seven days per week. The work is extremely hard under high temperatures, but is concentrated into short spells with periods of rest between.

There is no doubt in my mind that a draftsman could not work the same hours for years if for no other reason than that his eyes give out. I have frequently found by actual count that about 50 per cent. of the men in drawing rooms wear glasses. Many draftsmen and engineers after being in the business for a number of years become quite nervous.

I cannot understand item 4. Surely the writer did not expect a mechanic to go into the office and perform the office man's work and vice versa.

With regard to item 5 I fail to see why there should be more social intercourse between factory and office employees when their hours become the same. The employer does not pay his men for social duties during working hours, and when the whistle blows employees usually hustle for their cars and home.

My experience disproves the statement that no record is kept of how much work each one does. It is the usual practice to charge the time engaged on engineering work to the various jobs or job numbers, and some of the large places require a record of the time spent on each drawing.

As to the free use of the telephone, naturally the office man does not require as much time to answer a call as one who must be brought from the shop. However, the free use of the telephone is certainly not encouraged as it frequently interferes with important "company calls."

Some firms do not permit of its use during working hours, and some make a charge for its use at actual cost.

It is a fact that many firms consider the draftsman a nonproducer, which frequently means that in very many cases he is crowded into unsanitary and unsuitable quarters, sometimes with such a small amount of room that he can scarcely turn about.

In most cases the drawing room is very small compared to the shop, so that in itself gives it a cramped look. All these things combined have, in my mind, a tendency to make the working hours of a draftsman appear long, trying and tedious.

My own experience has been that it is not necessarily long hours that make work one long continuous grind, but that the working conditions and surroundings have more to do with it.

I can well recall an office where a day of less than seven hours under a "grouchy" boss, together with poor light, poor working tables and poor pay, appeared longer to me than at other places where the hours were 8½ and the bosses were pleasanter.

B. F. WARD.

Newark, N. J.

Where Are the Good Mechanics?

As Mr. Brophy observes on page 236, the good mechanics are few and far between. They are so because the old ones are fast wearing out and few efforts are being put forth to make new ones. The mechanics of the "old school" have seen this condition coming on for several years. They have talked it over much and often, with deep concern.

Formerly manufacturers took good care to secure the sons of their mechanics as apprentices, and these boys were carefully trained and taught, both by employer and father, as well as in many cases by an older brother who was following in father's and sometimes grandfather's footsteps.

Father was always glad for an opportunity to get his son into the shop to "serve his time" and took much pleasure in the attention devoted to the instruction of his own son so that he should become thorough and competent.

A boy who ran away and thereby failed to finish his time was disgraced. Neither would mechanics in other shops where he might try to pass himself off as a mechanic show him anything, so in most cases the runaway was forced to go back to complete his apprenticeship. Thus both employer and apprentice were protected and benefited.

It is quite different now. Fathers and older brothers offer every discouragement to sons or younger brothers who consider entering shops to learn, to be machinists. Why is this the case? This condition is largely due to the practice of manufacturers of breaking in men instead of making them machinists by the apprentice system.

Many young men after they leave school wander aimlessly about, driving delivery wagons, trucks or doing

some nice light work in offices or stores, until they begin to realize that they are learning nothing which will assure them an adequate income and that they have wasted from four to ten years of valuable time. They flock to the factories seeking a chance to learn something before it becomes everlastingly too late. Many such young men are taken in and broken in on some special job, good care being taken by the employer that they become expert in this one thing, which was formerly done by a machinist. Again, in too many cases the employer also takes care that these young men get no chance to learn anything else. The pay they receive is always far below that which would be paid to an all-around machinist. This process continues until soon the shop is full of such cheap labor. And the machinist must then work for like wages or get out.

These young men work hard and soon get to thinking that they have learned something that justifies them in asking for more money. When told that they are getting all they are worth (because their knowledge is so limited), they quit their jobs. Some other employer who is pressed for men hires these fellows for what they say they are and can do, always for a rate below that which would be paid for a machinist; and thus another machinist is displaced.

In this way some employers finally fill up their shops with, say, twenty-five or more operators or specialty men, all of them good on their own jobs, but none of them capable of doing anything else. And thus are twenty-five or more machinists crowded out.

All this has been seen and considered by the machinists of the "old school," men who have worked and struggled for what they now have—namely, a practical knowledge of and an experience with things mechanical, whereby they are able to perform that which the man who has been broken in can never know or acquire, because he has not pursued the right course to learn it.

It seems today as if the railroads are the only employers who are really and sincerely giving their apprentices a show. They awoke ten years ago to the fact of a coming scarcity of machinists, and some of them are now endeavoring with considerable success to recuperate their mechanical forces.

Why not have all the employers of a like craft in community or city combine to establish and maintain for apprentices a school similar to that of the New York Central R.R.? The writer would suggest this kind of training as a remedy.

I myself, being one who attended the "old school" and afterward advanced to an executive position, can fully appreciate the scarcity of good mechanics.

Indianapolis, Ind.

W. T. SEIDER.

The discussion on page 390 interests me. I am acquainted with an excellent all-around mechanic who had the form letter shown herewith printed and sent to two hundred manufacturers throughout the country (not munitions manufacturers) and received only three answers.

Mr. Manufacturer:

SUBJECT—MECHANICAL EXECUTIVE.

I am taking this unique way of placing my name before the manufacturer who is in want of a first-class mechanical executive.

I am an American, 45 years of age.

I have held the position of a foreman, assistant superintendent and superintendent for the past 25 years.

I have invented and patented a great many devices.

I have five patents before the patent office at present.

I have contributed a great many labor-saving devices to mechanical magazines.

Have been employed in the following lines: Builders' hardware, steel locks, cash registers, sporting goods, novelties, trolley supplies and electrical goods, fire-department supplies and general hardware.

I am well up on the following lines: Designing, drafting, pattern and models, tool making, finishing machine work, foundry, brass, gray and malleable iron.

I have been an executive with present company for past nine years.

I am well up on shop management and bonus systems, and have written a number of articles on these subjects.

In making a change, I wish to place myself permanently with some good company who can offer me a larger salary.

Yours very truly,

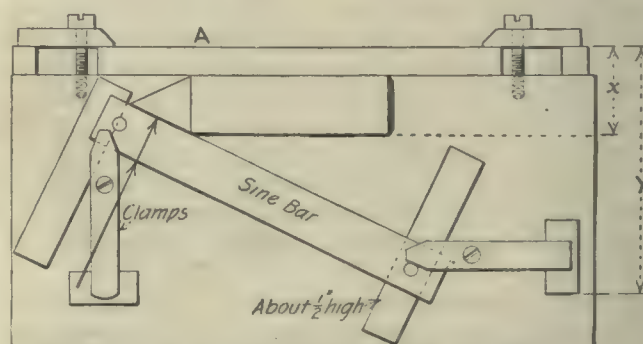
The letters were sent from a town of only three thousand population. What is the matter with this letter? Is it because he was in a small town, or was it his age? I would like to have opinions from the readers of the *American Machinist*.

A. E. HOLADAY.

Naugatuck, Conn.

Exact Angles for Lathe Centers

Replying to Mr. Greene's interesting article on page 298, I will answer the last query first. An error of 2 min. on a piece of such dimensions as is shown on page 298 would, if expressed, be in the decimal fraction of an inch, zero at the extreme point, increasing to 0.00072 in. at the base of the angle of which the point of the center is the apex. If, as is usually the case when using centers,



EXACT ANGLES FOR LATHE CENTERS

only a small portion of the center is used, this error may not be too great. But if for any reason whatsoever more accurate results are desired, they can and should be produced. Without resorting to highly elaborate methods a good gagemaker can reasonably be expected to produce a ground and lapped gage, such as the centers in question, with an error not to exceed 0.0001 in.

The accumulated error of Mr. Greene's three centers if they were 2 min. in error and all alike, would be a little over 2 thousandths and could readily be detected by the method he described. By testing in the manner just mentioned, the operator cannot be certain of the accuracy of the pieces until he is sure that the angles of all three pieces are exactly alike. The fact that the three pieces were ground with the same setting of the head of the grinder does not by any means give assurance that they will all be of exactly the same angle.

In the accompanying illustration is shown an excellent method of not only determining the accuracy of centers but exactly what error exists. Of course, other angles than 60 deg. can also be measured. A hardened and ground parallel A is clamped to the side of a surface

block. The side of the surface block to which the parallel is clamped is square to the face upon which the testing is being done. Two parallel pieces about $\frac{1}{2}$ in. high are placed under the sine bar to raise it to the proper level. The center or gage which is to be tested may be clamped in such a manner that it bears against the parallel and surface block. It will be well to mention that to test in this way the center should be ground while the shank is running dead true. The sine bar should be placed as shown, rubbed slightly against the gage and then while holding it firmly in this position it should be clamped to the surface plate. It is important not to disturb the location of the sine bar when clamping. It is also imperative that the pressure exerted upon the sine bar be delivered squarely to the side of the angle undergoing test and also be directed toward the center of the surface being tested, as indicated by the arrow. To properly locate and clamp the sine bar is the most delicate and important part of the entire operation, and the greatest care should be observed.

Two other methods of testing the pieces with the same rigging are to set the sine bar to the desired angle by measuring from the posts of the bar to the parallel piece, dimensions *X* and *Y* determining when the angle is correct, and then securely clamping them to the plate. By applying prussian blue judiciously, a very slight error may be detected. If a hole has previously been put through the plane surface directly under the point where the sine bar comes in contact with the center or gage, error may be detected by looking for light.

Newark, N. J.

GUSTAVE A. REMACLE.

✱

Young Men of Today--A Criticism

Mr. Brophy, in his remarks on page 269, seems greatly dissatisfied with the machinists that his and other large manufacturing plants are turning out. There is no doubt that the man who can tackle anything and get away with it is scarce nowadays. I wonder if Mr. Brophy has ever stopped to think of the little shop where the good mechanic of old days served his apprenticeship. I wonder if his boys have the doubtful pleasure of cleaning out the cupola, getting up the coke and iron, getting cussed by the molder, chipping the castings and finally seeing them through the shop, along with firing the boiler, watching the engine, helping the blacksmith, running errands and the like.

My own experience some 16 years ago in a large Corliss engine plant in Ohio gave me an opportunity to observe what small opportunity a boy has in a manufacturing shop. The first three weeks I faced nuts till I dreamed of them; the next two weeks was put in on governor shafts; then on the following Monday morning, when I could not see my lathe for valve castings corded around it, I fled to the little shop where there was everything in the repair line from grandfathers' clocks to 160-ft. windmills. You cannot blame the apprentice for seeking pleasure in the evenings as an escape from the monotonous routine stated above, for the apprentice is usually "still a boy."

To remedy this inefficiency I wish to make a suggestion: If Mr. Brophy will start a small repair shop in connection with his manufacturing plant, put in a first-class mechanic as foreman and let his apprentices

work there every other week, I assure him that this provision will afford the average boy enough pleasure. Moreover, the anticipation of the following week in the repair shop will keep the lad from getting melancholy while in the factory. I can see where such an enterprise would pay for itself.

RICHARD COWAN.

Crookston, Minn.

J. P. Brophy asks two questions that are really the vital questions for American mechanical trades to settle. Briefly, the questions are: "Where are the all-round machinists of former years?" and "Why do not the apprentice boys stay in the shops?"

Undoubtedly the allied trades of die sinking and tool making have taken a great many of the good all-round machinists of 10 years ago. The automobile industry has done so much to stimulate the drop-forging process that an unusual demand for die sinkers has been created. Every large shop now has a die-sinking department, and rather than train apprentices the practice generally prevails of taking in and teaching men who have shown themselves to be careful all-round men in the machine shops. Ten years ago tool makers were found only in the factories specializing in the manufacture of tools; other machine shops depended upon their all-round men to make what tools were necessary. Now, turret lathes, screw machines and automatics require so many special tools, and interchangeable systems of manufacturing require so many jigs and fixtures, that a great number of all-round machinists have been taken from the machine shops to supply the demand for tool makers.

There are three other minor reasons for the dearth of all-round machinists. Many have found greater opportunities and better pay in various divisions of the engineering profession. Most licensed marine engineers are all-round mechanics with more or less shop experience. Some employers are prejudiced against men who claim to be all-round machinists, claiming that there are no such men. Men seeking employment at their shops represent themselves as lathe, planer or miller hands in order not to create a bad impression; hence a few good all-round men are disguised by the machines they operate.

Lastly, we are not training all-round machinists in our well-equipped large shops. Several concerns—the Westinghouse, General Electric and Allis-Chalmers companies and the Pennsylvania R.R.—take in large classes of apprentices, but they become engineers, salesmen and executives rather than machinists. Railroad shops train a few all-round men, but they stay in the railroad business, so one does not find them in the factories.

In most shops after an apprentice has become used to his surroundings, has undergone the usual amount of hazing and horse-play and has learned to expect some absurd answer when he asks a question, he is put to work on a machine whose "internal workings" he has never seen. He clamps work into a jig that someone else made; sets a tool that someone else has forged, tempered and ground; takes a couple of cuts making the work fit the limit gage that he got by number from the toolroom. Then he repeats the process again and again.

Machinists are made by teaching, study and experience, and until American shops provide teachers, books and varied work for their apprentices there will be no more all-round machinists. The European War has shown what women and girls can do in specialized arms and ammuni-

tion manufacture. In several shops in this country they have done better and quicker work than men. Special instructors spent time and patience teaching them the principles and details of their work. If apprentice boys could be given one-tenth the instruction their sisters have been getting, our machinists 10 years from now would be the finest the world has produced.

The apprentice problem is an individual problem for each shop. Some shops cannot get apprentices enough, while others have waiting lists. One thing that is a necessity is a square deal for the boys. If, after a year in the shop, a boy is put on work on which others are working by the piece and making \$3 to \$4 a day, his 50c. seems rather small. The two years before he can get journeyman's pay seem an age, and nine times out of ten he will quit and go to driving a grocer's wagon, for which he may get \$8 or \$10 a week. Men of mature years will occasionally change their employment to get an increase of 300 per cent. in their pay; and unless the boy can feel that he is really learning something, he too is going to rise to the bait.

In the last three years I have had six young men as coal heavers and firemen who left shops after one year of apprenticeship. With what we could teach them with the small machine tools on board ship they have gone ashore and are now making good in shops as machinists, electricians and steam fitters. One of them is drawing—counting his bonus—a larger pay check than mine.

A man is only a boy plus experience. Attract the boy's interest to the history and romance of the manufacture of metals and mechanical processes, and he will find no spare time for dance halls and picture shows.

M. W. TORBET,

Lieutenant, U. S. Coast Guard.

Tompkinsville, N. Y.

The wail has gone up many times before that it is becoming more and more difficult to get hold of boys with brains to enter an apprenticeship of any kind.

When we think of "the happy days" when we started our four-year drill, how for the first three or four months the only tools we got a chance to use were a shovel and a broom, and how we were told to keep our eyes open and remember what we saw—all for the munificent sum of "four bits per"—we wonder why the kids of today do not do the same!

A little study might reveal some of the causes that have brought about such a state of affairs. We might consider the quality of the mechanic turned out today at the end of an apprenticeship. Anyone who has done hiring and firing for the past few years knows how very few real all-round machinists there are in existence. We have lathe hands, planer hands, shaper hands, miller hands, floor hands and so on, world without end, but not machinists.

There used to be a time, especially in the small shop, when a kid was shifted around once in a while from one machine to another and given a chance to "get next," but it is seldom the case now.

No youngster with any kind of a noodle wants to go into the shop and serve four years, sticking to one operation where he literally becomes a part of an automatic machine, with no chance to use what few brains the good Lord did give him. I think I am right in saying that most apprentice machinists get disgusted and quit because they are not given a chance to change once in a while.

The present-day machine-shop necessity, the price-time limit, has also had a great deal to do with knocking the gloss off a machinist's career. A shop with a slave-driving reputation has its own troubles in getting what few good men it has.

Another thing that has turned the twentieth-century kid toward the clerks or "shinies" is the fact that a clerk, no matter how far down his job may be, is tolerably sure of being known personally to the powers that be and feels, justly or not, that if he has the making of a good clerk he will be in line for anything that comes his way.

In nearly every concern (as we read in some recent numbers of your magazine) there is considerable discrimination in favor of the office force as against the shop. A kid leaves home in the morning, puts in an hour's work and then sees his neighbor kid come into the office. At 12:30 the lad in the shop hears the whistle to dig in again, and 30 minutes later he sees the office boy back from lunch. Then at 4:45 the office closes up, while our poor little machinist devil keeps drilling until 5:30. Of course, he should not notice a little thing like that, but he is human and cannot explain the difference.

Let us consider for a minute a foreign apprentice system. There the boys are put into a shop school part of their time and given the rudiments of a mechanical education. They are shown "movies" of shop operations, not only in their own line, but in other related departments, also "movies" showing dangers to avoid in handling machinery, how things are done and why. All during this course (two or three years) the records the apprentices make in study and shop are under observations by "the powers," and the ones that show ability and push are encouraged to get along as far and as fast as possible.

Last winter I visited a large technical school where a couple of hundred young fellows were putting in 9 and 12 hours a week in classroom, shop and laboratory. Each man was asked two questions: "Does your company by bulletin boards or otherwise encourage employees to take up night study?" "Do they make overtime or Sunday work less frequent for you on account of your school work?" The majority of the answers were, "No."

Many of our big corporations are opening schools of their own for their employees. In all our large cities there are such schools. If the employer would pay a part of their small expense and keep an eye on an employee's record, he would find a larger number willing to enter the shops, more loyalty and interest among the employees and receive a substantial percentage on the investment besides getting a line on the quality of "timber" in the works.

T. A. HUGHES.

Avalon, Penn.

Although I have read Mr. Brophy's theme, requesting the whereabouts of good mechanics, I cannot agree with some of his statements. Very few mechanics are looking for jobs at the present time; it's unnecessary. The jobs are looking for good mechanics.

In the old days it was unheard of for a shop owner to bring in green hands as laborers, and as they became familiar with the shop to place them on a machine and give them the same advantages as apprentices on this work.

Mr. Brophy would consider a man who could handle a planer, a miller and a lathe a very capable man, but would that man receive any higher wages or be dis-

tinguished in any manner from the specialist who has been on the same kind of work all his life and who could not handle another style of machine if his life depended upon it?

The remedy that I would suggest is to rate a man who has served an apprenticeship higher than the one who has not had such training.

B. A. DONLEY.

Renovo, Penn.

I have always read J. P. Brophy's articles with interest, and my perusal of his criticism of the young men of today on page 269 was no exception. It would appear that the young man of today, in starting out to work, considers his services slightly more valuable than did his father or grandfather, and I cannot help but think that in a measure he is justified.

Years ago, the boys going to high school were few in comparison to the numbers going today. They were sent from the grammar schools directly to work and became apprentices for three or four years, doing all kinds of labor, including general chores around their employer's home and taking the baby out for an airing. These boys lacked the training of the high schools in the very years in which they needed it the most. They also lacked the direct and exact teaching now given to our boys in the commercial and technical schools; even our grammar schools give instructions in manual training. It is safe to say that a boy from one of our trade schools is of more value eventually and can advance more quickly, especially in the mechanical trades, than could the apprentice of former years.

Very often the knowledge obtained by the apprentice was of the rule-of-thumb kind. This is often shown by the hard work he makes of it, when there is a special screw to cut or a taper to turn. The trained trade school boy not only knows how to get the correct results, but understands and can reason out the method. As a rule, these boys are at first jeered at by their fellow-workmen, especially by the old hands, and it is not to be wondered at if they find the old methods slow and of the cut-and-try kind. Many of the old hands had to pick up their trade by keeping their eyes and ears wide open and very often heard or saw only in part, so that when confronted by a new problem they are not sure of themselves and lose time by their indecision. It was because of these conditions, partly, that the time-study work and efficiency methods were adopted some few years ago in many large plants.

Our trade schools teach not only a particular trade, but its allied trades; for example, together with pattern making, instruction in foundry practice, machine shop and shop mathematics, all of which it is necessary that a good pattern maker should understand. To learn all this by the old apprenticeship methods would take years. Our schools, when run by a good, wideawake teaching staff, enable the boy to learn all this, and learn it more thoroughly, before he even applies for his first job.

This of course does not apply to the apprentice who is given classroom instruction along with his practical work. But this method is expensive, consequently the concerns that follow it are as yet few compared with the many others in which numbers of boys are starting out each year. It is therefore left for the boy to stand the expense of his own schooling, and those that do so should be recompensed for it when starting in to work.

While this latter form of apprenticeship is far in advance of the old-time system, the apprentice must not be content to stop his schooling with this alone, as the instruction thus given is often limited to a particular branch of the trade, is not of an all-round nature, and lacks that completeness which enables the young man to further teach himself.

It is also true that many trades do not encourage apprentices as of old, and in consequence of this a boy is handicapped in learning a trade and does not become a thorough mechanic. His fellow-workmen are not free in giving information and guard everything as a trick of the trade. A great many of these tricks are simply the details of the trade that require headwork and which are readily understood by any high school boy with the average training in mathematics, geometry, etc.

I have known of cases where trade school boys, while reasoning out and making short cuts, have been watched with jealous eyes by their foreman, who endeavored to learn from them what his own inefficient apprenticeship had failed to teach him. Are not these boys more valuable and consequently worthy of higher wages than were the boys of the old standard? Their education has been costly to them, while their employer immediately receives the benefit of it, whereas he formerly had to wait until the apprentice had very nearly finished his time.

I am strongly in favor of systematic training for young men desiring to become expert mechanics.

Thousands of dollars are spent annually in training young men for the professions; and it is for this reason that our dentists, for instance, are wanted in foreign countries because of their superiority over poorly trained home talents. On the other hand we want their mechanics, because they are well trained.

From considerations such as those I have given, I cannot altogether agree with what Mr. Brophy says in the article referred to at the beginning of this letter, for, while I agree that, as he says, times and conditions have changed, I think it a trifle unjust to attribute these changes to a falling off in the caliber of the young man of today.

M. T. SCHUMB.

Boston, Mass.



Standard Size Holes--Why?

In order to settle the question of whether it is better to produce standard size holes and vary the shafts to meet the requirements of the various fits, or to vary the hole size for the fit and keep the shaft standard, it is necessary to consider the conditions under which work would be produced in each case. The question was broached in an editorial, Vol. 44, page 1137.

If shafts (the entering parts) are taken as standard, what are the conditions of production and what tools and gages are required? The shafts would be turned or ground to standard gages of the "snap" pattern, and their production to fine limits would be a simple matter with standard machines and equipment. The size of the holes must then be varied to give the required fits; and to produce these an internal grinder, or boring bars and reamers, would be used. The tools required for this would be: Reamers for force, push and running fits (two or three of the latter if two or three classes of running fits are required) and plug gages for each of these sizes.

If the standard hole is taken as the base, one reamer and one gage only are required for each standard size of

hole, and a number of gages are required for the differing shaft diameters.

Now what are the advantages or disadvantages of each system?

In the first case a large stock of reamers must be carried with a large initial outlay and high cost of upkeep, but worn reamers for the running-fit holes could be ground and used for the push and force-fit sizes so that they would have a long life. It would be necessary for manufacturers of reamers to increase the size of their reamers to make them over standard, and also for them to make and stock three or four sizes for each standard dimension. A large number of gages would be required, but these would be of the plain cylindrical type, easily produced but not easily made adjustable for wear; although these, like the reamers, could be reduced for other sizes.

The shafts for this system could be easily produced with standard equipment, and only one gage for each standard size would be required.

In the second case only a small stock of reamers is carried, although as the same number of holes are required the reamers are subject to more wear and the upkeep would be about the same as for the first case. It is probable that the life of the reamer for this system would not be so long as for the other system, but a solid reamer can usually be "peened" and reground a few times and can then be reduced to the next standard size when badly worn. When finally "out of commission" it can be annealed and the steel used for a yet smaller size, while if the reamer is adjustable it would last quite a long time. Only one gage is necessary for each standard hole, but for the shafts, which are produced under the same conditions as in the other case, a number of gages are required. These can easily be made adjustable or with removable gage points which can quickly and cheaply be replaced.

Considering the two cases together, it seems to be really a question of reamers; and whether it is better to have a large initial outlay and be able to grind each reamer three or four times before starting to "peen" (set up)—that is, reduce it from the running-fit size to the force-fit size—or to buy about one quarter the number of reamers and peen before each grinding.

From this point of view the advantage appears to be with the standard hole, especially as in a modern manufacturing plant the work is not usually such as to require the frequent use of force, push and running fits for the over-standard size. A reamer, say 1 in. in diameter, when worn too small for the running fit may never be required again, as a 1-in. push or force fit may not be used. In such a case the reamer upkeep cost would not be reduced.

The two cases given in support of standard size shafts in the editorial on page 1137, Vol. 44, would hardly stand when fully considered, for the expense of producing holes of varying diameter would be exactly the same as for standard holes. The former would have to be made to limits the same as the latter, and the operations of line reaming, scraping and fitting would be just as necessary. The line reaming on assembly may just as well produce standard holes as holes a few thousandths over standard if the same limits are used.

Again, is it always the case that the driving fit part on a shaft is at the leading end when assembling? If the shaft was made standard, it is quite possible that in a number of cases the shaft would have to be forced for the

whole of its length through the smaller size hole, or caps be fitting to the bearing, although in both this case and a number of others where caps are at present fitted, the design is at fault and not the system.

Nottingham, England.

ALBERT F. GUYLER.

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How Far Can Supervision Replace Skill?

Though all the articles written lately, with the purpose of giving reasons for the disappearance of the good mechanic, contain some truth, still I am of the opinion that the main reason is stated in the editorial on page 435, "How Far Can Supervision Replace Skill?" Not only the indicated New England shop, but also hundreds of other manufacturing concerns have been earnestly endeavoring for the last decade to replace high priced labor with a combination of higher and poorer paid labor and have done so to their own financial advantage. I know of a medium-sized shop where there seem to be more bosses than workers. The owner has within three years replaced half a dozen good tool makers and a score of all-round machinists by one boss tool maker, a draftsman, a squad of lathe hands and several girls. The lathe hands so long as their services are required for tool work act as tool makers under supervision of the foreman and draftsman. Otherwise they do odd jobs on their lathes, machines or supervise a squad of girls, who are really efficient at the price, six dollars a week. The mistakes made worry the life out of the supervising mechanics, and the advantage of such methods, to the community as a whole, is doubtful, but only comparisons of payroll and actual output concern the manufacturer and they are of such a nature that his verdict cannot but be: Good mechanics are not wanted.

It is the old self-adjusting question of supply and demand, and but for the extraordinary conditions caused by the European War, the growing scarcity of good mechanics would have been unnoticed.

Brooklyn, N. Y.

JAN SPAANDER.

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The Problem of Hiring Men

With reference to the editorial on page 213, discussing the hiring of employees, I had an interesting experience in the office of a manufacturer a few months ago. I applied for a position. A clerk asked me innumerable questions about my life history and, after taking my pedigree, desired to know what I could do. I told him that I was an automatic screw-machine operator. He looked puzzled for a while and finally asked his assistant whether he happened to see one of those machines lying around anywhere. Then he went on with his interrogations. When I told him that I received 40c. per hr., he was incredulous and told me that there was no use in trying to get work there.

When I saw that there was no chance of obtaining employment in this place, I asked for my application blank. The clerk replied that he was not permitted to return the blanks after they were filled out, as he had to file them. I think this employment department is trying to qualify as Uncle Sam's official census taker.

The clerk did not seem to know anything about the work done in the place, the kinds of machinery used, the wages for different trades or the kind of help needed.

Brooklyn, N. Y.

S. WETZLER.

Editorials

A Factory Inspector's Vital Admission

An excellently designed, up-to-date power plant had been running for about a year. It supplied current for power and lighting for a manufacturing building. One day a factory inspector came in and ordered a rubber mat for the floor in front of the switchboard. The current used was direct and the switchboard voltage 240.

The chief engineer believed that this expense was entirely unnecessary and made a protest to the superior of the inspector. Thereupon the inspector's chief sent him back to the power station to look it over again. The chief engineer told him that so far as he could see, conditions in front of the board were safe and would not be improved in the slightest degree by adding an expensive rubber mat. The inspector at first said that if the floor was wet there might be a chance of danger. The chief engineer at once had a pail of water thrown upon the floor, and then standing on the wet spot took hold of the positive side of one of the switchboard's main switches.

The inspector was then asked again what were the possible points of danger without the mat. Finally, after being cornered, he said, "I don't know; I am no electrician. But I have ordered this mat, and now I must make good with my boss."

This is the spectacle: A man who admits he is no electrician is attempting to prescribe safeguards for electrical apparatus. It appears that we should have factory inspectors selected after the most careful examinations—perhaps as rigorous a one as that given to stationary engineers.

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Fatigue as an Important Cause of Occupational Disease

Industrial fatigue has had considerable study. Methods for its prevention have been devised, tried, and adopted or abandoned, as the observed results seemed to warrant. It is probable that the average machine-shop executive does not know just how he should view this matter; but there is good reason for saying that fatigue-producing conditions cannot be ignored in any plant without seriously affecting the well-being of the working force.

Medical testimony is to the effect that "Undue fatigue is one of the most common causes of occupational disability. It lowers the vitality of the individual and thereby increases his susceptibility to the hazard of his occupation and to disease in general." Beyond its increase of the occupational hazard, it also has an aspect of direct practical importance. Fatigue lengthens the time required to perform a given amount of work. It increases the liability to errors. It is a cause of accidents.

J. A. Watkins, passed assistant surgeon, United States Public Health Service, has recently written a technical paper on "Health Conservation at Steel Mills." In discussing the subject of fatigue in industry, he states that certain details should be considered when a study is

being made of any particular occupation. He lists the following items:

"Does the work involve fixed mental attention, alertness, or fixation of vision?"

"Is the amount of physical exertion required great or small?"

"Is the work rapidly or leisurely performed?"

"Are the movements simple or complicated?"

"Are they performed over and over again, or are they varied so as to break the monotony?"

"Is the operative subjected to any or all of the following conditions: High temperatures, high relative humidity, noise, vibration, insufficient illumination, excessively bright or harmful industrial light, or vitiated, fume-laden, or dust-laden air?"

"Has the employee the proper toilet and washing facilities?"

"Has he an abundance of good drinking water at hand?"

"Is he given definite, regular, and sufficient intervals in which to rest and eat?"

Many of the undesirable conditions indicated by these questions may prevail in machine shops. To them might very properly be added other queries dealing with the mental harassment to which employees may be subjected, and which may produce a greater degree of fatigue than those conditions that merely concern physical well-being.

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The Honor of Long Service

The impression that recent comment and discussion on the length of service in machine shops must have made on many readers is that the duration of the average job is pretty short. Statistics have been presented several times over, quoting case after case where as many or more workmen were hired during a year as were in the shop at the year's end. The purpose of all this discussion has been to call attention to one of the weak spots in shop management and to emphasize the expense of constantly changing the working force. It is estimated that millions of dollars are lost each year in American industries through the shifting of employees.

With the memory of all these comments fresh in our minds, it is relieving to turn to some of the facts in the article in this issue, "Old-Time Tools and Mechanics in a New England Shop—II," and to the first installment, which appeared in last week's issue. In addition to describing some of the old machines and methods of production that are still in use in one of the oldest pump-making shops of this country, a part of the article in this issue is devoted to the personality of some of the workmen. Seven have remarkable records of service. In years these are: 43, 44, 46, 50, 50, 50, 50. The total is 333 years for seven men, or an average of, say, 47½ years each.

In the article are portraits of some of these men, showing them amid the familiar scenes where they work each day and alongside the machines and tools upon which

they are engaged. The *American Machinist* is glad to present these, because of the belief that there is real honor in long service.

One conclusion that may perhaps be drawn from these records is that machine-shop work is not necessarily harmful to health. One of the men mentioned served his apprenticeship in the shop where he is now employed and has lost only four weeks all told in a working life of over 50 years. Quoting: "He has never taken a vacation, and has never been absent from the plant, other than for the four weeks mentioned, except for parts of a day or once in a great while, waiting for castings or other material to come to his department for finishing. His only period of lay-off, the four weeks mentioned, should be explained as having been due to a lame knee (not a shop injury) requiring confinement in the hospital."

Considering the lives of these seven men—there are many others in the country whose records equal theirs—and putting their long terms of service over against the statistics of the rapid movement and change among workmen today, a query that comes into one's mind is, Have any of the changes in business and in working and living conditions influenced the length of employment? Do the increased speed of modern life and the increasing rate of business acceleration have anything to do with the length of time that a man is willing to work at one job? And another question, Are there young men who are entering machine shops today who 50 years hence will be working in the same place, with an unbroken record of faithful service?



Elect Engineers to Congress

In the current Naval Appropriation Act appears an innovation with respect to the method of paying for new ship construction. Heretofore, all new ships have been built by contract, at stipulated prices, arrived at after competition among shipbuilders. The new act provides that the Secretary of the Navy may contract for the construction of the new battle cruisers "upon the basis of actual cost, plus a reasonable profit to be determined by him."

What an opportunity it would have been for an engineer, as member of Congress, to pick to pieces that provision in debate!

How shall the "actual cost" be determined? Take the two first elements of cost—direct labor and direct material. How is the Government to know what labor is expended? Obviously, unless its representatives are present in large number and attend to the timekeeping, it will be impossible to know. For some kind of material it would not be difficult, but for others the conditions would be as for direct labor.

It would also become necessary to define the terms direct labor and direct material. There is no uniformity in practice, particularly among shipyards, nor even in any one yard. They may charge supervision directly in some cases, indirectly in others. Not uncommonly, big jobs are charged with their own supervision and have to bear also a pro rata share of the supervision of small jobs. Some tools are charged directly some times, indirectly at others. Some materials—such as service bolts, used in bolting the plates and shapes together preparatory to riveting—are charged directly or indirectly, according to local practice or individual preference.

The problem of direct charges is simple, in comparison with that of indirect charges. Not only is it difficult to determine overhead charges, it is more difficult yet to dispose of them. The determination of the amounts of some of the elements of overhead, such as the coal bill, presents no great problem; but as to allowances for depreciation, interest on investment, transportation, etc., complete agreement among authorities is not yet reached, and the shipyards have no uniformity of practice. And how about general administration expense?

When it has become necessary to make a change in one of the contracts, as heretofore made, an adjustment of price has always been necessary; and almost invariably there has been a dispute between the Government and the contractor as to the amount of the adjustment, the dispute arising because of the lack of knowledge of the facts involved. The amounts in question are usually not great; but the amount involved in the construction of a battle cruiser is very great indeed—\$16,500,000 for each ship.

Another point is involved: If Uncle Sam is paying the bills, will the shipbuilder watch costs as closely as he does now? Will he be as alert to take advantage of the market as he now is?

It is true that some big engineering works, such as bridge and railroad and building construction, are handled in this cost-plus-percentage method with comparative satisfaction both to contractor and to customer; but the surrounding conditions are widely different from those attendant upon the construction of a ship for a customer in a plant where a number of other ships for other customers are being built at the same time.

This is one matter of legislation in which engineer-legislators could have done some good work. Every session of Congress is faced by many such matters. An engineer has been described as one who can do for a dollar what anybody else could do for a dollar and a half.

Why not let them help make laws?



Production Versus Time Cards

A shop exists to turn out product. As a detail of its operation a record is kept of the time worked by the employees and the time required to do certain things. But like everything else in the plant, the work of timekeeping is secondary to the work of production.

To emphasize this point and to show that the information collected in connection with timekeeping has a vital importance in planning and controlling production, H. L. Gantt is beginning to drop the term "time card" and use instead "production card." The type of card that he calls a production card was shown in last week's issue, page 537.

It is likely that this name will stick. It is probable that, as time goes on, more and more of the cards that record the man's name and number, the operation, the time allowances, etc., will be called production cards.

This is one of those small but important changes that help us to realize from a name what the thing really is and what it is intended to do. In this respect it is like the admirable change of terms from "nonproductive labor" to "indirect labor." How many men have been underestimated in the past and considered a drag rather than a help upon the manufacturing organization, simply because they were classed as nonproductive? So we are prepared to welcome with appreciation the newcomer, production card, and nod our good-byes to an old friend of many years' acquaintance, the time card.

Shop Equipment News

Special Lathe with Thread-Milling Attachment

The illustration represents the latest development by the Gisholt Machine Co., Madison, Wis., of a special machine for taking the finish-boring and facing cuts and also milling the threads in the base or nose end of shells. This machine can be adapted for cutting either right- or left-hand threads, either external or internal, U.S. Standard or metric.

This machine has been brought out so that the boring, facing and threading operations can be done without transferring the shell from one machine to another, thus saving time of rechucking and thereby assuring accurate threads. This machine is of simplified design and heavily proportioned. The collet chuck is supported at its outer end by a heavy steadyrest and is driven direct from a spiral pinion on the back-gear shaft engaging with a spiral gear secured to the collet-chuck flange, which in turn is secured to the ends of the spindle nose. The spindle has large bearings provided with bronze bushings, and the end thrust of the spindle is taken by a ball bearing against the rear housing. The drive from motor to back-gear shaft is through a silent chain.

Special back gearing through worm and wormwheel is provided for reducing the speed of the spindle to the proper speed for milling the thread at one revolution of the spindle. Either the slow speed for milling or the regular speed for boring and turning can be instantly obtained by shifting the headstock lever. Change gears are furnished, so that the relative speed between the

quired for the screw-cutting operation. The power feed for the boring operation is through rack and pinion in the apron mechanism, and interlocking mechanism prevents the engagement of the rack feed and the screw-cutting feed at the same time.

The tool post is of cast steel and is mounted on the front of the cross-slide. The index pin on the cross-slide insures accurate lining up of the tool-post holes with the headstock spindle when it is desired to use double-ended boring cutters.

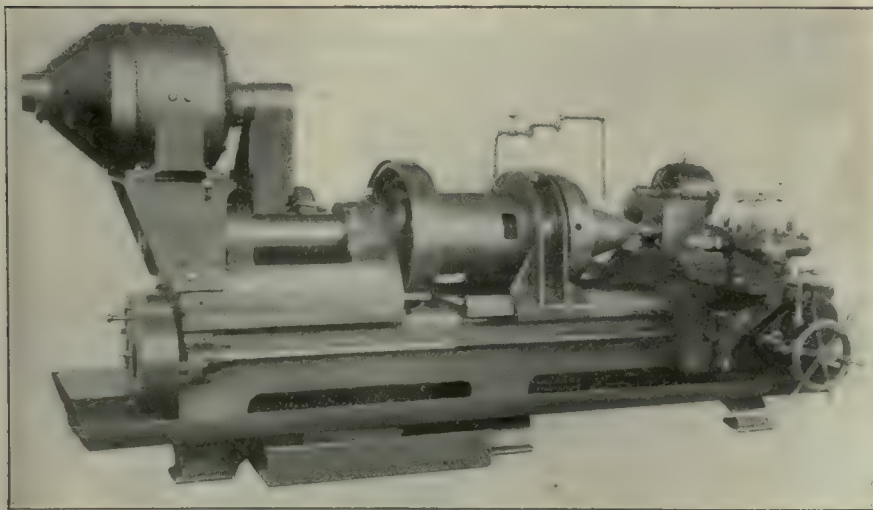
The thread-milling attachment is mounted on the rear of the cross-slide and is provided with radial adjustment for aligning the spindle of the thread-milling attachment with the lathe spindle. The thread-milling spindle is mounted in adjustable bronze taper bearings and has thrust washers and adjusting collar for preventing backlash of the spindle. The spindle is driven by worm and wormwheel and spiral gears from a small motor mounted directly on the cross-slide. The spindle is fitted with an arbor for a hob. The front end of the crossfeed screw has an adjustable cam for accurately feeding in the hob to the correct depth of thread before the main spindle begins to revolve.

This machine is made in a larger size for shells up to 16 in. in diameter.

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Dustless Disk Grinder

The motor-driven disk grinder shown was designed to be especially adapted for wood and metal pattern work, although its application to all classes of disk grinding will be apparent. The principal feature of the machine is the self-contained vacuum dust-removing system, which collects the dust as soon as formed and carries it away from the machine through the exhaust pipe into a sack or out of a window. This system is made possible in the design of the disk and exhaust guard. The back of the disk is made in the shape of a fan; and the guard, which incloses the whole back of the disk and the lower portions of the front part of the disk, forms a complete exhauster, so that practically no dust is permitted to accumulate on the work. The disk is made of aluminum. It is readily removed from the shaft, and back of it is a ball thrust bearing to relieve strain against the motor. The table is operated through a circular rack and pinion, by a handwheel. It can be tilted upward to an angle of 20 deg. and



SPECIAL LATHE WITH THREAD-MILLING ATTACHMENT

Swing, 25 in., 10-ft. bed; capacity for shells up to 12 in. in diameter; bore through spindle, $6\frac{1}{4}$ in.; four tool-post holes, $2\frac{1}{4}$ -in. bore

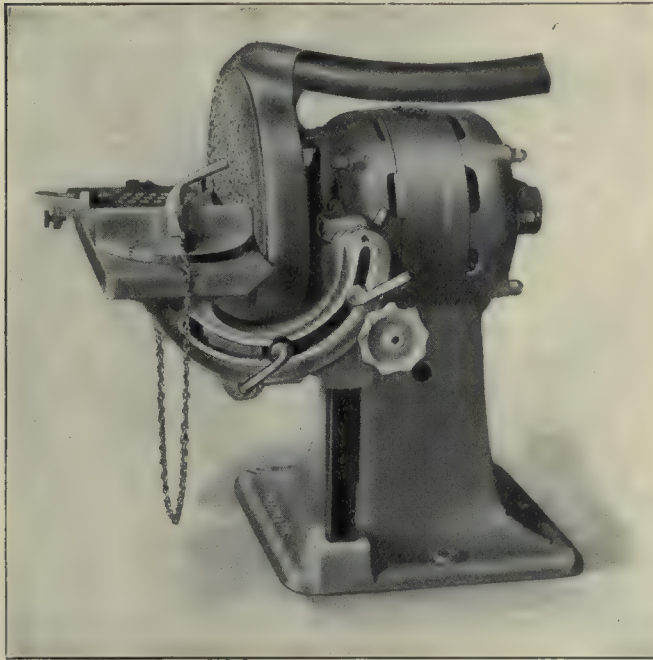
boring speed and the milling speed can be varied to suit conditions.

Three rates of quick-change feeds are provided at the headstock end of the machine, and also the usual change gears for obtaining various feeds and for threads re-

downward to an angle of 45 deg. A graduated gage permits setting the table accurately to any angle, and thumb screws arranged in the guide hold it in place. The table also has a rise and fall of sufficient length to permit removing the disks at its lowest point.

Angle and centering gages are provided to slide in the table slot. The angle gage, which is of the protractor type, is furnished with an adjustment for accurately grinding the ends of segments or any other angular face. The centering gage is laid out with holes into which small

blades are set 180 deg. apart and the nosing blade is set halfway between or at right angles to them. As will be noted, the rear of the nosing blade overlaps the side blades; and in the case of finishing the head all are cylindrically ground in place to proper contour, thus



BENCH DUSTLESS DISK GRINDER

Disk diameter, 9 in.; table, $4\frac{1}{2} \times 11\frac{1}{2}$ in.; $\frac{1}{8}$ -hp. motor; machine base, 9 in. square; height, 15 in.; weight, 55 lb.

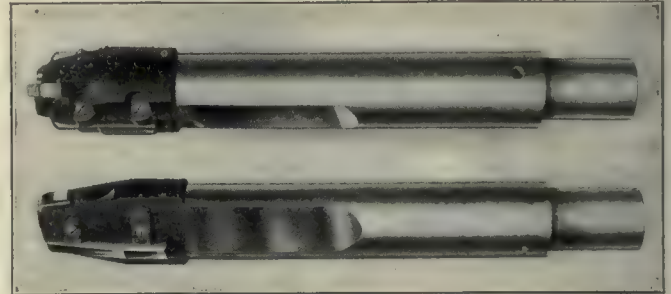
steel centers may be inserted; it is also arranged with an adjusting screw, which makes the gage especially useful in grinding core prints, bosses, etc.

The machine is of the portable type. It is a recent product of the Pioneer Dustless Disc Co., Syracuse, N. Y.

Shell Boring Head

The shell boring head shown is of the inserted-blade type; a set is composed of two heads, one for roughing walls and bottom and the other for finishing the same surfaces.

Each head contains three blades, two side-wall cutters and one bottoming, or nosing, cutter. The side-wall



SHELL BORING HEAD

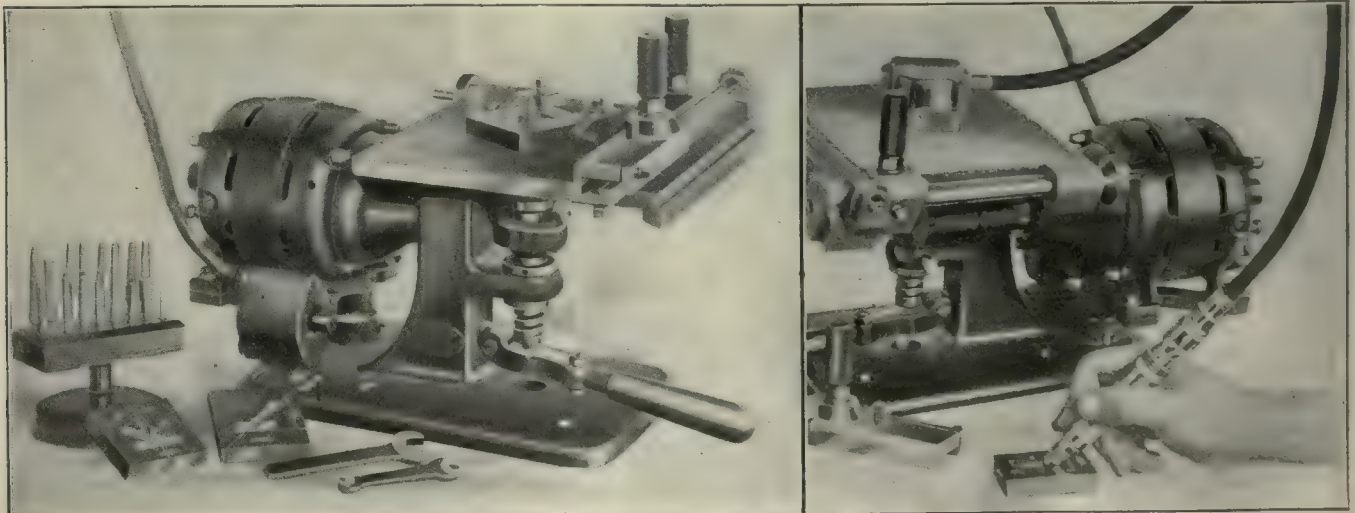
eliminating any possibility of leaving a shoulder in the shell at the junction of bottom and side walls.

The heads were designed to be economical in the use of high-speed steel, as a minimum cross-section of blade is employed and they can be lined out and reground a number of times before discarding the small weight of steel that remains. Each blade is backed up and supported by the metal of the head. A wedge and screw system of clamping is designed to eliminate chattering of a blade in service. Provision has been made for the unobstructed flow of chips back from the blades and for the flooding of the blades with lubricant under pressure through a central lead with an inlet at the turret end of the head.

The heads, clamps and screws are casehardened and the shanks ground for accurate fit to the turret. Keyways and flats are provided at this end to suit the turret. This form of head is a recent product of the Black & Decker Manufacturing Co., Baltimore, Md.

Controlling Fixture for Die-Forming Machine

The illustrations show an attachment that has recently been developed by the Anderson Die Machine Co., Bridgeport, Conn., for use in connection with its die-forming machine on work having straight members.



CONTROLLING FIXTURE AND FLEXIBLE SHAFT FOR DIE-FORMING MACHINE

The object of this mechanism is to make it possible to finish accurately the sides of a die or similar work at a definite angle with a base or base line. For example, suppose a die is intended to produce a sheet-metal part the body of which may be of any shape, and from this main body an arm is to extend outward at a definite angle relatively to some portion of the main body of the sheet-metal piece. In such a case the die is laid out with center lines in certain relation to the sides of the die block. The body of the die is then finished, and with this device the arm can be finished accurately to the angle required. The flexible shaft shown in the illustration is driven by means of spiral gears contained in the box on top of the machine table. No screws are necessary for securing the gear box to the table, a stem being held and driven by the chuck on the machine. When in operation the flexible shaft and gear box are free to swing around the table, eliminating the possibility of the shaft kinking.

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Recording Thermometer

A type of recording thermometer for temperatures as high as 800 deg. F., or 425 deg. C., is being manufactured by the Brown Instrument Co., Philadelphia, Penn. This instrument operates on the principle of the expansion of gas with a change in temperature. A bulb of copper containing nitrogen gas under pressure is connected to a recording instrument by a small copper tube protected by flexible steel tubing.

The recording instrument, Fig. 2, has a helical spring, somewhat similar to that used in pressure gages, and the expansion of the gas in the bulb exerts a pressure that is conveyed by the capillary tube to the helix, which expands proportionately. This helix, Fig. 1, is directly connected to a recording arm which marks on the record chart.

This type of instrument can be furnished with tubing of sufficient length to enable the recording gage to be placed at a maximum of 100 ft. distant from the point

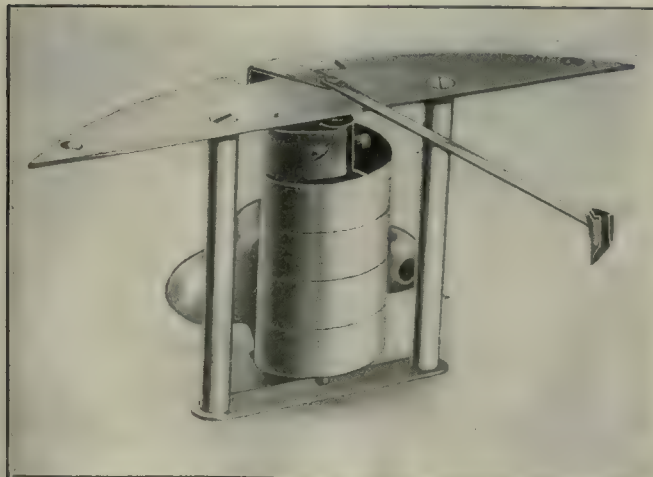


FIG. 1. HELIX AND RECORDING ARM

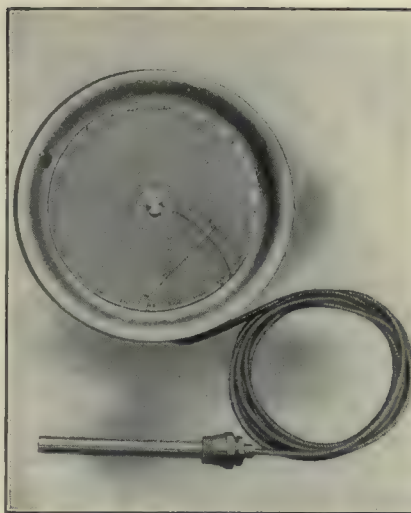


FIG. 2. RECORDING GAGE

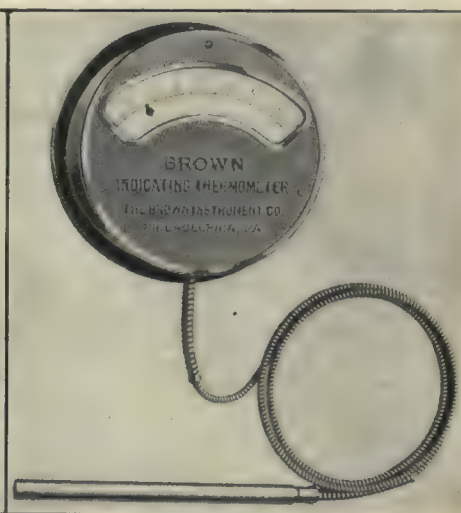


FIG. 3. INDICATING GAGE

where the temperature is measured. This permits of its application in numerous processes where it is desirable to keep a constant record of the temperature on a chart.

The clock which revolves the chart is mounted directly on the front plate on which the chart revolves, which insures alignment of the clock and chart plate. The clips that hold the chart in position are mounted on the door, so that when the latter is swung aside the clips are automatically swung away from the chart, permitting its easy replacement without interference. A device is furnished which raises the chart pen from the chart automatically when the door is opened and frees the pen automatically when the door is closed.

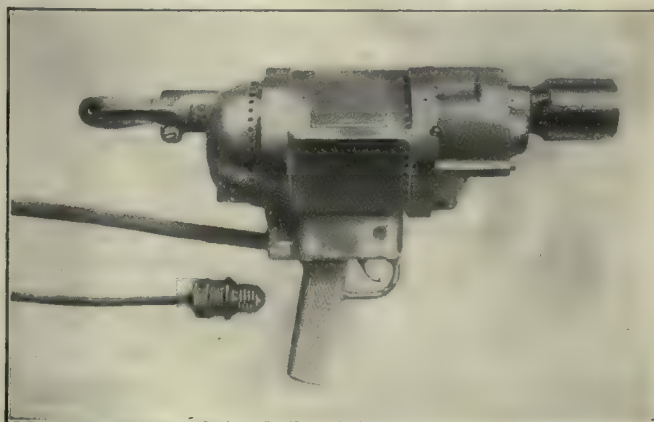
This instrument is made also in indicating form, Fig. 3, where desired, to indicate the temperature on a dial instead of recording it on a chart. It is furnished with a number of different types of bulbs, either with threaded connection for insertion in mains and pipes or with lead coating to withstand chemicals and acids.

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Portable Electric Drilling Machine

The special claim of the makers—the Black & Decker Manufacturing Co., Baltimore, Md.—for the portable electric drilling machine shown is the low drill breakage maintained by an automatic trigger control.

It will be seen that the control is that of the automatic pistol, one finger doing the work without in the slightest



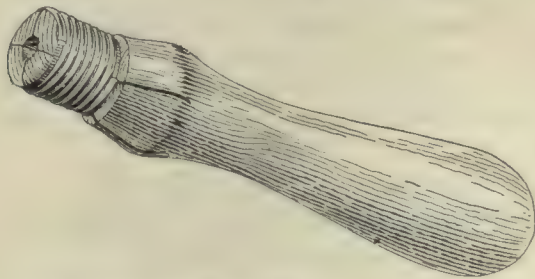
PORTABLE ELECTRIC DRILLING MACHINE

affecting the steadiness of the aim or the firmness of the support of the tool. The housings are cast from aluminum alloy. The gears are cut from solid bars of chrome-vanadium steel. The chuck spindle is hardened and ground and runs in a bronze bushing, the end thrust being taken care of by a ball thrust bearing. The motors are ventilated by forced draft, and provision for bearing lubrication is through automatic lubricators. The commutator and brushes are readily accessible by removing four screws, which enables the top cover to be slipped off. The cover does not carry the armature-shaft bearing. This bearing and brushes are carried by an inner spider, which is protected from external injury or strains tending to bind the bearing. This construction allows the drill to be run while the cover is removed for inspection of the brushes and commutator. This form of machine is made in several sizes.

File Handle

The illustration shows a file handle manufactured by the Strong-Hold Manufacturing Co., 307 Arch St., Philadelphia, Penn.

This clever device consists of a handle of wood in the form of the ordinary file handle. It is drilled at the end for the reception of the file tang. Two saw slots cross-



FILE HANDLE WITH ELASTIC FERRULE

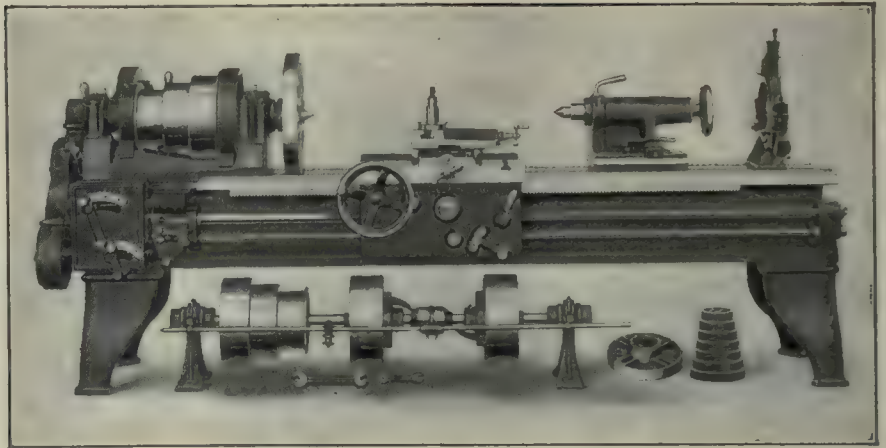
ing each other at right angles pass axially through the tang hole. The ferrule is in the shape of a helical spring and is forced on its seat, closing the saw slots. When the file tang is driven into the hole, the spring gives and the tang is held with an elastic grip.

Back-Geared Engine Lathe

The lathe shown is equipped with double back-gears, is provided with a semi-quick-change gear box, and when desired a compound rest and a turret tool post are furnished.

The bed is cross-webbed at intervals of 2 ft. and the ways are V-shape. The apron is the double-plate type. A locking device is provided to preclude the possibility of engaging the feed-rod and lead-screw simultaneously. An apron reverse is provided for all feeds that may be operated independently of the reverse screw in the head-stock.

The carriage is provided with a friction feed and the cross-feed screw is graduated to read to 0.001 in.



BACK-GEARED ENGINE LATHE

Swing over bed, 21 in.; swing over carriage, 14 in.; distance between centers, 8-ft. bed, 3 3/4 ft.; hole through spindle, 2 1/8 in.; width of driving belt, 4 in.; ratio of double back-gears, 10 to 1 and 3 1/2 to 1; spindle speeds, 7 to 285 r.p.m.; gear feed, 6 to 90 per in.; weight, 8-ft. bed, 4,100 lb.

It will be observed from the illustration that the general design and construction of the machine follow conventional lines. The machine is built by the Waterville Iron Works, Waterville, Maine.

Air-Operated Arbor Press

To provide a more rapid and less fatiguing arbor-press service, the Hannifin Manufacturing Co., Chicago, Ill., has designed and built the pneumatically operated type shown. The downward, or pressing, stroke consists of a



AIR-OPERATED ARBOR PRESS

No. 1: Capacity, from base of press to arbor when arbor is up, 16 in.; center of arbor to face of body, 5 in.; stroke of arbor, 5 in.; bore of cylinder, 6 1/2 in.; diameter of arbor, 1 1/2 in.; power developed, 80 lb.; air pressure, 7,900 lb.; weight, 375 lb. No. 2: Capacity, from base of press to arbor when arbor is up, 23 in.; center of arbor to face of body, 8 in.; stroke of arbor, 6 1/2 in.; bore of cylinder, 8 in.

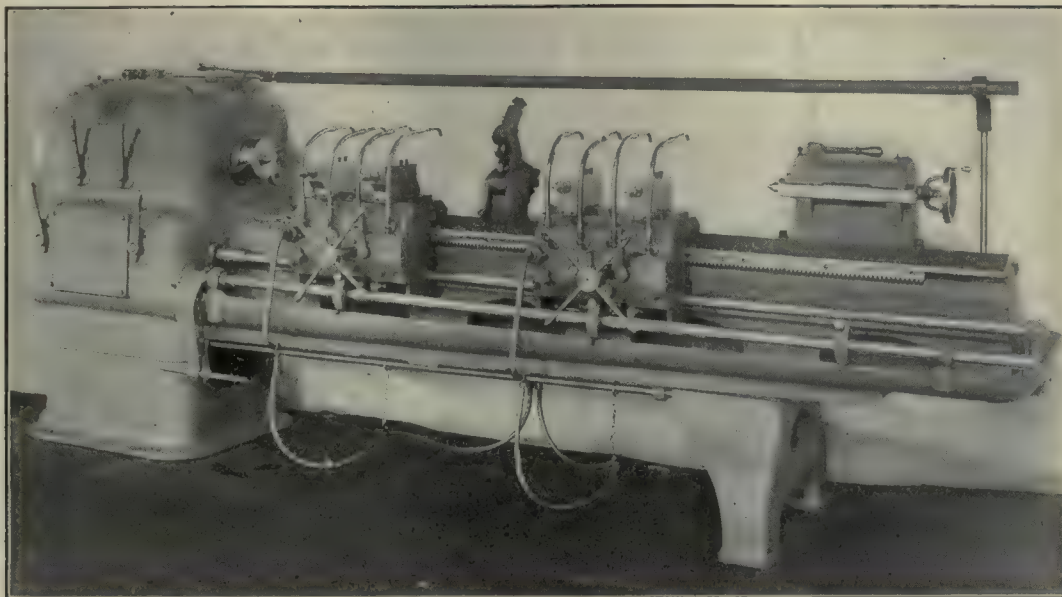
steady movement; the upward stroke is a fast return.

The arbor is provided with a stop collar, which enables the setting of the downward stroke to a definite stop, so that duplicate operations can be performed semi-automatically. The press is made in two sizes.

The 8-In. Lo-Swing Lathe

In response to the demand for a machine to handle larger work than the original 3½-in. Lo-Swing lathe the Fitchburg Machine Works, Fitchburg, Mass., have

the belt-driven machine is 24 in. in diameter with a 6-in. double belt at 500 r.p.m. For electrical drive a 15-hp. motor is advised. The shipper rod still runs the whole length of the lathe and now controls a double knuckle-joint clutch in the pulley instead of the countershaft, as



THE 8-IN. LO-SWING LATHE

brought out a new and much larger size, known as the 8x84-in. machine. This swings 10 in. in the clear and will actually turn work of this diameter, but as with all other lathes, most of its work will naturally be of a smaller size in the turned portions. Motor-truck axles, with their spring seats that must be swung, automobile crankshafts and projectiles are among the immediate uses of the machine.

The headstock and carriages have been redesigned as well as enlarged, the speeds being now controlled by the two upper levers on the front of the head, which is much more convenient than the arrangement in the smaller size.

The spindle speeds are six in number and range from 25 to 325 r.p.m. The feed mechanism in the head is not materially changed, nine feeds being provided, ranging from 0.010 to 0.166 in. per revolution. The carriages retain the front bearing feature so as to pass the tailstock readily, but heavy V-ways replace the flat bearing, and the carriage is gibbed to the bottom on the bed. The carriage itself has also been redesigned and is now self-contained in every way. The carriage feed gears are driven through Oldham couplings, which avoid the necessity of exact alignment. The reverse in the carriage is by means of a sliding gear instead of the right- and left-hand worm formerly used. The front spindle bearing is 4x5¼ in. and the rear 3½x5 in., the bearings being of bronze with the same adjustment and roller thrust as before. The two carriages are 18 in. long and are regularly supplied with three tool blocks and four oil, or coolant, tubes each, but these can be varied as the work demands. There is also an extra oil tube for flooding the tail center. The tools used are ¾x1¼ in.; the pulley on

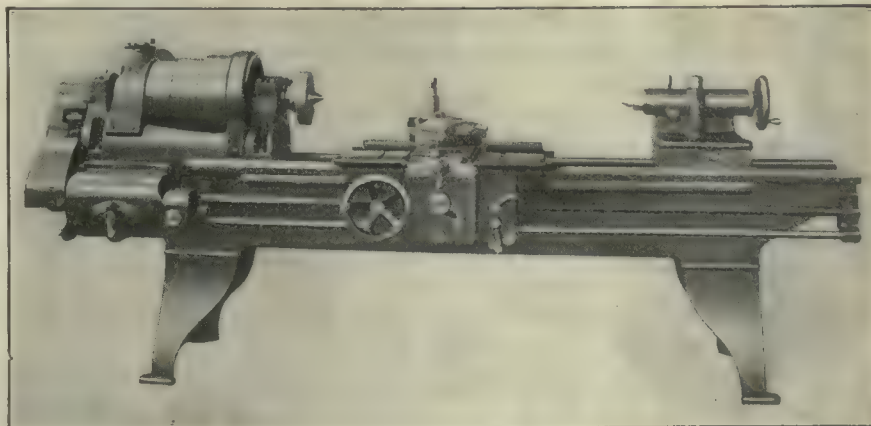
before. The machine weighs approximately 5,000 lb. and occupies a space measuring 41¾x151¾ in.

Quick-Change Engine Lathe

The illustration represents the latest addition to the line of engine lathes built by the Morris Machine Tool Co., Cincinnati, Ohio.

The machine is made with either single or double back-gear head and with quick-change or semi-quick-change feed.

The apron is of double wall construction with all-steel gears. Both the cross and longitudinal feed are oper-



QUICK-CHANGE ENGINE LATHE

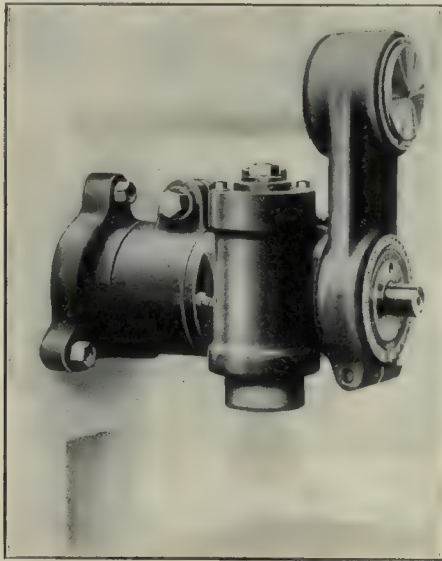
Swing over bed, 23¼ in.; swing over carriage, 15½ in.; front-spindle bearing, 3½ in. in diameter, 6 in. long; hole through spindle, 2 in.; length of carriage, 33½ in.; diameter of cone pulley steps in double back-gear, 11½, 12¼ and 14 in. by 4¼ in. wide; weight, 4,500 lb.

ated by one lever through expanding ring frictions. The headstock has two large drop ribs running its full length. The compound rest is clamped by one bolt by means of a steel dovetail clamping ring. In general the machine follows the lines of other sizes made by the manufacturer.

Semi-Universal Milling Attachment

The milling attachment shown is a recent development of the Valley City Machine Works, Grand Rapids, Mich., and was designed to permit angular cuts with less overhang, resulting in greater rigidity.

The attachment swings clear under the overarm and may be reversed if desired. The hole through the spindle is easily accessible when the spindle is in a vertical position.



SEMI-UNIVERSAL MILLING ATTACHMENT

tion, this being accomplished by offsetting the spindle from the miller spindle proper. The drive is through a splined arbor, coarse pitch miter gears, an intermediate ball-bearing shaft, and a pair of steel spur gears as final spindle drive. The spindle rotates in the same direction as the miller spindle and is fitted with a No. 10 taper.

The attachment is furnished with a clamp base that is bored to fit the spindle box and secured with screws to the column.

Beauty in Machine Design

One of our friends, an accomplished engineer, remarked on looking over a fine new machine tool, "A thing of beauty is a joy forever," and his remark was sneered at by a shop foreman, who boasted himself as "a practical man, first, last and all the time." An impression prevails among many ignorant mechanics that beauty of form and utility cannot go together. That is prejudice resulting from ignorance and defective mental training.

It is not necessary that we should have the intellectual apprehension of the fitness of anything for its use, in order that we shall see the sense of harmony and regard the object as beautiful. But if in any case we do have the perception of fitness, then this perception must be satisfied, or else the object cannot appear beautiful.

Machinery, where, as in the case of architecture, man is himself the creator, affords admirable illustrations of the same truth. Here we are able to see with peculiar distinctness the necessity for harmony if anything is to appear beautiful to us. The illustrations of these truths that may be drawn from machinery possess an especial force and value, because here all uses lie within our comprehension, and the fitness of every part of any machine, and of the machine as a whole, for its use, can be determined in an unmistakable manner. Every machine has its special use. This use was proposed by its constructor, and he has made all the adaptations of the several parts and of the whole of the mechanism to its accomplishment, and the degree of success or failure is a matter of certain observation to the instructed mechanical engineer. No mechanical forms or proportions can appear beautiful unless a good mechanical reason can be given for them. Those forms and proportions are always the most graceful and elegant that most completely fulfill mechanical requirements. We are able to see at once that the pleasure which the builder of a machine can derive from the contemplation of his work, all the beauty that it can possess in his eyes, depends wholly upon his perception of its fitness for the use for which it was designed.—*Railway and Locomotive Engineering.*

Personals

A. L. Buiwitt recently arrived from Petrograd and will assume charge of the New York office of the Russian Metal Trading Co.

W. I. Ballentine, until recently general superintendent of the Indianapolis works of the Link-Belt Co., has become connected with the Chain Belt Co., Milwaukee, Wis., in a similar capacity.

J. T. Slocomb, president of the J. T. Slocomb Co., Providence, R. I., was presented with a loving cup by his employees on the occasion of an outing arranged by the employees and held on Sept. 16.

George S. Haley, who has for nine years been chief draftsman and mechanical engineer for the H. Mueller Mfg. Co., Decatur, Ill., has resigned to accept the position of superintendent of the A. Y. MacDonald Co. factory at Dubuque, Ia.

Sven Winquist, inventor of the S. K. F. ball-bearing, is at present in this country for the expressed purpose of inspecting the new American plant of the S. K. F. company in Hartford. Mr. Winquist is president of the Swedish company and a trustee of the American concern.

Dr. Cary T. Hutchinson has been selected as the executive secretary of The Engineering Foundation to represent the engineering professions in the organization of the National Research Council proposed by the National Academy of Sciences. Doctor Hutchinson is a well-known electrical consulting engineer, possessed of a scientific as well as an engineering type of mind, and has the endorsement of the National Academy for the work he is about to undertake.

Trade Catalogs

Overfired Furnaces.—Tate-Jones & Co., Inc., Pittsburgh, Penn. Circular No. 154. Pp. 8. 8½x11 in. Illustrated.

Improved Simplex Sine Bar.—The Model Tool and Gauge Co., 187 John St., Bridgeport, Conn. Circular. Illustrated.

Plate and Angle Heating Furnace.—Tate-Jones & Co., Inc., Pittsburgh, Penn. Circular No. 153. Pp. 8. 8½x11 in. Illustrated.

Lubrication and Casings for Silent Chain Drives.—Link-Belt Co., 39th St. and Stewart Ave., Chicago, Ill. Booklet No. 286. Pp. 8. 6x9 in. Illustrated.

A Model Foundry.—Whiting Foundry Equipment Co., Harvey, Ill. Booklet. Pp. 36. 8x11 in. This covers particularly the equipment necessary for a grey-iron foundry and contains illustrations of some typical installations.

Forthcoming Meetings

National Machine Tool Builders' Association. Annual convention, Oct. 24-25, Hotel Astor, New York City. Charles E. Hildreth, general manager. Worcester, Mass.

American Society of Mechanical Engineers. Annual meeting, Dec. 5-8, Engineering Building, New York City. Calvin W. Rice, secretary, 29 West 39th St., New York City.

American Society of Mechanical Engineers. Monthly meeting, first Tuesday. Calvin W. Rice, secretary, 29 West 39th St., New York City.

Boston Branch National Metal Trades Association. Monthly meeting on first Wednesday of each month, Young's Hotel. W. W. Poole, secretary, 40 Central St., Boston, Mass.

Providence Association of Mechanical Engineers. Monthly meeting, fourth Wednesday of each month. J. A. Brooks, secretary, Brown University, Providence, R. I.

New England Foundrymen's Association. Regular monthly meeting, second Wednesday of each month. Exchange Club, Boston, Mass. Fred F. Stockwell, 205 Broadway, Cambridgeport, Mass.

Engineers' Society of Western Pennsylvania. Monthly meeting, third Tuesday; section meeting, first Tuesday. Elmer K. Hiles, secretary, Oliver Building, Pittsburgh, Penn.

Rochester Society of Technical Draftsmen. Monthly meeting, last Thursday. O. L. Angevine, Jr., secretary, 857 Genesee St., Rochester, N. Y.

Superintendents' and Foremen's Club of Cleveland. Monthly meeting, third Saturday. Philip Frankel, secretary, 310 New England Building, Cleveland, Ohio.

Western Society of Engineers, Chicago, Ill. Regular meeting, first Wednesday evening of each month, excepting July and August. J. H. Warder, secretary, 1785 Monadnock Block, Chicago, Ill.

Philadelphia Foundrymen's Association. Meetings first Wednesday of each month. Manufacturers' Club, Philadelphia, Penn. Howard Evans, secretary, Pier 45 North, Philadelphia, Penn.

Technical League of America. Regular meeting, second Friday of each month. Oscar S. Teale, secretary, 35 Broadway, New York, N. Y.

Teaching the Manufacture of United States Munitions

By HOWARD E. COFFIN*

SYNOPSIS—The author emphasizes anew the need of organizing and educating the industries of the United States. He points out the functions of the Naval Consulting Board: To inventory resources, to train and educate industry and to enlist skilled labor. He then indorses the plan of the "American Machinist" to present in its pages comprehensive, detailed information on the manufacture of United States munitions.

In this issue of the *American Machinist* is the beginning of a work fundamental to the practical initiation of all our plans for the military defense of this country. I refer to the article on page 635, dealing with United States munition making and with the projected work that is to show the methods and processes of the quantity manufacture of army and navy materials.

Our vital need for a textbook dealing with this work should require little either by way of explanation or comment. Two years' experience on orders for foreign governments has taught our American manufacturers that the making of materials of modern warfare is a new art. It is an art with which we have had little or no previous experience and in which our workmen are unskilled.

In England a little over two years ago there were three government arsenals. Today more than four thousand of England's leading industrial plants are being operated as government factories for the production of war materials, and many other thousands of factories still under private control are concentrating their energies in the same direction. The teaching of the munitions-making art to these thousands of manufacturers and to millions of industrial workers has called for a work in industrial organization and education such as the world has never before seen.

We have here in the United States vast resources in manufacturing and producing equipment, but they are unorganized and uneducated for the national service. Our observations of the European War have taught us that it is upon organized industry that we must base any and every plan of military defense, and that in the event of trouble with any one of the several first-class powers between 80 and 90 per cent. of our industrial activity would of necessity be centered upon the making of supplies for the Government.

OUR RESOURCES AND THE NEED FOR PREPAREDNESS

We have had no experience in the kind of warfare now being waged abroad, and yet this is exactly the sort of thing for which we must prepare, or it is worse than useless that we prepare at all. Industrial preparedness is strictly in keeping with the natural tendencies and abilities of our people. It is the basic and at the same time the cheapest form of preparedness. We have already the investments in plants, in tools and in machinery,

and more important still are our resources in skilled workers. But it is only through the most careful methods of organization and education that we may make all these resources available to us in time of emergency.

An up-to-date text dealing with munitions work will be found indispensable in this educational campaign. We have heard much of the difficulties that American manufacturers have experienced in getting out foreign war orders. Months of experimentation, argument and delay have resulted because of the lack of proper information as to the processes and methods involved in the quantity production of such materials. Fortunately for us, we have not been one of the principals involved in the European struggle, and however costly failure in delivery may have been to individual manufacturers, it has not produced a national calamity.

THE WORK OF THE NAVAL CONSULTING BOARD

The work of the Naval Consulting Board involves three steps: First, an inventory of the country's manufacturing and producing resources; second, the training and education of these resources for a national service both in peace and in war; third, the enlistment of the skilled laborers of the country in an industrial reserve that shall keep the skilled worker in his place in the factory, the mill or the mine and prevent his loss through enrollment in the fighting army. It is in the second step in this program that accurate, complete information on munition manufacture will prove invaluable. In the event of any future war in this country the munitions industry must become our one great national industry.

The work accomplished by the Committee on Industrial Preparedness of the Naval Consulting Board will in due time be turned over to the newly created governmental body known as the Council of National Defense. It is under the auspices of this council that the education and organization of our resources for national emergency service will be carried forward. It is by this body that the textbook of munition making will be put into the service of the nation, the beginning of which is the series of articles commencing in this issue.

There is no question as to the value of this educational campaign to the manufacturer. He will know in advance that in the event of war his producing equipment will be kept busy at a reasonable profit to himself. He will have an intimate knowledge of the work that he will be called upon to do in the national service. His skilled men will be kept on the job, and suffering through unemployment will be reduced to a minimum throughout his district.

Too much credit for this vitally important achievement cannot be given to the editor-in-chief of the *American Machinist*, and to the corps of efficient workers on his staff. To him and to them is due the patriotic initiative that has given to us, through articles already printed, a permanent record of the invaluable experience gained by our manufacturers in the filling of foreign munition orders, and through the work already well under way is to give us in like manner a comprehensive knowledge of the manufacture of United States munitions.

*Member, Naval Consulting Board of the United States, and Chairman of its Committee on Production, Organization, Manufacture and Standardization.

Special Tools for Machining Steam-Pump Elements

BY ROBERT MAWSON

SYNOPSIS—On this and the accompanying page are shown some of the jigs and fixtures used by one of the leading steam-pump builders of the country. It will be seen that the tools have several interesting features for locating and holding the work. This article should be of special interest, as this branch of manufacturing does not usually employ many special tools, jigs and fixtures. In most shops the various holes or surfaces are laid off, and the operations are performed to these guide lines. In some instances templets are made for the drilling operations.

The jigs and fixtures illustrated and described in this article have proved valuable for machining certain steam-pump elements. It will be observed that time-saving features have been introduced in the designs, and the tools are economically producing parts of an interchangeable character.

The milling fixture for the fork lever is provided with guide arms to assist the operator in setting the part in alignment in the fixture at both ends for the operation.

The jig used in drilling the tappet has at the lower end a pin that fits into a bored hole in the part. Another pin, which is part of a threaded stud and is operated with a knurled head, furnishes the other locating medium. As the hole to be drilled is at an angle, the base of the tool is placed at an angle to suit these requirements.

The milling fixture used in machining the auxiliary slide valve is provided with a tongue to locate the part to be machined. The piece is forced and held in position with a cam-shaped lever, operated by a handle.

The milling cutter has shoulders on the shank, which fit against a stop plate. By this method the milling cutter is brought into the correct location to machine the slot in the casting.

The tool for drilling and reaming the lever has a fixed V-block at one end to locate the piece. At the opposite end of the jig is a sliding V-block operated by a setscrew.

After the part has been placed in the fixed V-block, the sliding V-block is screwed up, thus locating the part in alignment. Setscrews hold the piece securely in the jig. A slip bushing is provided so that the hole may be drilled before the reaming operation.

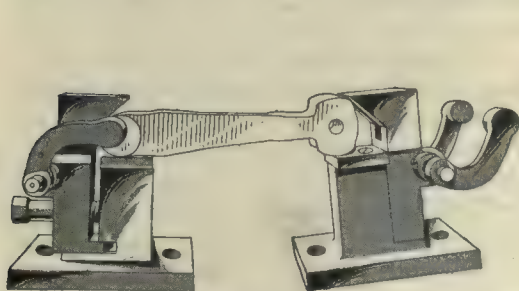


FIG. 2

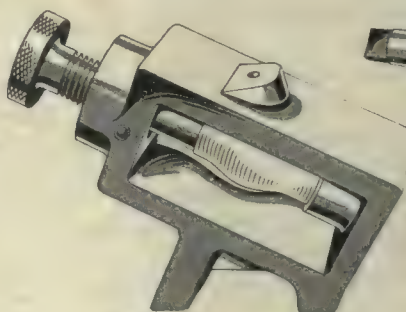


FIG. 4

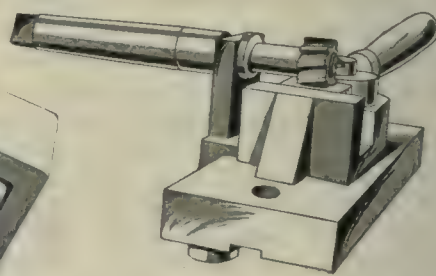


FIG. 6

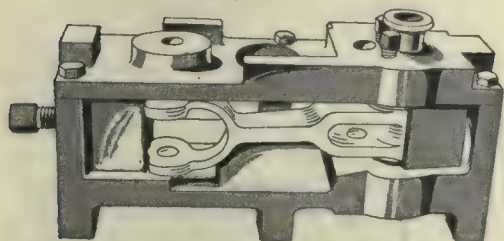


FIG. 8

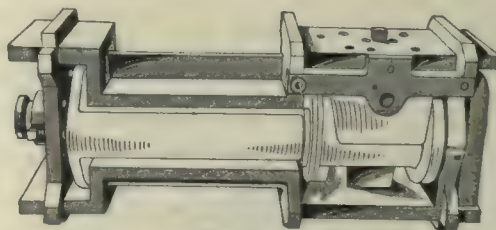


FIG. 10

TOOLS USED IN MACHINING STEAM-PUMP ELEMENTS, WITH WORK SHOWN IN PLACE

FIGS. 2 AND 2-A

Operation—Milling lever, Fig. 1. The rough lever is placed against the angular serrated surfaces of the fixture elements, and the adjusting lever swings up to bring the part into place. The adjusting arms are then moved back, and the fixture is ready for the milling operation.

Surface Machined—Inside of fork, using a 7-in. side mill operating at 21 r.p.m. with a feed of 0.3 in. per revolution.

FIGS. 4 AND 4-A

Operation—Drilling tappet, Fig. 3. The part, which has been turned, faced and had the center hole drilled, is located by a fixed pin at one end and a screwed pin at the other.

Hole Machined—One $\frac{1}{8}$ -in. drilled.

FIGS. 6 AND 6-A

Operation—Milling auxiliary slide valve, Fig. 5. The casting is located on a tongue in the fixture and held against a fixed jaw by a cam-shaped lever.

Surface Machined—Depression, using a $1\frac{1}{4}$ -in. milling cutter operating at 150 r.p.m. The feed is controlled by hand.

FIGS. 8 AND 8-A

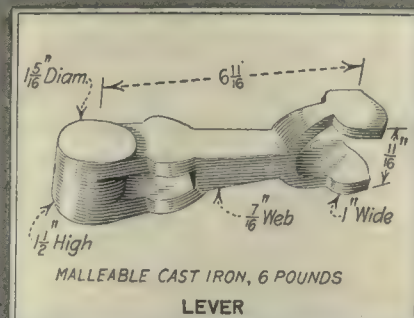
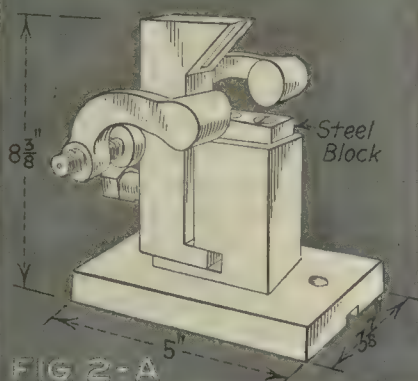
Operation—Drilling and reaming, Fig. 7. The piece is located in a fixed V-block at one end and in a sliding V-block at the other end. Setscrews are then tightened on the part to hold it securely in the jig.

Holes Machined—One $\frac{1}{8}$ -in. drilled, one $\frac{7}{8}$ -in. bored and one $\frac{63}{64}$ -in. drilled after being reamed to $\frac{3}{8}$ in.

FIGS. 10 AND 10-A

Operation—Drilling steam cylinder, Fig. 9. The casting is located on plugs at each end, which fit with holes previously bored. Setscrews are tightened on the piece to hold it in position.

Holes Machined—Four $\frac{1}{8}$ -in., six $\frac{3}{8}$ -in., two $\frac{1}{2}$ -in. and four $\frac{3}{4}$ -in. drilled; two holes for $\frac{1}{2}$ -in. pipe tap and one hole for $\frac{3}{8}$ -in. pipe tap.



TIME OF OPERATION, 10 MINUTES

Steel Block: 3 3/4" x 2" x 1"

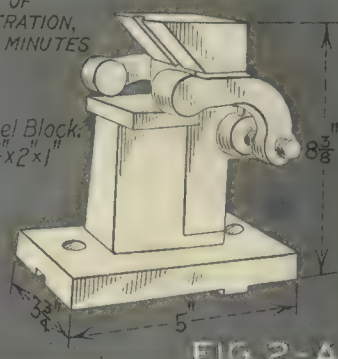
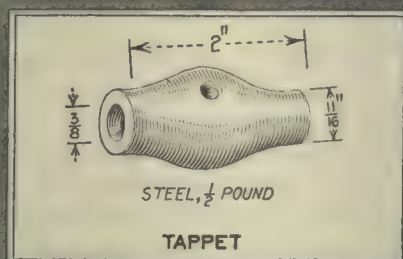


FIG 3



TIME OF OPERATION, 3 MINUTES

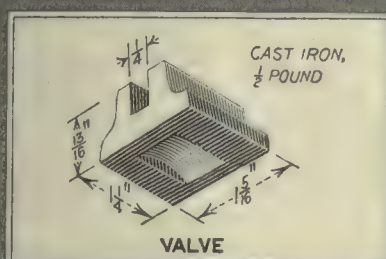
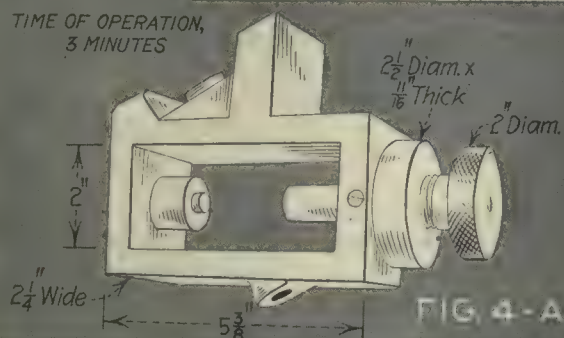


FIG 5

TIME OF OPERATION, 6 MINUTES

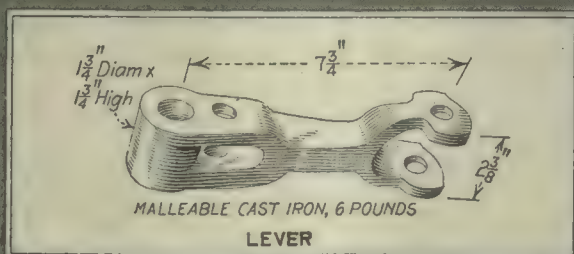
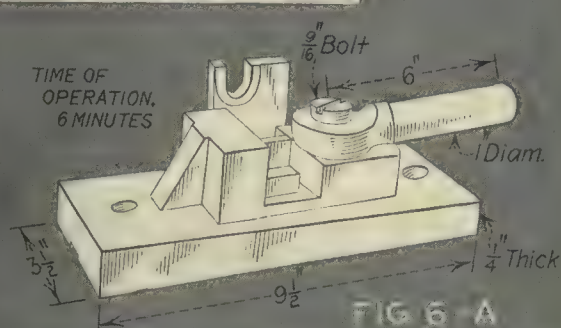


FIG 7

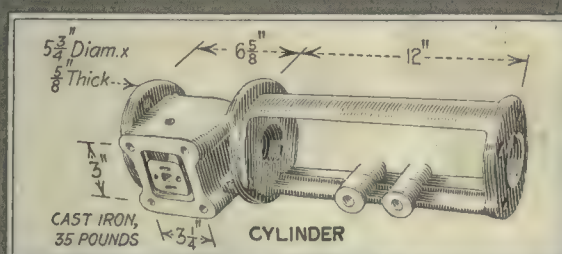
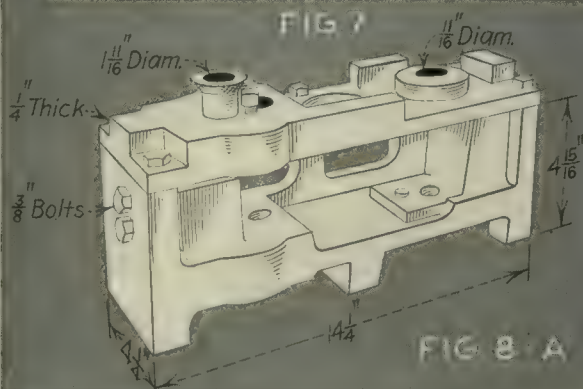
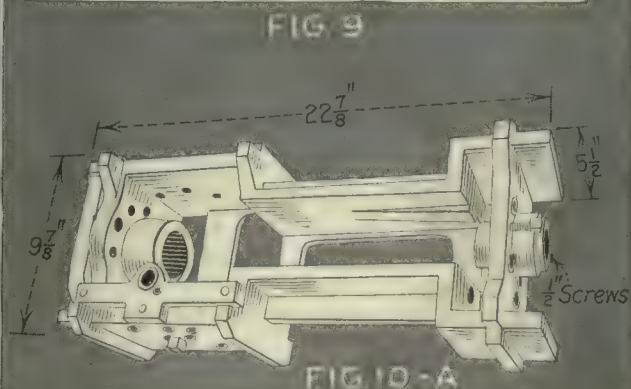


FIG 9



ALL BUSHINGS USED FOR GUIDING TOOLS ARE BLACKENED OR HEAVILY RULED. ALL JIG AND FIXTURE BODIES ARE CAST IRON, STRAPS AND FASTENINGS, MACHINERY STEEL; GUIDE BUSHINGS ARE TOOL STEEL, HARDENED AND GROUND

Centrifugal Force in the Small Shop

BY JOHN H. VAN DEVENTER

SYNOPSIS—The man who runs a shop successfully, be it a large or a small one, must understand the laws of human nature. These are often comparable to physical laws, and in this article Dave Hope throws a new light on centrifugal force, lubrication and some other matters.

"The red-headed lad at the end of that bench is taking a course in physics at the night school," remarked Dave, pointing to a lean, raw-boned, but ambitious looking chap, who was engaged in fitting keys. "It may not do him any harm," he continued pessimistically, "but I doubt if it will do him any good. If he would spend his time studying the laws of human nature instead of absorbing natural laws, I might make a foreman out of him."

"What's the matter, Dave," I asked, "don't you believe in educated foremen?"

"It depends on the kind of education," replied Dave. "A man that intends to go in for grand opera may benefit by studying French and Italian, because he will have to wiggle his chin in tune with those languages, but Chinese won't help him much in his profession."

"You're looking at it from too narrow an angle," I objected. "Think of the satisfaction that comes from the broadening effect of a liberal education."

"Not half so satisfying as the effect of a liberal pay envelope," retorted Dave. "These shop boys who work overtime at night school, or who take a course at home, do not do so for the purpose of getting to be cultured, but to better their pay. That's why nine-tenths of the correspondence school ads are written around the picture of a fat pay envelope. But they don't always choose the right subject—physics won't do Tom any good, for example, as long as he makes his living building machines that somebody else has designed. He may understand the principles behind them a little better, but he won't build them a bit faster, and they won't run any smoother when he gets through with them. Let me tell you of my experience with a higher education."

"I thought you were one of the old school mechanics, Dave," I interrupted in surprise. "Where did you get your higher education?"

HOW DAVE GOT AND LOST HIS EDUCATION

"Hired it," he replied. "Got it for fifteen dollars per week and kept it in the shop just three days. Then I got rid of it. Tied a can to my higher education, so to speak, and said farewell to it forever. But I had to give it the full week's pay."

"I sent this higher education of mine out to see why it was that Jim Fosdick's gas engine wouldn't run his mill. It came back and said it had measured the diameter of the cylinder and the length of the stroke, and that according to algebra it would develop 45 hp. at 300 r.p.m. It said it had also figured the power needed by the mill to be 21.5 hp., so that the engine would run it after all and somebody must have made a mistake in saying it wouldn't.

"The next thing I did was to go myself and found that somebody had run a wagon over the gasoline feed pipe, and one wheel had squashed the place flat so the flow was cut off. After this was fixed, away she went. My higher education told me, after I expressed my opinion of it, that this was no reflection upon it whatever, as it had said in the first place that the engine was all right, and so it was—the trouble was in the feed pipe, and nothing had been said about investigating that.

DEVELOPING MEMORY AND PARALYZING REASONING POWER

"No, sir," continued Dave, "that kind of a higher education often seems to develop a man's memory and paralyze his reasoning power. He swallows everything that comes along and doesn't digest anything."

"The best educated man I ever met was an ex-boss of mine, who, so far as I know, had never received a day's education after he was nine years old. He retired from business several years ago with a million or so that had been honestly earned. Although his education was so limited, he had developed his reasoning powers to a point that made him almost infallible on business and mechanical questions. He didn't attempt to keep his scheme of doing this a secret, and it consisted, as he said, in thinking about what he was doing. He said that most people believe that they think, but there isn't one in a thousand who uses more than 1 per cent. of his brain power in this line. Like everything else, it is a matter of habit. He said that the all-round thinker is the man who is prepared for whatever happens, and that some men get to think quite efficiently in a limited field, but are unable to do any real thinking about anything outside of that field. Something like the celebrated mathematician who was short-changed for years at a certain restaurant and didn't know it until a friend pointed it out.

"I see examples of this in the shop every day," continued Dave. "Even the best men depend on experience and training and not on reasoning power. As long as the course of work comes within their experience they do well; but let some new condition appear and they are up in the air. Some day, perhaps, the public schools will teach reasoning power and observation, and cut out some of the general information filling that is crammed into the youngsters' skulls.

"If Tom is really bent on advancing himself in the shop, I could give him some advice on what to study after hours. You might call it the study of physics—the physics of human nature. He would have to study the laws of friction, lubrication, inertia, centrifugal force, stresses and strains, and the like, but as applied to human beings instead of to iron and steel and machines.

"Take the subject of friction. This is always present when a number of human beings get together, and the man who has the job of directing their efforts must reduce it to a minimum if he wants to avoid overheating. Friction will put a machine to the bad quicker than anything else that I know of, and in the shop it will spoil

a gang in double quick time. The way to remedy it is by proper lubrication, and this is applied to men a good deal as it is applied to machines except that instead of coming from the spout of an oil can it comes occasionally through the pay envelope, or in more cases through appreciation, tact and understanding. When you find a shop with one department that works smoothly and another one in which it takes main strength and perseverance to get out last week's work next week, you can be fairly sure that the boss of the first department is an expert on lubrication and that the man in charge of the second has let his oil can run dry!

"Tom showed me a page in his book the other day that told the way to figure the balance of forces. For instance, if you have a force of 10 lb. shoving in one direction and one of 8 lb. in the opposite direction, the net result is a force of 2 lb. in the first direction. I have to balance forces in the shop every day, although I don't do it on paper. When two fellows are working at cross-purposes you must separate them if you want the net result to be greater than the difference in their efforts. Sometimes you have to combine forces just as I did last week in the case of John Ribault and Hans Schmidt. Just at present, as you know, there is a little difference of opinion between these two nationalities, and it is reflected back in its effect on human nature, even on this side of the water. I had a job consisting of a hundred pieces in which the milling and the drilling work was well balanced, so I put John on the milling and Hans on the drilling. John tried to swamp Hans,

and Hans on the other hand did his best to keep 'way ahead, so he could holler for more work. The result was quite as satisfactory to me as the successful working out of a problem in physics would be to Tom. Forces, both of them opposite to start with, were made to shove in the same direction toward a big output.

"When it comes to inertia, which is something else that Tom's book deals with, there are a lot of truths that apply to men as well as to lifeless objects at rest or traveling through space. Human inertia is what makes it so hard to speed up an old shop and comparatively easy to keep it up to speed after it is once there. It makes it almost impossible for a man to see twelve pieces as a day's work when he has been used to six. Some human beings have more inertia than others, but these are the very ones that will have the effect of fly-wheels after you get them turning at the proper rate. A man who will switch tracks too easily is likely to jump the rails at the wrong place and wreck the train. Fellows with a little inertia to them seem to have the greatest amount of 'stored energy' as the book calls it, when they once get going, and once going are most likely to meet scheduled time.

"Centrifugal force is the big problem," concluded Dave. "When you keep things going 'round at a good rate, each man has a tendency to fly off at a tangent, and it is the boss' job to hold them together. And you can't do it by means of a formula with a square root sign over a couple of letters. It takes more than algebra to do that!"

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Cast-Iron Drop-Forge Dies

BY A. R. BRADEN

SYNOPSIS—Cast-iron drop-forge dies have been regarded chiefly as expedients where the work to be done has been unimportant as to quantity and quality. This article describes the method of making drop-forge dies which has proved successful on a large variety of shoe machine forgings.

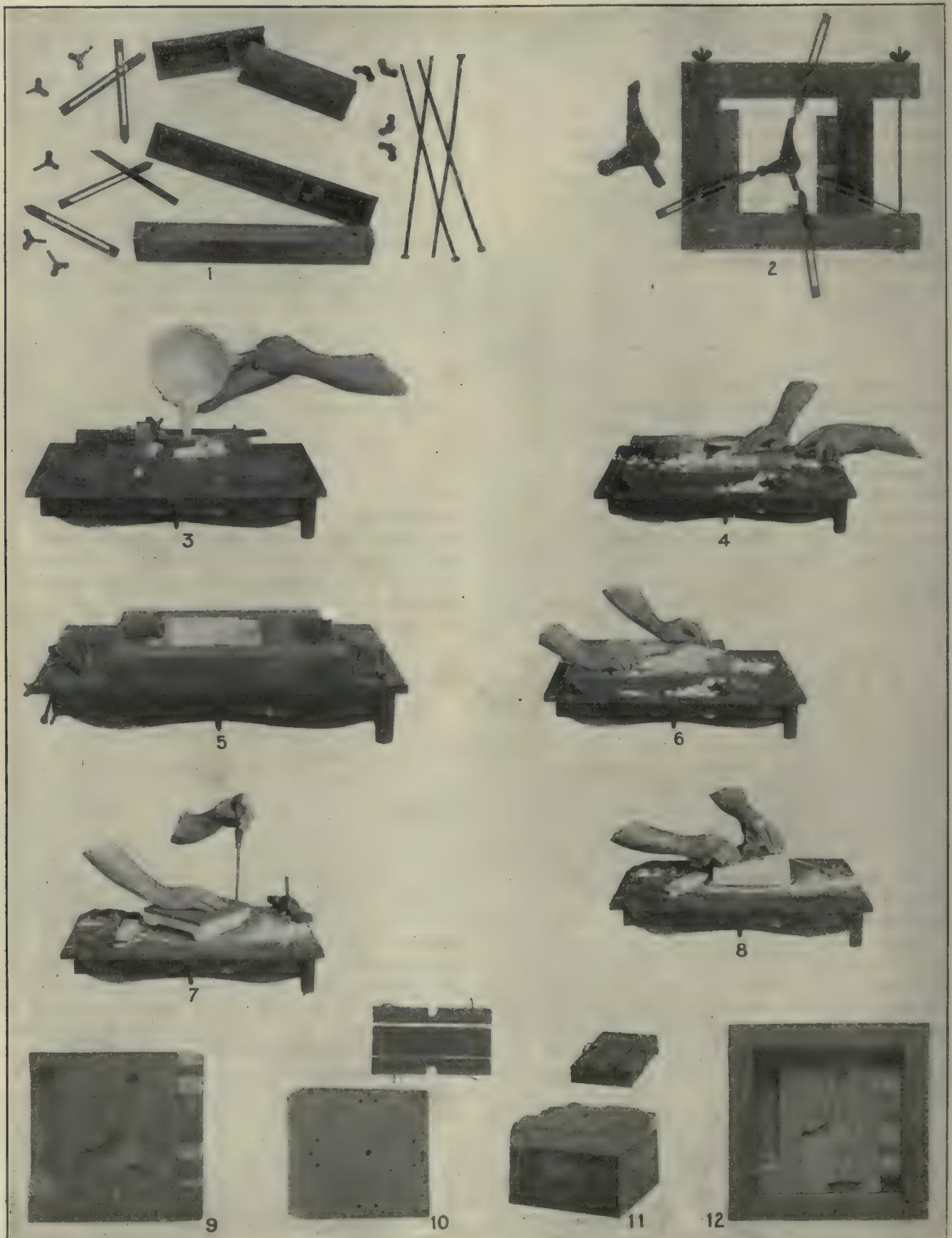
In the early part of 1911 a pair of cast-iron drop-forge dies was made in the Beverly factory of the United Shoe Machinery Co. Differing from experiments made with similar dies by various other parties, this pair of dies gave evidences of success. But before taking up the details, it might be well to explain the circumstances that led up to the trial of cast-iron drop-forge dies, and their subsequent adoption.

The experimental department of this factory, being constantly engaged in devising new machines and improving those already in use, has a large demand for new parts, many of which are forgings. Formerly, these forgings were made by a blacksmith, who, though using his best skill and taking plenty of time, was unable to produce a satisfactory forging for the simple reason that the irregularity of most of the required pieces made hand-forging to any close dimensions almost impossible. As a result of this condition of affairs, it was a long and expensive operation to machine the rough hand-forgings to the proper size, and one that was detrimental to the department,

inasmuch as time was often an important factor in the work.

The old method of hand-forging was set aside as giving too unsatisfactory results, leaving one other alternative—drop-forging. Surely, steel dies could not be considered, as the time necessary to make them was prohibitive, not to mention the cost. Cast-iron drop-forge dies were suggested, bringing forth of course the statement that they had been tried many times without avail. Besides, the time taken was just as much as the time consumed in the making of steel dies and therefore the expense was equal except for the difference in the cost of the stock. But by discarding the idea of "sinking" the impression in the iron blocks and in its place using the plan of casting them, at the same time incorporating a mixture of iron, known in this foundry as cam-metal, a pair of dies was produced that more than satisfied all expectations. The success achieved with this pair of dies disclosed the solution for the experimental department problem, and, as over two hundred forgings were made from these dies, it also brought forth another question—Why could not cast-iron dies be used in regular forging work?

Of course the thought of making cast-iron dies to replace steel dies opens up a field of great possibilities and is therefore worthy of a thorough test. Not only is there an opportunity to effect a large saving in the cost of new dies, but on orders of between five and ten thousand pieces it is invariably necessary to repair the steel dies and



FIGS. 1 TO 12. EQUIPMENT AND METHOD USED FOR MAKING CAST-IRON DROP-FORGE DIES

Fig. 1—Parts of the adjustable casting frame. Fig. 2—Casting frame with piece; ready to pour. Fig. 3—Pouring with plaster of paris. Fig. 4—Cutting down to the parting line. Fig. 5—Master plate removed from cast. Fig. 6—Leveling top surface of cast. Fig. 7—Fitting to cast-iron backing plate. Fig. 8—Testing depth of impression. Fig. 9—Finished plaster cast. Fig. 10—Loose pieces for casting the shank and base block. Fig. 11—Plaster cast fitted to base block. Fig. 12—Ready to make the dry sand core

often to plane off the old impressions and "sink" new ones, an operation that is costly and one that holds up forging work until such time as the dies can be put into commission. Another common requirement is the changing over of steel dies to agree with a change in the design of the forging, an operation that is nearly as expensive as making new dies.

The method of making cast-iron dies, as used for the first month or two, was simple; but so many improvements have been made that at the present time the process seems to have been perfected to the highest point. The patterns for casting form the bulk of the work in die making, and it is to these I refer when speaking of the process of making. The original patterns consisted of two sections—a pattern containing the impressions of the forging and a pattern for the remaining part of the die block. The former was simply a rectangular wooden frame, of certain dimensions—we use eight different sizes of die blocks—which held a plaster impression of the forging. The molding of these impressions was a very simple operation. For instance, a frame of suitable size for the piece was placed flat on a surface plate. Then by means of a small strip of wood tacked temporarily to opposite sides of the frame, the wood model of the forging was held in the proper position—this model being made to shrink dimensions, allowing the required draft. Plaster of paris was then poured into the frame until the parting line of the model was covered. The surface of the "cast" was smoothed up, and the "flash" cut out. The breakdown, sprue, anvil and cutoff were next chiseled out of the frame and plaster. This gave a correct molding-impression pattern for the upper or lower die.

REDUCING MACHINE WORK

The pattern for the whole die block was obtained by securing the impression pattern to a wooden block, which was nothing more than a closed box of corresponding dimensions. The great difficulty with the castings obtained from these patterns was that the tongue or shank had to be planed out of the solid block, with allowance of course for the draft, and then it was necessary to mill out the dowel holes. To decrease the amount of machine work the die-block pattern was changed so that a shank, without draft or dowel holes, could be cast on the block. This step resulted in a big saving, but was not in use for long, because a pattern was soon originated that made it possible to cast the die block and the shank with both draft and dowel holes, thus doing away with all machine work. To accomplish this the pattern for the shank was made in three parts—a wide rectangular centerpiece and two smaller strips, on each of which were cut the draft and dowel holes. These small pieces were held to the centerpiece by two pins running through each small piece into the middle one. Hence, when in molding the pattern was ready to be drawn from the sand, these pins were removed and the main part of the tongue drawn, making it possible to draw the small strips. This could not be done otherwise on account of the draft.

Although the wood frames of the impression patterns were well shellacked, they soon absorbed the water from the plate with the effect that the wood warped, thus spoiling the correctness of the pattern. This trouble was overcome by securing a casting of the pattern, and using the latter as a model for molding the first die

and for filing for future use. This iron pattern—called a "master plate"—before being used for molding purposes was treated with a specially prepared wax to give it a smooth molding surface and to prevent rusting. Along this same line another improvement was soon made, in the shape of providing an aluminum block pattern to replace the old wooden one, thus giving a completely indestructible die pattern, with the exception of the pattern for the tongue, which it has not as yet been found necessary to replace by metal.

ECONOMICAL PLASTER PATTERNS

The latest improvement concerning the making of the original plaster patterns is one that is bound to reduce the cost of that method considerably, both by lessening the actual expense of making patterns and by eliminating the need of the cast-iron "master plates." The old wood and plaster pattern made in the wooden frame is abandoned altogether and in its place is substituted a pattern entirely of plaster. A special frame, similar in shape to the old wooden one, is made of cast iron and is adjustable by means of pegs and dowel holes to any one of the eight standard die sizes. This frame is placed flat on a surface plate, the wood model of the forging being held in the proper position relative to the frame by means of four clamps that bear on the parting line. These clamps are about 4 in. long and have a long central slot, one end being beveled to a knife-edge. Thumb-screws hold the clamps rigid on the frame in any desired position. The patterns for the breakdown, anvil, sprue and cutoff are sawed out of wood and placed in their proper positions inside the frame. The plaster is then run into the frame and allowed to set. When hard, the frame is removed, together with the model and patterns, leaving a complete plaster impression ready for molding. The advantages of this new improvement are instantly apparent. All wooden frames are discarded. These frames were quite an item of cost, inasmuch as they had to be accurately and strongly made, and it was necessary, heretofore, to carry a stock of wooden frames of all sizes, to be ready for new orders. A great deal of time is also saved in that the breakdowns, anvils, sprues and cutoffs can be cast with the impression of the forging by simply cutting out the necessary patterns from waste stock on a band saw. These plaster patterns, made with the adjustable frame, may be filed away without danger of warping. If they break they can be replaced in an hour's time.

CARE IN MOLDING AND CASTING

The molding and casting of the dies is not a difficult operation, though it requires a certain amount of care and should not be hurried if good results are desired. A core is made of the impression pattern to withstand the weight of the iron and consequent crumbling, which ordinary sand could not do. The molding flasks used are in three parts—the "drag," containing the core and plaster pattern; the middle part, holding the aluminum block pattern, and the "cope," the wood pattern of the tongue or shank. Instead of pouring the molten iron through the top of the shank, a special inlet is made through the sand and to one side of the mold, thus allowing the iron to run out over the core instead of falling onto it. In this way the mold is filled from the bottom up, making possible the casting of delicate impressions without fear of breaking the sharp corners. An opening through which the iron is stirred is left in the top of the



FIGS. 13 TO 22. CAST-IRON DROP-FORGE DIES, WITH SOME EXAMPLES OF THE WORK PRODUCED BY THEM

mold, which happens to be in the shank, at the same time providing for the shrink of the cooling iron and bringing the "slag" to the surface. All that remains to be done to prepare the castings for the hammer is to clean out the impressions with a brush or file and to stamp them with their designating numbers.

The three important considerations in the die-making department of this factory are time, expense and results. In many instances all thought of expense is put aside in order to turn out certain work before a specified date. In other cases expense is sacrificed to secure certain desired results. Cast-iron dies have been tried with the idea of reducing the time and expense of die-making to the lowest possible point, at the same time equaling in quality and number the forgings produced from steel dies. The success that has been attained during the long period of trial has been pleasing to those directly interested and surprising to those who were inclined to discourage the idea at the start.

The maximum time required to turn out cast-iron dies ready for the hammer is four days; the average time for steel dies is between one and four weeks. On one order a pair of cast-iron dies produced five thousand forgings—equaling the mark of the steel dies for the same part.

This record will not hold for all iron dies, but in many cases the life of the dies nearly equals the average duration of steel dies. Even if cast-iron dies did not produce one-third as many forgings as steel dies, the saving in cost would be sufficient to continue their use, let alone the time saved by not waiting for dies, a condition so often detrimental to efficient factory production.

Nothing has been said, so far, in reference to trimming dies. But it might be interesting to know that actual trials have proved them to be as successful in their line of work as the drop-forge dies are in theirs. Excellent results have been obtained both in hot and cold trimming work; for instance, one die—ground once—and one punch trimmed a thousand forgings through a flash fully $\frac{3}{16}$ in. thick. These dies were cast of white iron and were converted, but even then there was scarcely any comparison of cost between them and steel trimming dies.

Up to the present all cast-iron drop-forge dies have been used in the hammers without a converting process of any kind. It is true that a special mixture of iron has been used, but from the results already obtained it is impossible to predict a limit to the success that may be attained through toughening the iron through a suitable converting process. The possibilities are alluring.

Developing New Lines of Product

By A. G. POPCKE*

SYNOPSIS—Outline of methods used to develop and test a new line of product in a large manufacturing firm where efforts must be constantly made to keep up to date. Suggestions are studied from every angle, the financial possibilities being decisive. The makeup of the development committees is given in detail and their duties outlined.

The success of any manufacturing establishment depends largely upon its ability to keep its product up to date to fulfill the latest requirements. The most progressive firms make improvements on their product to keep ahead of competition, thereby reaping large profits before other manufacturers of the same class of goods are ready to offer similar articles. To enable a manufacturer to carry on the necessary research and missionary work to keep up to date, a certain amount of money must be expended, ordinarily known as development expense. The method employed to carry out these developments depends upon both the size and scheme of the organization. In a small manufacturing establishment, where one man takes the responsibility for carrying on the enterprise, success depends to a great extent on his ability to keep his product in line with or ahead of competition. The tendency of manufacturing firms is more and more toward large organizations composed of stockholders who elect a board of directors and the necessary officers to run the organization; these officers are directly responsible for the success of the enterprise. It is the object of this article to outline how in large organizations of this kind developments are carried on to keep abreast with progress.

Any large organization is divisible into the following departments: (1) Executive—president, vice-president.

(2) Financial—treasurer, auditor. (3) Production—engineering and manufacturing. (4) Sales.

Each of these divisions (except 1) can be divided into those doing executive work and those engaged in productive work. The executive is always the final judge when decisions are made. The executive function is taken care of by one man or several men acting together. The general policies of the organization are determined by the executive department.

The financial department is closely related to the executive department and its principal function is to determine the financial soundness of the undertakings. Also, by proper accounting, to show the financial history of the institution and indicate safe paths for the future. Further, to establish adequate banking connections, obtain credit and be in a position to determine the credit of those with whom the organization desires to do business.

The function of the production department is to design and build the articles manufactured. In large organizations the production department consists of two general divisions—the engineering, responsible for the design of the products, and the manufacturing, responsible for the turning out of the product sold or to be sold by the sales department.

The sales department is continually in touch with competitive conditions; it is in better position than the other departments of an organization to keep informed as to future market requirements. The engineering department, on the other hand, must design and produce articles that will meet future requirements, both as regards quality and cost. There is, therefore, close coöperation necessary between these departments and the manufacturing departments responsible for producing a given design of product at the lowest possible cost.

*Engineer, Westinghouse Electric and Manufacturing Co.

Manufacturing establishments can be divided into two general classes: First, those manufacturing one definite kind of product; second, those manufacturing a large variety of products. In the first case it is a comparatively simple matter to keep up to date, but in the latter a greater amount of development work is necessary. Large electrical manufacturers, for instance, must do a great deal of development to keep in step with the rapid progress that is being made in the various phases of their business. A discussion of the various phases of this problem as handled by a large organization manufacturing motors, generators, controllers and other electrical apparatus will serve to illustrate the necessity of having a definite organization to carry out economically the new developments.

An electrical goods manufacturer in business to supply the demands of the trade must have experts in the engineering, works and sales organizations to design, build and sell the various products. Each of these three departments is, therefore, split into sections to handle one or more types of apparatus. The table shown outlines the general form of organization.

In organizations of this kind the executives are not sufficiently familiar with the details of the business to be in a position to initiate developments. For this reason an organized method must be employed by which new developments are initiated by those who handle the design, manufacture or sale of the apparatus in greater detail. To accomplish this, committees are appointed that are responsible for recommending changes in existing standard apparatus, or the development of new lines of apparatus. These apparatus committees consist of the following members: (1) Representative of sales department (in charge of sale of particular apparatus in question). (2) Representative of works department (superintendent in charge of particular apparatus manufactured). (3) Representative of engineering department (head of section of engineering department, designing particular apparatus in question). (4) Chairman-secretary.

The subjects to be discussed or in the docket of these committees are determined as follows: Any employee who feels that an improvement could be made in an existing piece of apparatus or who believes a new piece of apparatus could be sold at a profit, refers his recommendations to the acting vice-president, giving his reasons for doing so. These recommendations are referred to a committee of works manager, manager of engineering department and manager of the division of the sales department interested; this is known as the general committee. If this committee concurs in the expediency of the subject being considered, it will be placed on the docket of the proper apparatus committee. The object of referring a subject to this general committee is to eliminate all subjects that for reasons of policy could not be timely or possible of accomplishment at the time.

BOARD OF HIGHER OFFICIALS

The apparatus committee submits its recommendations to the general committee, and also to a board consisting of the following higher officials, in the form of a report, the details of which will be discussed later: Vice-presidents, sales manager, works manager, manager of engineering department, auditor, treasurer, credit manager, purchasing agent.

This board passes on the advisability of development from a purely business, banking and policy standpoint.

The reports give data under the following headings: Subject, date of docket, number of report, date of report, object of report, relation of proposed apparatus to existing apparatus, date to be on market, amount of sales in number of units, life of design, statement of earnings, reasons for development, cost of development, time to develop, number of units to pay for development, details of cost, details of selling price, recommendation.

The function of the chairman-secretary is to obtain the necessary data from the other three members of the committee and to submit a report recommending what should be done. Following is a summary authorizing generally the nature of developments considered:

1. Apparatus is entirely new: (a) A new line of business; (b) to entirely replace existing apparatus.

2. Improvement in existing piece or line of apparatus: (a) Change in design to produce cost reduction, to produce better quality or to correct defects; (b) change in method of manufacture to produce cost reduction, to correct defects or to facilitate production; (c) change due to commercial conditions to reduce cost, to better quality or to bring up to date.

DUTIES OF THE VARIOUS COMMITTEE MEMBERS

The sales member of the committee is responsible for obtaining the following information: (1) Number of units of proposed apparatus to be sold per year. (2) Estimated life of design based on commercial knowledge. (3) Commercial reasons for carrying out the development. (4) Net price at which the apparatus under consideration will be sold.

In determining the demand, the relation between production and distribution must be carefully considered. If the product already exists, the number of manufacturers making a similar product and their annual output should be carefully considered. The relation of this output to the total annual demand of users that can utilize the product should be carefully analyzed. If the product is entirely new, a demand must be created and the possible annual sale must be carefully estimated.

The engineering and manufacturing members are responsible for the following information:

1. Estimated life of design, based on engineering knowledge.

2. Cost of development to produce an experimental sample, including cost of design, drawings, patterns to build experimental sample and testing of experimental sample.

3. Cost of development to enable manufacture of apparatus commercially after the sample has been approved as a feasible engineering, manufacturing and commercial proposition. This consists of cost of tools to enable economical manufacture, cost of sample made with tools and cost of trying out accuracy of tools by building sample and cost of testing sample to see if it meets the contemplated specifications.

4. Cost to produce each unit when on final commercial basis ready to be sold in quantity.

5. Time to carry out the development and testing of experimental sample, time to produce the tools and samples made with tools and time to produce a sufficient number of units to be placed in stock to enable the sales department to sell the new apparatus. Setting a date at which work should be started, the date of marketing is determined, which will enable the sales department to

prepare its advertising campaign and literature to illustrate and describe the apparatus under consideration.

6. Facilities for producing the new product in regard to tool equipment, floor space and its effect on output of existing apparatus must be carefully analyzed.

With these data available, the chairman is in a position to work up a report of the form indicated in the foregoing. The statement of earnings is the item that the members of the governing board, who must pass upon the recommendation submitted, are most interested in. It consists of the following items: Number of units sold per year; total cost of producing these units; total returns obtained by sale of the units; profit in dollars per year; percentage profit.

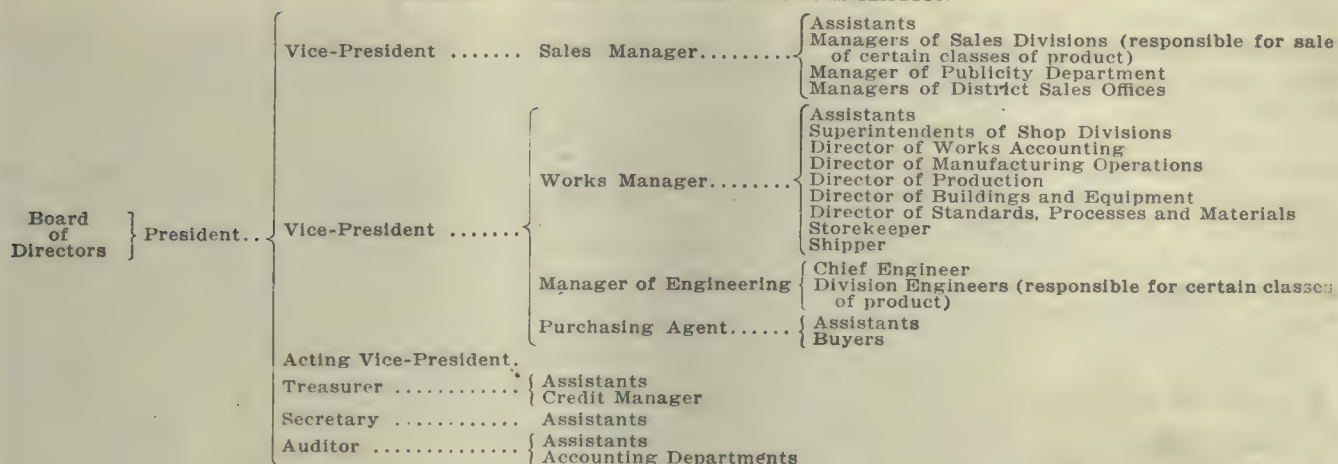
THE TOTAL COST OF PRODUCING

The total cost of producing the units requires a little explanation. It is the product of producing each unit

enters an order to cover the expense of designing, making drawings, necessary patterns for castings and the experimental sample and testing it. After the experimental sample has been built and tested to the satisfaction of the engineer responsible for its design, it is submitted to a committee consisting of an individual of wide general engineering experience, as the chief engineer, and an individual of wide manufacturing experience, for approval to proceed with its manufacturing and commercial development. If this committee approves it as a good engineering and manufacturing proposition and it is passed by the party responsible for its sale, steps are taken to have tools made that will enable it to be manufactured on the most economical basis.

The first step before starting the tool development is to check the drawings of the experimentally built sample to see that they are in final shape. After this has been done, an itemized estimated cost of tools is made up by

GENERAL OUTLINE OF FORM OF ORGANIZATION



by the number of units sold. In obtaining the cost of each unit, the following are included in the factory cost: Labor, material, indirect factory expense and development cost per unit. The amount added for development expense per unit is determined by the length of time allowed to recover the development. A definite time of one or two years, or sometimes more, is set for this purpose, depending on the life of the design. After the factory cost has been determined, it is increased by a percentage to cover administrative sales and advertising expense. The total cost per unit obtained in this way is multiplied by the sales per year to obtain the total cost.

The total sales value of a year's business is determined by multiplying the net selling price per unit by the number of units sold per year. The profit is then determined from total cost and total sales value.

With this information, the chairman submits a report signed by the apparatus committee members to the board of officers for approval. After the report has been approved, it is necessary to have a system organized that will insure the prompt carrying out of the recommendations. This system is similar to a production system necessary for building units as ordered by customers. The chairman of the committee is advised whether or not authorization has been given to carry out a development recommended by his committee.

As soon as a report is approved, the chairman advises the committee members. The engineering member then

the shop superintendent responsible for its manufacture. Two general classes of tools must be considered—those necessary to insure interchangeability of parts and accuracy of workmanship, and those required to produce a reduction in cost by saving labor, if quantity of production warrants it. An estimated cost of the product when finally manufactured with the list of proposed tools is submitted.

These estimates are checked with the original estimates given in the report that requested the development. If the new estimate is higher than that originally made, the committee must check to see if the continuation of tool development will result in a profitable commercial proposition. If it does, the development of tools is started after an order has been entered by the superintendent in charge of the manufacture of the proposed apparatus. The order gives an estimate of both time and expense necessary to complete the tools requested.

BEGINNING OF THE SALES CAMPAIGN

After the tools are completed, samples of the new apparatus are built with the tools and these samples are referred to the committee that passed on the experimental samples. Upon its approval, the apparatus is ready to be sold as a commercial product and steps are taken to issue literature describing and advertising it. Standard apparatus is usually carried in stock. Therefore the next step is to place the newly developed apparatus in stock.

To insure economical handling of orders for standard apparatus, a stock specification is prepared. Each piece of apparatus and part thereof is given a style number. Permanent information for making these various pieces is filed in the various parts of the shop where they are manufactured or assembled. The sales department specifies the minimum number of completed units of each size and type that should be carried in stock. It is then the function of the production department to see that the proper number of units are available in stock at all times. The sales department is to see that the stock is kept moving.

During the period of development, the accounting department keeps a record of the expenditures on the various experimental orders and orders for making tools changeable to a given report. As soon as it is seen that the estimated appropriation will be overrun, a new estimate for the completion of the development is made and a recommendation as to whether or not to complete the development with reasons is made by the apparatus committee for approval by the general committee. In case it becomes necessary to change the scope of the original report submitted, approval by the board of governors is necessary.

To carry out a system as just outlined requires lots of time and often delays the starting of a proposed development. A long period of time is required to actually market the new or improved product. But a system of this kind insures that the subject is analyzed from all angles and thus eliminates lots of expensive blunders that may result if ideas of individuals are too hastily carried out.

Opportunities for Civilians To Become Engineer Officers

By W. M. BLACK*

It is expected that the next examination of candidates from civil life for appointment as second lieutenants in the Corps of Engineers, U. S. A., will be held on or about Jan. 29, 1917. There will probably be about 30 vacancies, which it is desired to fill from that examination. Candidates to take this examination must be (a) unmarried, (b) between 21 and 29 years of age, (c) graduates of approved technical schools, (d) eligible for appointment as junior engineer in the Engineer Bureau of the War Department.

It is believed that there are a large number of well-qualified young engineers who comply with the conditions (a), (b) and (c) above and who will desire to take this examination. *In order to qualify under item (d) above, it will be necessary for all such young men, who are not already so qualified, to take the Civil Service Commission's examination for junior engineer, civil, to be held at numerous points throughout the country Oct. 11 and 12, 1916.* The Civil Service Commission informs me that the results of the October examination will be determined in ample time to allow the successful candidates to take the War Department examination for second lieutenant on or about Jan. 29, 1917.

Applications from persons along the Atlantic Coast to take the examination Oct. 11 and 12 should be submitted so as to reach the United States Civil Service Commission, Washington, D. C., at the very latest by Oct. 8. For other

parts of the country applications must be submitted earlier. In every case applications should be submitted as soon as possible to insure the receipt of the approved application at the place of examination by Oct. 11. Application blanks may be secured by addressing the Civil Service Commission, Washington, D. C., or by addressing or calling upon the secretary of any of the civil-service districts. These districts with their headquarters are as follows:

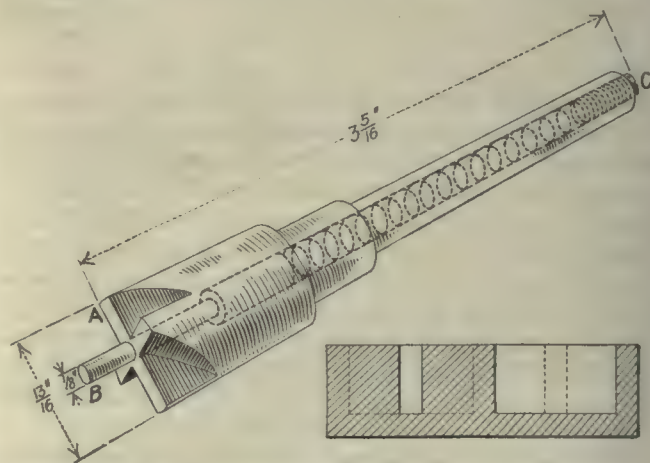
First	Boston, Mass.....	Post Office Building
Second	New York, N. Y.....	Custom House
Third	Philadelphia, Penn.....	Post Office Building
Fourth	Washington, D. C.....	
Fifth	Atlanta, Ga.....	Post Office Building
Sixth	Cincinnati, Ohio.....	Post Office Building
Seventh	Chicago, Ill.....	Post Office Building
Eighth	St. Paul, Minn.....	Post Office Building
Ninth	St. Louis, Mo.....	Post Office Building
Tenth	New Orleans, La.....	Custom House
Eleventh	Seattle, Wash.....	Post Office Building
Twelfth	San Francisco, Calif.....	Custom House

It may be stated that while the examination papers from the recent examination for second lieutenant, held Aug. 21 to 25 of this year, have not yet been completely marked, a preliminary report received from the board marking the papers shows that several of the candidates will probably receive marks of over 90 per cent., from which it would appear that the examinations are not too difficult for the class of men desired.

Counterbore with Disappearing Pilot

By JAN SPAANDER

The counterbore shown in the illustration was used to drill holes part way into metal strips. As the holes had to be spaced accurately, an ordinary flat counterbore could not be used. We made one with a $\frac{1}{8}$ -in. disappearing



A SPECIAL FORM OF COUNTERBORE WITH DISAPPEARING PILOT

pilot for which holes had to be drilled of the same diameter and of slightly less depth than the large flat-bottomed holes. The tool consists of a body A, partly pierced with a $\frac{3}{8}$ -in. and partly with a $\frac{1}{8}$ -in. hole for the small diameter of the disappearing pilot B. The pilot is forced down by the wire spring shown under the screw C.

Efficacy of Hot Lunches—It is claimed that the falling off in efficiency shown in the afternoon by laboring men is due in large measure to eating a cold lunch at noon. For this reason some contractors are beginning to experiment with containers designed to keep hot the lunches and drinks of their men.—“Compressed Air Magazine.”

*Chief of Engineers, U. S. A.

Pattern, Pipe and Sheet-Metal Shops on the "Prometheus"

BY FRANK A. STANLEY

SYNOPSIS—These departments on this naval repair ship carry the usual equipment found in similar shops ashore. They turn out woodwork of all kinds, such as patterns, cabinet work, wood repairs, pipework of different kinds and sheet-metal articles in a great variety. The equipment is all electrically driven, as are the tools in the machine shop on board.

The illustrations herewith show two departments that were only mentioned in the previous articles on the mechanical equipment of the United States naval repair

possible within the space allowed has been worked out satisfactorily. This feature is of particular interest in view of the complication of pipes, conduits, steam lines, water mains and other utilities that have to be taken into consideration in fitting up a shop of this kind, in order that the tools shall in no way interfere with lines running through the ship as a whole.

The same remarks apply to the department in Fig. 2—the pipe and sheet-metal shop—which is also shown, so far as installation of equipment goes, in the plan, Fig. 4, where, as indicated, the shop occupies one of the galleries above the foundry. This sheet-metal and pipe shop has in its equipment pipe-threading machines, hydraulic pipe

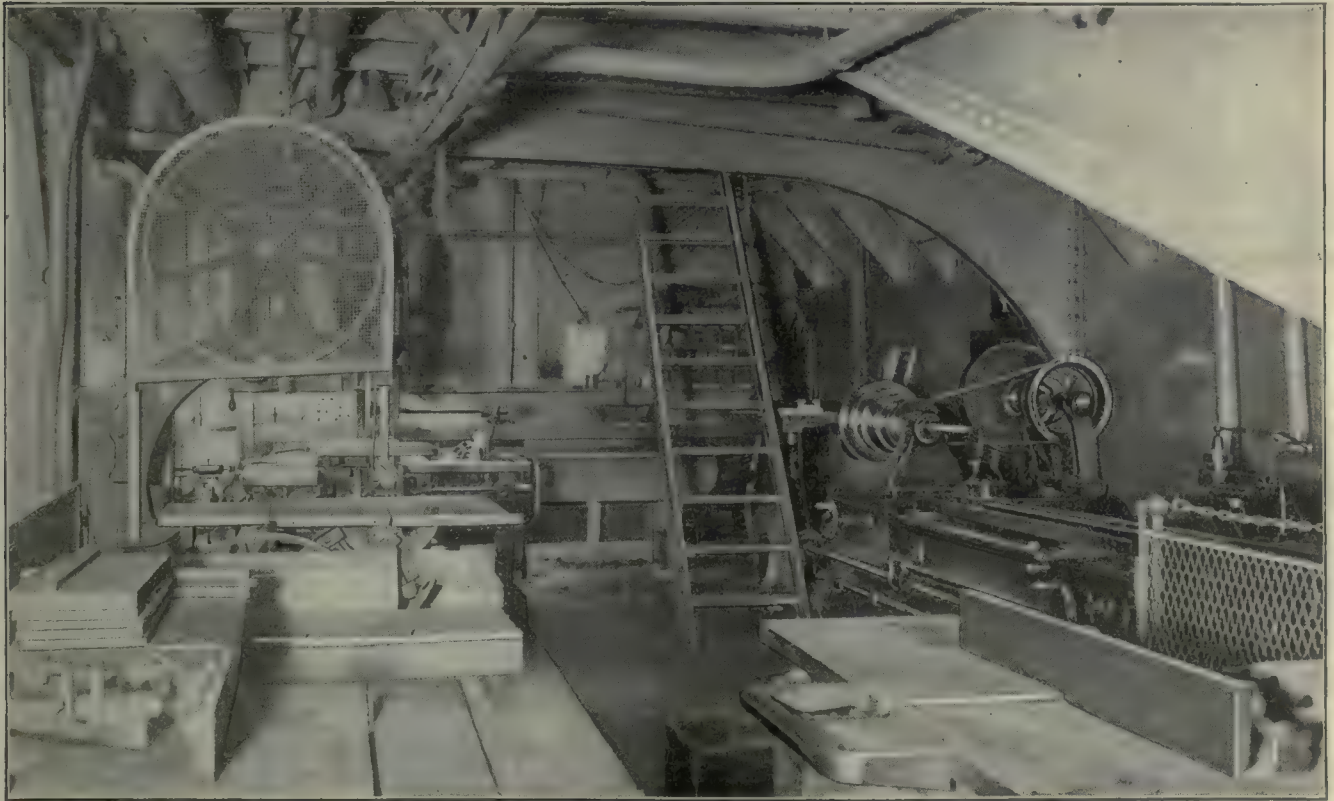


FIG. 1. A GENERAL VIEW OF THE WOODWORKING SHOP

ship "Prometheus." These photographs give a good idea of the arrangement of machinery and the general organization of the departments for woodworking and for sheet-metal work.

Figs. 1 and 3 are general views in the woodworking shop, where all kinds of woodwork, cabinet work, furniture work, pattern making and the like are carried on. Fig. 4 is a plan of the gallery in which the pattern shop is arranged. As will be seen from the drawing, the equipment includes speed and gap lathes, wood trimmers, saw bench, jointer, mortiser, universal woodworker, band-saw, grindstone and so on. These machines, like all the others in the different departments, are driven by individual motors.

As with the other mechanical equipment, the problem of installing the machines in as convenient a manner as

benders, hydraulic test pumps (motor driven), hand shears, hand rolls and other tools.

It will be obvious from these illustrations and those in previous articles about the same ship that nearly everything in the way of metal-working and woodworking machinery usually found ashore for factory operations appears on this vessel. It is certainly a novel experience to most mechanics to visit such a ship and see the activities carried on in the different mechanical branches precisely as they would be in the jobbing shops with which such visitors are better acquainted.

The facilities on this vessel for pattern making, for molding, for forging, for machining, for fitting and erecting are exactly the same as they would be in any first-class jobbing foundry and machine shop. The great variety of work that comes here from different ships, as

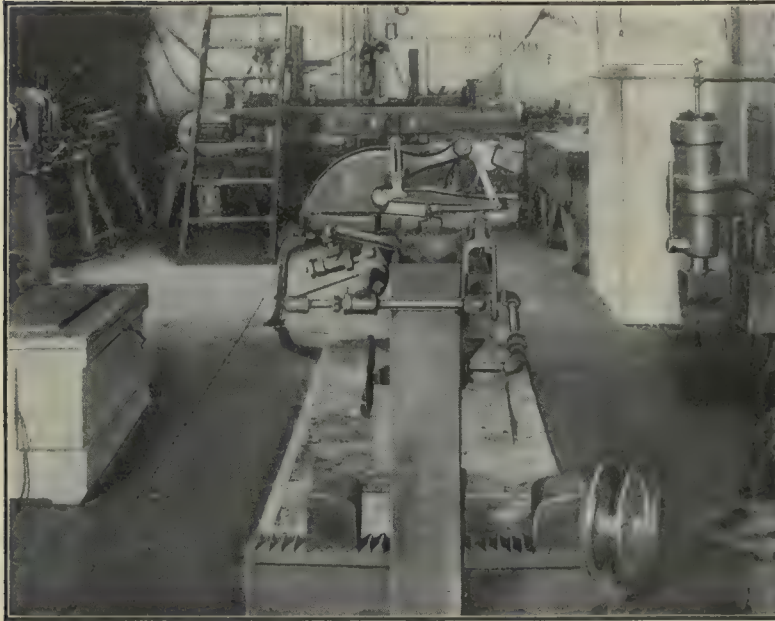


FIG. 2. PIPE AND SHEET METAL SHOP

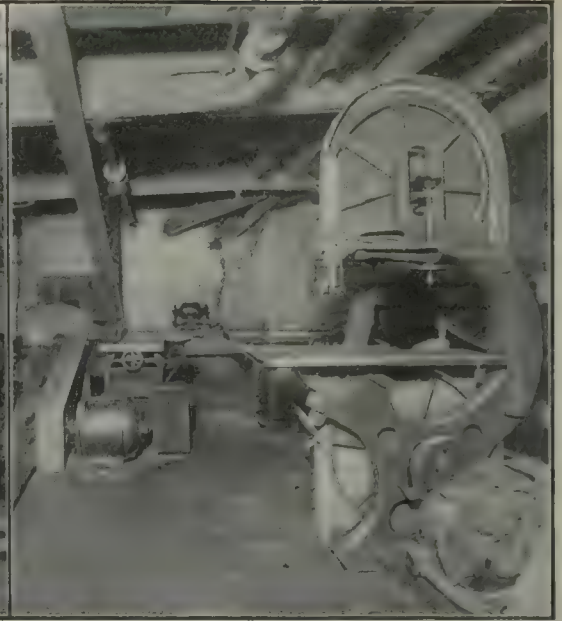


FIG. 3. A CORNER OF WOODWORKING SHOP

well as from the repair ship itself, gives the mechanics an opportunity to handle a varied line of work (differing in size and in character) hardly to be found in any general shop ashore. As a rule, these repair undertakings must be put through in a hurry; and frequently they have to be applied to some piece of machinery that must be kept

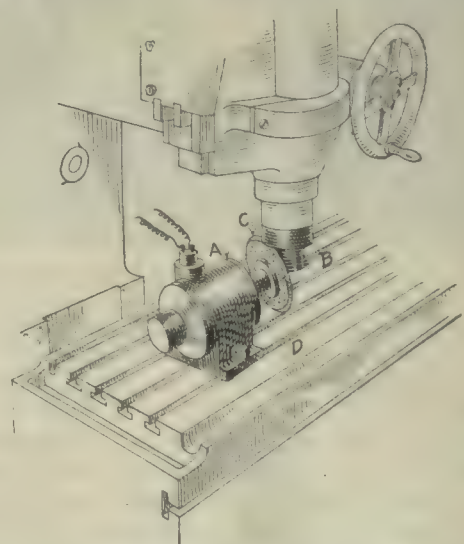
things on board, frequently while the vessel is under way. The actual machines and fitting processes are not of themselves strikingly different from the same class of work coming to the job shop ashore.

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Facing Spindle Flange with the Electric Grinder

By W. BURR BENNETT

An interesting use for the electric grinder is shown in the accompanying sketch. The portable grinder *A* is mounted on the table *D* of a vertical miller and the grinding wheel *C* is used to face off the flange of the spindle *B*.



USING A PORTABLE ELECTRIC GRINDER FOR FACING ON THE VERTICAL MILLER

The vertical and horizontal feed of the wheel is obtained with the table control on the machine. And of course the spindle is driven while being ground. This method is not only very accurate, but also rapid and handy for the average shop.

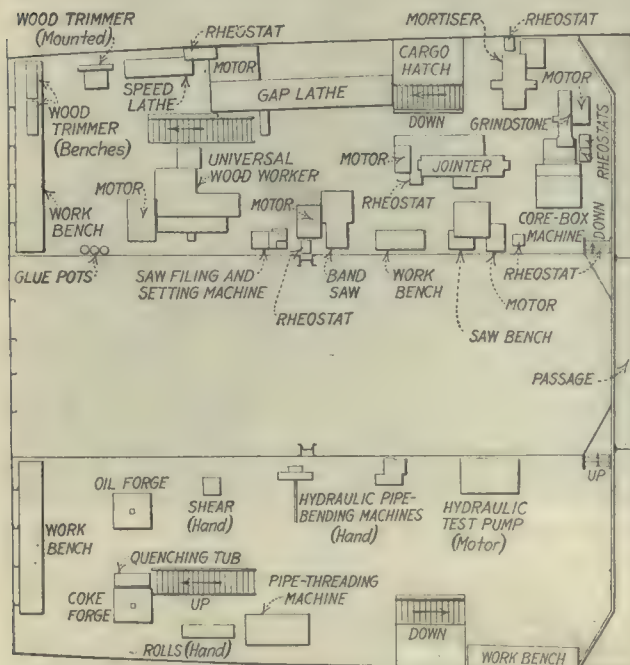


FIG. 4. PLAN—GALLERY. PLUMBER'S AND COPPER SHOP

running a good share of the time or to some apparatus that is in an almost inaccessible place, but which to the sea-going mechanic seems easy enough after his experience with similar work.

It is after all a matter of practice and experience. Men accustomed to living on a vessel soon get accustomed to working on it and doing with its equipment what they have formerly done with fixed equipment in shops ashore. So in the long run it is more a matter of getting used to the "feel" of the ship and to the principle of doing

Manufacture of Pump Leathers

SPECIAL CORRESPONDENCE

SYNOPSIS—The production of leather parts for machine use is a line of manufacture with which few mechanics are acquainted. For this reason and because of the importance of leather parts themselves this article, dealing with the manufacture of pump leathers as produced in the plant of the W. & B. Douglas Co., Middletown, Conn., will be of interest.

As machinists we are great believers in the integrity of metal parts, with a feeling of high appreciation for good foundry and shop work, recognizing the advantages of high-grade workmanship and at the same time taking

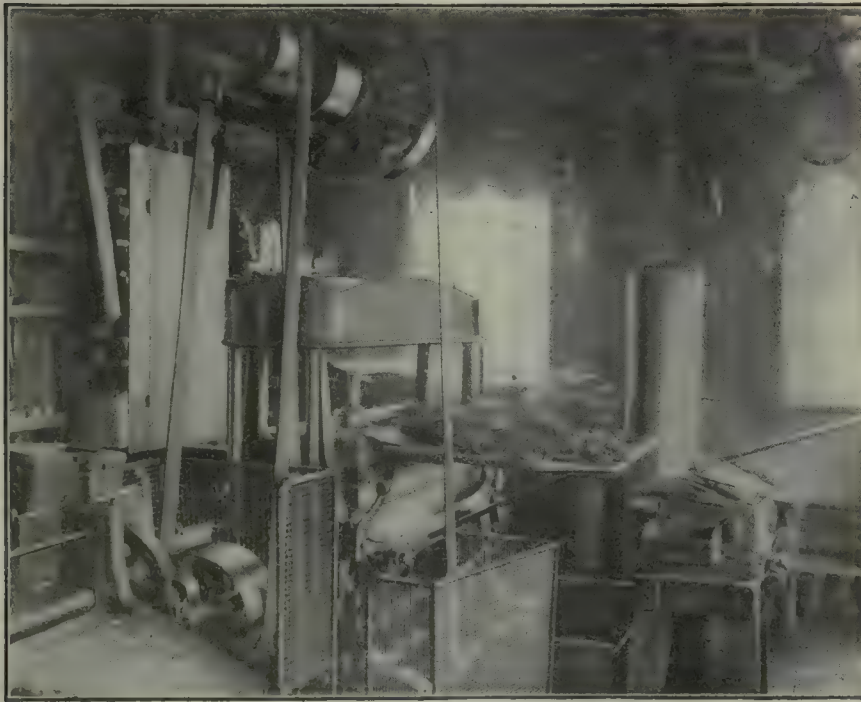


FIG. 1. PUMP-LEATHER DEPARTMENT

into consideration the necessity for various classes of fits for different parts, according to the character of the work and the demands of the service in which the equipment is to be employed. As workers of metal we are apt to belittle to a certain extent the wood-handling processes, owing to the ease with which such materials are cut and shaped and, further, to the fact that ordinarily any attempt toward holding such articles to exact sizes is disregarded in general practice.

Along with this we maintain a similar attitude toward the manufacture of objects from leather, paper and other materials worked in the semiplastic or quite plastic condition, for we feel that in the usual course of events the shaping of such work is more a matter of using the right kind of tools than of exercising any great ingenuity in bringing the work through to definite size, because the nature of the material allows it to conform more or less to deviations from so-called standard dimensions, thus making allowances automatically for what in the metal-working trade would be considered very poor workman-

ship. We have at the same time to acknowledge that leather plays a most important part in many pieces of machinery. Coming down specifically to the pump proposition, here is a mechanism used throughout the world in some form or other for first-aid work to humanity.

The life of a pump leather depends upon various factors: In the first place the better the material from which it is made the more lasting the finished leather; the machining conditions under which it is cut out and finished are important; the production of leather cups by what is really a drawing-up process analogous to the working of brass and other sheet metal imposes upon the material a peculiar set of conditions that may be controlled to a degree, assuring long life to the finished cup,

or which if indifferently attended to, results only in the turning out of an object likely to give dissatisfaction from the moment of application. The Douglas company has an extensive department devoted exclusively to making cup leathers, valve leathers, air-chamber packing, piston leathers, head packing, coupling packing rings and other items of the same material. All of these involve in their respective forms and classes certain peculiar kinds of operations, and special tools of definite character have been developed to carry on the work under the most satisfactory conditions. In a general way, whatever the finished article is to be—whether a flat disk, a flat valve or a cup—the elementary stages in its fabrication are usually identical throughout the complete list of shapes turned out. Fig. 1 represents a corner in the cup-leather department and shows in the immediate foreground a machine for shaving the leather to desired thickness, this being the

starting point in the making of the cup leather. After this shaving of the material to thickness the work is cut out to the desired size and shape by the punches and dies on the machine seen in the background, where a punch is shown standing on the table of the press. At the back of the press are cups, washers, packing rings, leather valves and the like, and in Fig. 2 are shown a large number of punches.

These tools are commonly called dinking dies and are quite like appliances used for cutting out similar shapes from paper and cloth. The cutting edges are made with a keen edge and a sharp taper, and the devices for ejecting both blank and scrap are like those with which regular punch-press tools are equipped.

These dies are made in hundreds of sizes and in scores of patterns—some plain cylindrical tools, some large sectional tools, some for merely cutting out arcs of leather and shaping it to rings, some for plain washers, some for flat valves, and so on. A good many typical jobs are shown on the bench alongside the tools. At the left-hand

end of the bench in Fig. 2 are three cylindrical dies—a portion of the equipment for forming up cut leathers in various sizes. These cylinders, which may be considered as drawing dies, are about 1 ft. in length and are simple castings with a brass sleeve lining inside.

The forming operation is accomplished in the pneumatic press, Fig. 3. In this machine, operated by air under 60 lb. pressure, the work is pushed down to a steam-heated die, which is the brass-lined cylinder just referred to. The actual die surface is about 1 ft. deep, and each cup leather as pushed and formed up punches the ones below it down through the bottom of the die. As each cup leather has to travel about 12 in. in passing through the die, it holds the working size all the way down.

There is a steam-pipe and there is also a cold-water pipe connection at the rear of the cylinder in which the die is placed. Before beginning operations, the workman gets the die well heated with live steam, which is turned into the casing surrounding the brass-lined die. He then puts the work in place, a round disk of leather with an individual die or punch lying on top of the leather disk. This arrangement is shown in the photograph. When the air is turned on, the plunger begins to force the plug or punch and the work down into the die valve. Then

If the die or sleeve in which the work is formed gets too hot, the leather is likely to crack; so the cold water is turned on when the operator can tell by a touch of the hand that the die has become too highly heated. How-

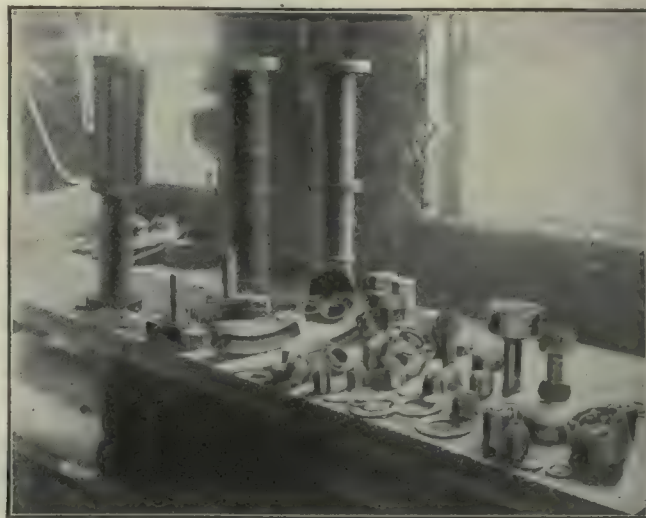


FIG. 2. DIES FOR PUMP LEATHERS

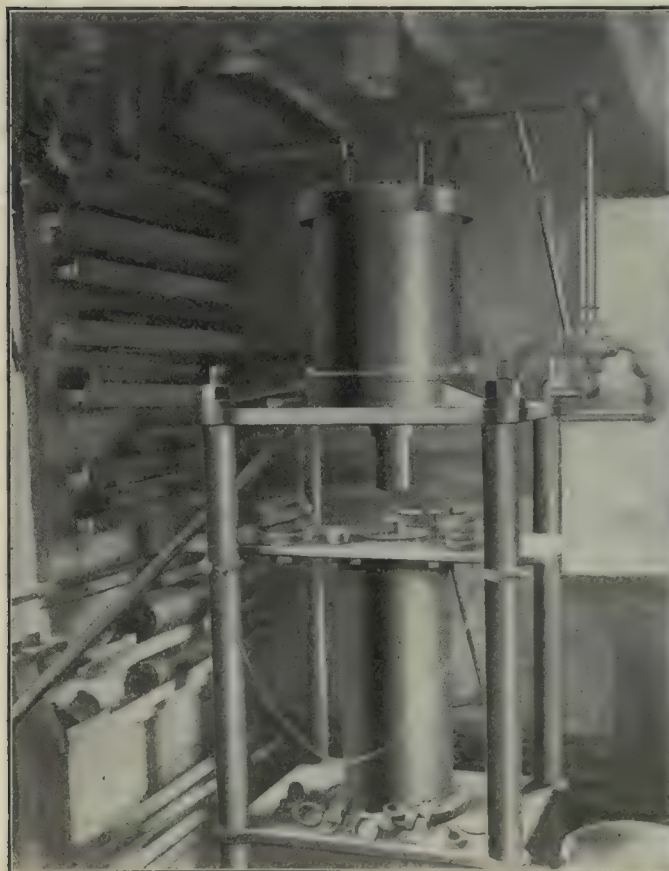


FIG. 3. PNEUMATIC PRESS FOR CUP LEATHER

another blank and another short plug are placed on the die, and these in turn are forced down. There are thus always a dozen or more cup leathers being pushed down step by step with each stroke. It is common practice to put two of these individual plugs on top of each leather disk in order to push down each cup a little farther at each stroke of the plunger and get them through the die quicker, although it is desirable that they remain in the process long enough to be kept true to size.



FIG. 4. POWER SCREWDRIVER FOR ASSEMBLING BENCH

ever, it is just as important that the die should not get too cold; for if it does, the cup leather will wrinkle in the drawing-up process just as sheet metal will wrinkle under certain conditions when not properly prevented by the contacting surface of pressure pads between punch and die. This wrinkle, which appears in the leather surface, will prevent the formation of a good cup, as the cup will not stay shaped properly, but instead flares out, as shown in Fig. 5.

For these cup leathers a good grade of regular hide is used. Before the workman puts the disk into the pneumatic-press die, he dips the leather disk into a pail of cold water to moisten it, but does not let it soak. It is just wet enough to be lubricated in carrying down through the die, but not soft enough to tear or for the surface to ruffle up under the pressure.

This drawing-up of cup leathers is an operation requiring considerable skill and judgment on the part of the workman. Certain conditions obtained are quite similar to the drawing up of metal. While there is probably no appreciable elongation of the cup as formed up, there is nevertheless a slight compression of the inner corners of the work, and the outer surface of the leather is certainly stretched materially in bending it up around the corner of the punch in producing the exterior of the cup.

Inspection of a cup leather with a wrinkled surface shows how unsatisfactory such an object might be in service. A slight wrinkle in the forming of the cup leathers actually produces a shallow channel in the outer surface of the cup. While the cup material is flexible enough to take care of a certain degree of irregularity, it is not desirable that a depression or crease extending



FIG. 5. CUP DISK AND LEATHERS

across the face should result from this forming process. It is really up to the skill of the workman to see that he handles his blanks and tools under such conditions that these wrinkles are not likely to be produced.

A view of the cup-leather department of the Douglas plant is given in Fig. 4, which represents the work bench with a power screwdriver for facilitating the

upright with the projecting arm acting on a sleeve on the screwdriver spindle, and this descending movement is produced by pressure of the foot treadle, which draws down the connection to the screwdriver upright. The hand sleeves are operated to put the disk on the brass valve, then to adjust the screw to position on the screwdriver.

Parallel-Depth Bevel Gears

BY WILLIAM C. GLASS

The Williams system of "Master Form" gearing, as described by Mr. Trautschold in the *American Machinist*, on page 353, is interesting because of its novelty. From a manufacturing standpoint, however, its value may have been exaggerated. Indeed, the article does not state that this system has been tried out under actual manufacturing conditions, which would be its most convincing recommendation.

Mr. Trautschold admits the narrow limits of the system, and in addition to those which he has named there are others, especially for machines in the field for which repair parts must be carried in stock.

Recognizing, with Mr. Williams, that the particular shape of the teeth is nonessential, provided the teeth in the mating gear are conjugates in so far as action is concerned, the ideal condition would be to have the teeth of such a form that exactly the same procedure and kind of cutter would be required to produce both. To express a concrete case, the ideal condition would be to have the teeth of both gears of a pair of miters identical.

If, then, such a form of tooth can be produced with rotary cutters, say for example commercial bevel- or spur-gear cutters, on an automatic machine that can be set up by an ordinary machinist, the improvements claimed for the Williams system will have been preserved and some of the objectionable features eliminated. The ideal condition will have been realized.

This has been accomplished in such a simple manner that a description of the method would hardly attract

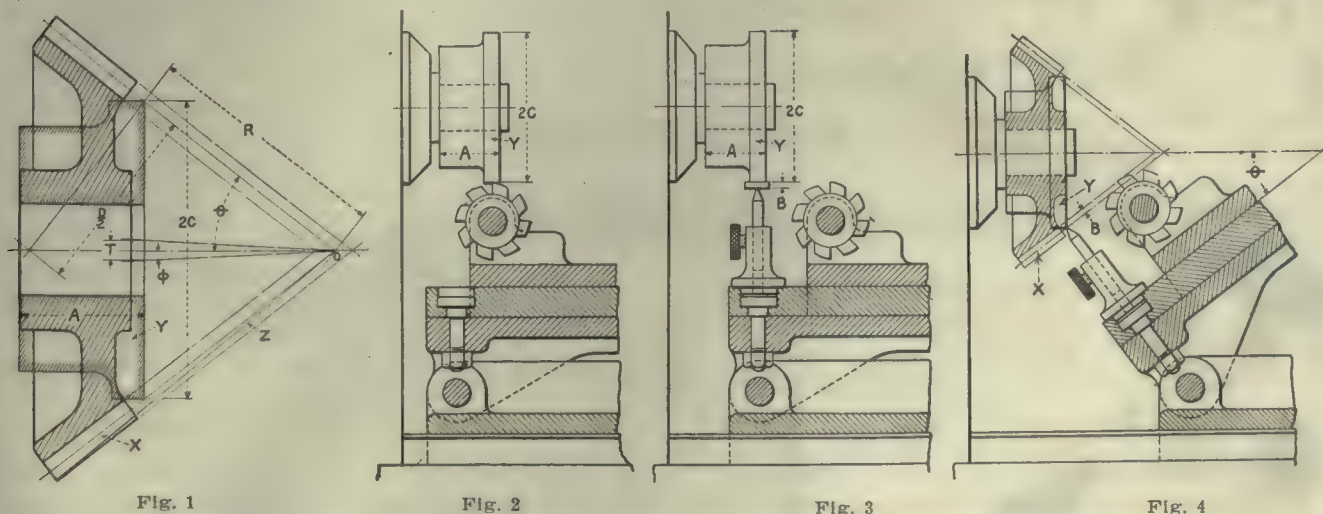


Fig. 1

Fig. 2

Fig. 3

Fig. 4

FIGS. 1 TO 4. LAYOUT AND METHOD OF CUTTING PARALLEL-DEPTH BEVEL GEARS

assembling of leathers on their valve plate, the two parts being secured together by brass screws. The style of the screwdriver is apparent from the photograph. The location of the screwdriver is secured by drawing down the

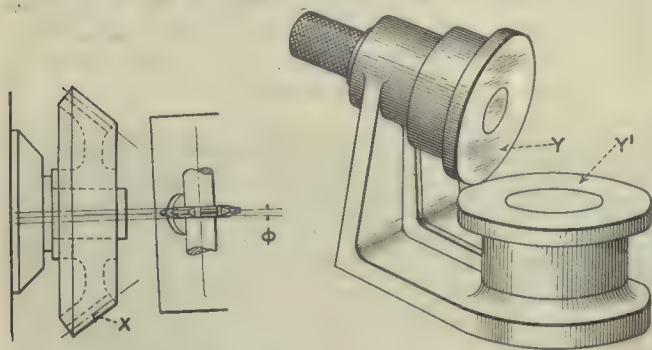
more than passing notice. The proof of its value, however, is that hundreds of gears cut out by this method, for it is a method rather than a system, are giving excellent service under most severe tests. These gears are

capable of exact duplication in large quantities without the necessity of complicated special machinery.

Up to this time they have been cut on a universal gear cutter requiring only two settings to complete a gear, but it will be readily apparent after a careful reading of the following description that it would not be a difficult undertaking to make the operation fully automatic.

It has been stated by a good authority on the subject that the milling of bevel gears is now practically a thing of the past. To add that it never was a thing of the present would be equally true, on account of the lack of reliable data on the subject. The purpose of this article is to present a practical method of designing and milling bevel gears which will enable the small shop to produce them accurately and economically. The advantages and benefits of such a method are too obvious to need further comment.

Theory will have no part in the explanation, for although the presence of errors is not denied, they are so slight as to be negligible in practice. Furthermore,



FIGS. 5 AND 6. FINAL CUT AND TESTING FIXTURE

this method has been tried out under actual manufacturing conditions, and hundreds of gears cut by this process are giving absolute satisfaction.

The process admits of two general designs, which are sufficient to meet any requirements: (1) The stub-tooth form, used preferably in new designs on account of its greater strength; (2) the standard-depth form for gears to mesh with others cut by one of the generating processes.

The process is not limited to miter gears or to bevels with shafts at 90 deg. The rules laid down in the "American Machinist Gear Book" should be followed as carefully in designing gears to be cut by this process as for any other.

It is necessary to have for each gear a gage for setting the gear cutter and a thickness gage equal to

$\frac{1.157}{\text{diametral pitch}}$ for obtaining the proper depth of cut.

It is preferable also to have a testing fixture for trying the gears in pairs. This fixture may be universal in design. However, when large quantities of a given gear are to be made, it is better to have an individual testing fixture for each pair, with master gears to test the quality of the cutting.

In designing the gear and preparing the drawing follow the general rules in the "American Machinist Gear Book." In addition, Fig. 1 gives the particular data required in this process. In Fig. 1, X represents a bevel gear and Y its setting gage. For the stub-tooth form use a standard involute spur-gear cutter. For the standard-depth form we use an involute bevel-gear cutter.

Known W = Center and cut angles,* diametral pitch;

N = No teeth;

T = Thickness of cutter at a depth of

$$\frac{1.157}{\text{diametral pitch}}; \dagger$$

Wanted $2C$ = Diameter of setting gage; ‡

V = Set-over angle;

D = Diameter from which to choose cutter.

$$C = \frac{T}{2 \sin \frac{90}{N}}$$

$$R = \frac{C}{\sin W}$$

$$D = 2R \tan W$$

$$\sin V = \frac{T}{2R}$$

The cutter is set central in relation to and in line with the spindle and brought to the gage, as shown in Fig. 2. The cutter is drawn back (see Fig. 3) and replaced by a height gage that is centered over the swiveling stud in the gear cutter. A thickness gage equal

to $\frac{1.157}{\text{diametral pitch}}$ in thickness = B is placed between the point of the height gage and the gear gage. The slide is then tipped up to the cut angle and moved out until the point of the height gage is brought to the corner of the gage Y, as shown in Fig. 4. The gear gage Y is then replaced by the gear blank X. The slide is next turned about the swiveling stud the amount of the set-over angle V (see Fig. 5) and a cut taken around the gear. The slide is then set over the opposite side of the center line the amount of the set-over angle V and a final cut taken around the gear.

In some exceptional cases, however, a central cut may be required to remove points of metal left in the center between the cuts, at the outside of the gear. Gears cut in this way will not require filing or fitting, as they are finished when they leave the machine. Fig. 6 shows the regular form of testing fixture with the testing gages Y and Y' in place instead of the gears.

Although I have shown and described the process in connection with a universal gear cutter, it is readily applicable to the ordinary miller. On a miller, however, the cutter is fixed while the setting is accomplished with the gear blank held in the index head. The index head should be mounted on a block arranged to swivel on a stud set into one of the T-slots of the platen. This block should be provided with graduations for measuring the set-over angle, and a clamping device to secure it to the platen when adjusted. When the principles and formulas of the process are thoroughly understood, it rests very largely with the individual to determine for himself how best to apply them to meet his particular requirements and equipment.

Frank C. Stevens developed this interesting and valuable process.

*In the stub-tooth form W is the center, cut and face angles. In the standard-depth form W is the center and cut angles, while the face angle is formed by a line Z, Fig. 1, from the corner of the gear to the apex of the pitch cone as in the regular bevel gear.

†When using a spur-gear cutter, T may be obtained from a table of standard chordal thicknesses of cutters. When using a bevel-gear cutter, the cutter itself must be measured to get the value of T.

‡The gage point may be at or inside the small end of the gear.

United States Munitions

The Springfield Model 1903 Service Rifle

General Specifications and Barrel Operations

STAFF CORRESPONDENCE

SYNOPSIS—This article begins a complete description of the manufacture of the Springfield rifle, showing each operation on each component part and illustrating the machines, tools, jigs, fixtures and production methods.

The Springfield rifle, known as the model of 1903, has a bore of 0.30 in. and uses a ball cartridge weighing 395.5 grains. The bullet weighs 150 grains, and the

is 0.004 in. deep. The total length of the gun is 43.212 in. without the bayonet, and its total weight, also without bayonet, is 8.69 lb. The weights of the various parts are given in Table 1.

There are 93 component parts in this rifle. These are illustrated on the board in Fig. 1. The names are listed under Fig. 2, which shows the important parts by number. Thus the action of the rifle is evident, all details being made clear by a reference to the various parts.

Before taking up the manufacture of the rifle, it seems best to show exactly the kind of material selected for the various parts. The steel used is divided into seven classes—A, B, C, D, E, also music wire and screw stock



FIG. 1. SAMPLE BOARD, SHOWING VARIOUS PARTS OF SPRINGFIELD MODEL 1903 SERVICE RIFLE

weight of the powder charge is about 50 grains. This gives an initial velocity of 2,700 ft. per sec. The total length of the barrel proper is 24.006 in., the bullet traveling 21.697 in. in the barrel. There are four right-hand rifling grooves with a uniform twist of one turn in 10 in. The width of the grooves is 0.1767 in., three times the width of the lands, which are 0.0589 in. The rifle groove

of commercial grade. The two latter require no physical tests. Classes A, B and C are simply carbon steel to be made by the openhearth or crucible process. Classes D and E are also carbon steel and may be produced by either the openhearth or the Bessemer process. The physical requirements and the chemical composition are given in full detail in Tables 2 and 3.

The requirements for materials which are to be used for rifle parts are such as to insure dependability without calling for the fulfillment of impossible conditions. The necessity for machinability tests and the rejection of material which does not meet such requirements even if physical and chemical analyses are met, is apparent.

Steel of all classes must machine freely for its grade in the ordinary operations of manufacture. This is determined by taking samples from each lot and putting them through the different manufacturing processes. In order to be accepted the stock must be worked with the regular tools and at the piecework price in force. The allowance for rejection for various classes is as follows:

ALLOWANCES FOR SEAMS OR OTHER DEFECTS

Class A	} of 1 per cent. of the number of pieces machined in the working test
Class B	
Class C	} 1 per cent. of the number of pieces machined in the working test
Class D	
Class E	

The chemical composition contained in Table 3 is based upon the analyses of steels that have been found satisfactory in both the physical and working tests and is for information only. The contractor may vary the proportion of carbon, manganese and silicon, but the maximum limits given for manganese, sulphur and phosphorus must not be exceeded, and Class C steel must not contain more than 0.35 carbon. No nickel or other alloys shall be used in any of the grades.

Steel of all classes must be free from checks, heavy scale and hard spots. All steel will be delivered unannealed, in lengths not exceeding 12 ft. and without any heat-treatment, unless otherwise specified. The sizes and classes of steel used for various parts are shown in Table 3-A.

INSTRUCTIONS FOR ANNEALING COMPONENTS

In general, all forgings of the components of the arms manufactured at this armory and all forgings for other ordnance establishments will be packed in charcoal, lime or suitable material and annealed before being transferred from the forge shop.

Except in special cases, all annealing will be done in annealing pots of appropriate size. One fire end will be inserted in the center of the annealing pot nearest the middle of the furnace and one in the furnace outside of but near the annealing pots.

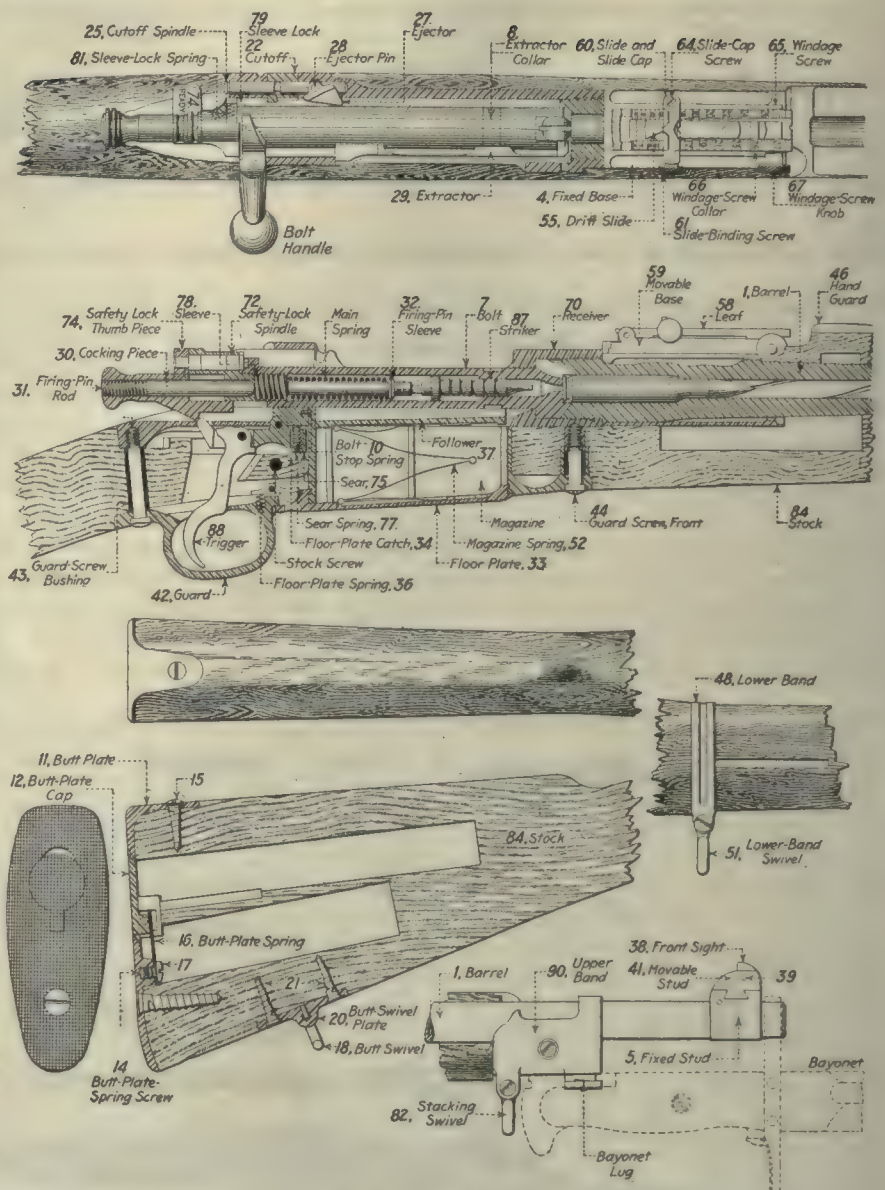
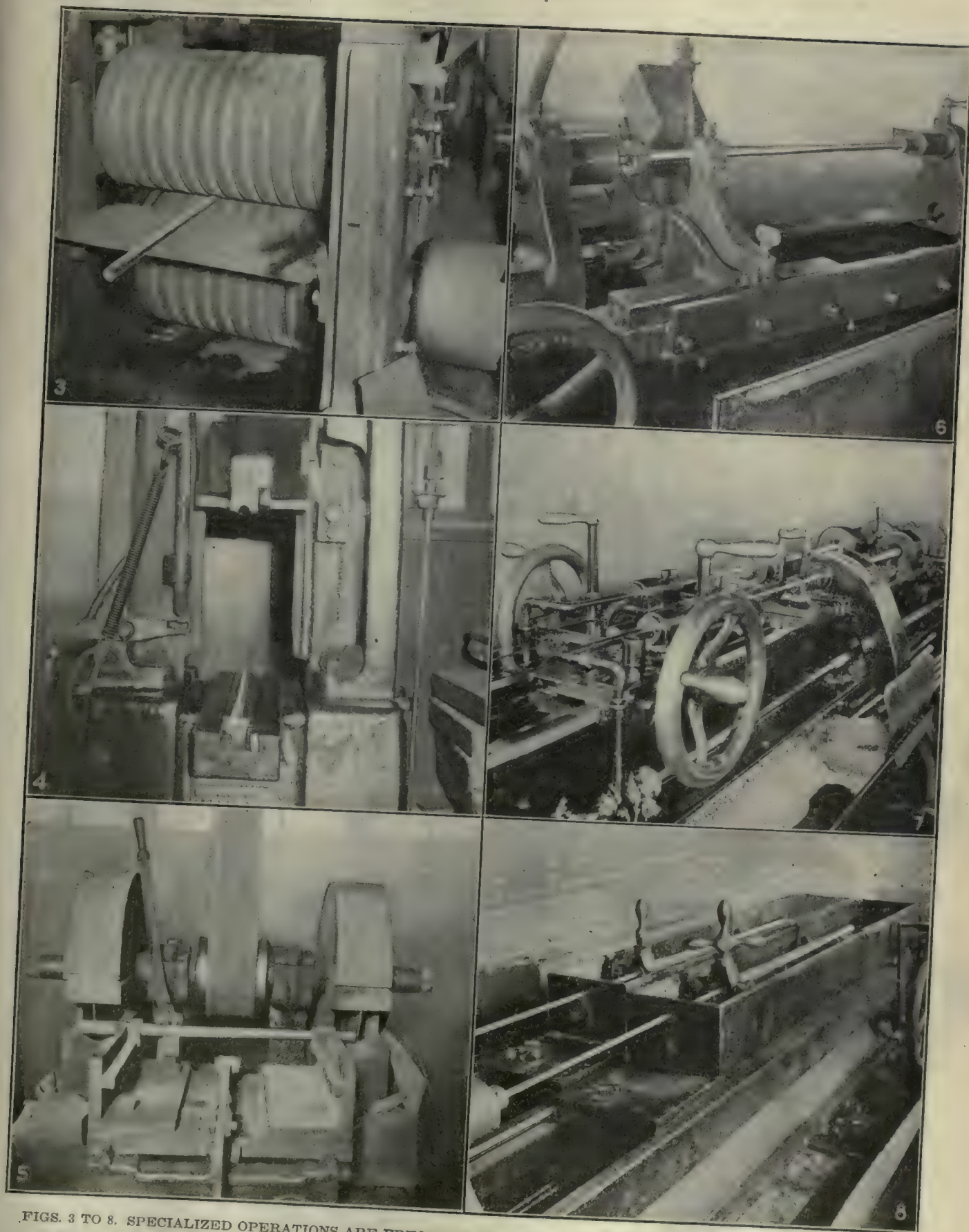


FIG. 2

FIG. 2. SECTIONS OF SPRINGFIELD MODEL 1903 SERVICE RIFLE WITH PARTS NUMBERED FOR IDENTIFICATION

UNITED STATES RIFLE Caliber 0.30—Model of 1903

Barrel:	Firing Pin:	Rear Sight (Continued):
1 Barrel	30 Cocking piece	61 Slide binding screw
2 Base pin	31 Firing-pin rod	62 Slide cap
3 Base spline	32 Firing-pin sleeve	63 Slide-cap pin
4 Fixed base	33 Floor plate	64 Slide-cap screw
5 Fixed stud	34 Floor-plate catch	65 Windage screw
6 Stud pin	35 Floor-plate pin	66 Windage-screw collar
Bolt:	36 Floor-plate spring	67 Windage-screw knob
7 Bolt	37 Follower	68 Windage-screw pin
8 Extractor collar	Front Sight:	69 Windage-screw spring
Bolt Stop:	38 Front sight	70 Receiver
9 Bolt-stop pin	39 Front-sight pin	Safety Lock:
10 Bolt-stop spring	40 Front-sight screw	71 Safety-lock plunger
Butt Plate:	41 Movable stud	72 Safety-lock spindle
11 Butt plate	42 Guard	73 Safety-lock spring
12 Butt-plate cap	43 Guard-screw bushing	74 Safety-lock thumb piece
13 Butt-plate pin	44 Guard screw, front	75 Sear
14 Butt-plate screw, large	45 Guard screw, rear	76 Sear pin
15 Butt-plate spring	46 Hand guard	77 Sear spring
16 Butt-plate spring screw	47 Hand-guard clips (2)	Sleeve:
Butt Swivel:	48 Lower band	78 Sleeve
18 Butt swivel	49 Lower-band screw	79 Sleeve lock
19 Butt-swivel pin	50 Lower-band spring	80 Sleeve-lock pin
20 Butt-swivel plate	51 Lower-band swivel	81 Sleeve-lock spring
21 Butt-swivel screws (2)	52 Magazine spring	82 Stacking swivel
Cutoff:	53 Mainspring	83 Stacking-swivel screw
22 Cutoff	Rear Sight:	84 Stock
23 Cutoff plunger	54 Base spring	85 Stock screw
24 Cutoff screw	55 Drift slide, 0.05 peep	86 Stock-screw nut
25 Cutoff spindle	56 Drift-slide pin	87 Striker
26 Cutoff spring	57 Joint pin	88 Trigger
27 Ejector	58 Leaf	89 Trigger pin
28 Ejector pin	59 Movable base	90 Upper band
29 Extractor	60 Slide	91 Upper-band screw



FIGS. 3 TO 8. SPECIALIZED OPERATIONS ARE FREQUENT IN MAKING THE SPRINGFIELD 1903 RIFLE BARREL.
 Fig. 3—Rolling barrels. Fig. 4—Hammer for straightening barrels. Fig. 5—Sawing barrels to rough length.
 Fig. 6—Turning outside of barrels. Fig. 7—Drilling holes in barrels. Fig. 8—Reaming holes in barrels.

In describing the making of the barrel and other important parts of the Springfield rifle all the principal operations will be shown in detail, minor operations being briefly described. It will be noticed that the operation numbers, Table 5, do not follow in alphabetical or numerical order, owing to the fact that it has been found advisable to change the sequence of operations since these designations were established. It has been found best to retain these symbols in order to avoid confusion both on the part of those who are now engaged in this work and those who may possibly take it up at some later date.

TABLE 3-A. SIZES OF STOCK FOR RIFLE COMPONENTS

Class A:	
Barrel, 1.35 in. round in 12-ft. lengths	
Class B:	
For extractor, 0.33 in. square	
For lower-band swivel, 0.47 in. round	
Class C:	
Bolt, 0.89x0.70 in. rectangular, length in multiples of 7½ in.	
Receiver, 1½x1½ in. rectangular, length in multiples of 15 in.	
Class D:	
Sear, follower, stacking swivel, safety-lock thumb piece, movable stud and leaf, 0.47 in. round	
Floor plate, 0.52 in. round	
Rear-sight movable base, 0.60 in. round	
Rear-sight fixed base, 1.4 in. round	
Ejector, sleeve lock and slide cap, 0.26 in. square	
Floor-plate catch and slide, 0.30 in. square	
Extractor collar and butt swivel plate, 0.40 in. square	
Cocking piece, 0.56 in. square	
Sleeve and fixed stud, 0.80 in. square	
Butt-plate cap, 0.48x0.28 in. rectangular	
Trigger, 0.50x0.30 in. rectangular	
Cutoff, 0.60x0.50 in. rectangular	
Lower band, 0.68x0.38 in. rectangular	
Butt plate, 0.88x0.48 in. rectangular	
Guard, 1½x1½ in. rectangular	
Sight cover, 0.055 in. thick, 3½ in. wide by 48 in. long. This stock must be annealed, smooth, uniform in thickness and capable of being bent double, cold, without cracking	
Class E:	
Upper band, 1.4 in. round	
Screw Stock:	
This wire must be soft, bright, straight, free from kinks and capable of being easily worked in automatic machines. Wire to be shipped in boxes. No physical tests required.	

For	Diameter, In.	Length, Ft.
Dropper.....	{ 0.057 ±0.001 }	10
Screwdriver rivet, bright, soft rivet steel, capable of being headed twice its diameter, without splitting	{ 0.190 +0.001 +0.229 -0.002 }	10
Cutoff spindle.....	{ 0.245 -0.001 0.254 +0.001 }	10
Ejector pin.....	{ 0.275 -0.001 0.325 +0.002 }	10
Bayonet-grip screw and safety-lock spindle.....	{ 0.331 ±0.002 0.46 ±0.001 }	10
Lower-band screw, stacking-swivel screw and upper-band screw.....	{ 0.290 -0.002 0.42 ±0.001 }	10
Stock screw.....	{ 0.290 -0.002 0.42 ±0.001 }	10
Guard-screw bushing, windage-screw collar and stock-screw nut.....	{ 0.290 -0.002 0.42 ±0.001 }	10
Butt-plate screw, large.....	{ 0.290 -0.002 0.42 ±0.001 }	10
For	Diameter, In.	Length, Ft.
Firing-pin rod.....	{ 0.290 -0.002 0.42 ±0.001 }	10 1
Striker.....	{ 0.290 -0.002 0.42 ±0.001 }	10

There are many details in connection with work of this kind which it is impossible to describe or illustrate so that the work can be exactly duplicated by inexperienced men. We shall, however, as far as possible, point out the little kinks and devices which have been developed through long years of experience, in the belief that they will be found worthy of careful consideration.

One of the noticeable features of the work at the Springfield arsenal is the extremely smooth reaming of all essential holes. One instance of this is the use of what is known as a "scrape reamer," in which the teeth have no cutting rake, but as the name implies, scrape the last thousandth of metal from the bore. The same is true of the rifling cutters, which have been found more satisfactory for shop use than those of the hook type.

The details of the rifle barrel are illustrated in Fig. 9. This makes it unnecessary to show the dimensions of the barrel gages. They will for the most part be presented in outline only, so as to indicate the form of gages used, the dimensions being obtainable from the barrel itself, Fig. 9. Some of the special gages will be shown in full detail in their proper place.

TABLE 4. CLASSES OF STEEL FOR FORGINGS

Bayonet			
Component	Class	Component	Class
Bayonet.....	B	Bayonet guard.....	D
Bayonet catch.....	D	Bayonet-sabbard catch.....	D
Rifle			
Barrel.....	A	Movable base.....	D
Base spring.....	B	Movable stud.....	D
Bolt.....	C	Receiver.....	C
Bolt stop spring.....	B	Safety-lock thumb piece.....	D
Butt-plate.....	D	Butt-swivel plate.....	D
Butt-plate cap.....	D	Cocking piece.....	D
Fixed base cap spring.....	B	Cutoff.....	D
Fixed stud.....	D	Drift slide.....	D
Floor plate.....	D	Ejector.....	D
Floor-plate catch.....	D	Extractor.....	B
Follower.....	D	Extractor collar.....	D
Front sight.....	B	Sear.....	D
Front-sight cover.....	D	Sleeve.....	D
Guard.....	D	Sleeve lock.....	D
Leaf.....	D	Slide.....	D
Lower band.....	D	Slide cap.....	D
Lower-band spring.....	B	Stacking swivel.....	D
Lower-band swivel.....	B	Trigger.....	D
Magazine spring.....	B	Upper band.....	E
		Hand-guard clips.....	B

Bearing in mind that the important part of the rifle barrel is the bore, the reason for straightening and finishing the barrel after it has been bored and reamed will be apparent.

The working point of the barrel is the bore, and in connection with this are the two "spots" left on the outside for chucking in the skiving, operation 21.

TABLE 5. OPERATIONS ON RIFLE BARREL

Operation
O Cutting bars from stock
A Heating
B Rolling from billet
C Catching
D Straightening under hammer and sawing to length
E Annealing
6 Milling to working length for turning
6-A Stamping lot number to show maker
2 Centering on lathe ends
1 Straightening outside
8 Spotting muzzle, turning to working size
9 Turning outside rough
9-A Stamping, repetition of 6-A, which has been removed by turning.
5 Drilling bore 0.293 in. in diameter
7 Reaming to 0.295 in. in diameter
19 Chambering to remove stock to working size
13 Straightening the bore when necessary
20 Turning spots for holding barrel for operation 21
21 Skiving with form cutter at both ends
11 Finish-turn outside
12 Filing outside to gage
11-A Stamping
24 Milling muzzle to working length
32 Filing butt and tenon
33 Finishing butt-tenon-shoulder neck and reaming rear end of chamber for threading-machine center
34 Cutting thread for receiver and marking for draw
23 Milling front-sight spline
39½ Stamping shell and flame, S. A. and year on barrel
17 Reaming to 0.298 in. in diameter
26 Reaming to 0.300 in. in diameter
25 Straightening bore
27 Rifling bore
28 Burring thread and shoulder
35 Cutting chamber ramp
36 Chambering to finish
36-A Burring chamber corner
37 Hand-milling extractor cut
37-A Burring extractor cut
38 Rounding lips of muzzle to finish length and shape
38½ Hand-milling seat for fixed stud and front sight
39 Filing muzzle
40 Assembling rear-sight fixed base and front-sight fixed stud to barrel
41 Drilling and reaming front sight, fixed stud and barrel for securing pin
42 Drilling and reaming rear-sight fixed base and barrel for securing pin
43 Pinning front-sight fixed stud and rear-sight fixed base to barrel
44 Drilling rear-sight spline pin hole in base and barrel
45 Assembling and driving rear-sight fixed-base spline pin
46 Grinding and polishing ends of securing pin
47 Browning barrel

OPERATION O. CUTTING BLANKS FROM BAR

Transformation—Fig. 10. Machine Used—Hilles No. 2 stock shears, belt drive. Number of Operators per Machine—One. Number of Cuts—One. Coolant—None. Gages—Stop on machine. Production—250 billets per hr. Note—Size of stock 1.35; crucible steel used; length of bars, 13 1/4 in.; work pushed to a stop.

OPERATION A. HEATING THE RIFLE BARRELS FOR ROLLING

Number of Operators—Two, one roller and one catcher; these can be doubled for increased production. Description of Operation—Rolling general outline of barrel from billet 13 1/4 in. long to 25 or 25 1/2 in.; the billets are preheated to about 550 deg. C. (1,025 deg. F.), then to 741 deg. C. (1,364 deg. F.). Apparatus and Equipment Used—Gilbert & Barker oil furnaces; use air at 13 to 15 lb. pressure; furnaces about

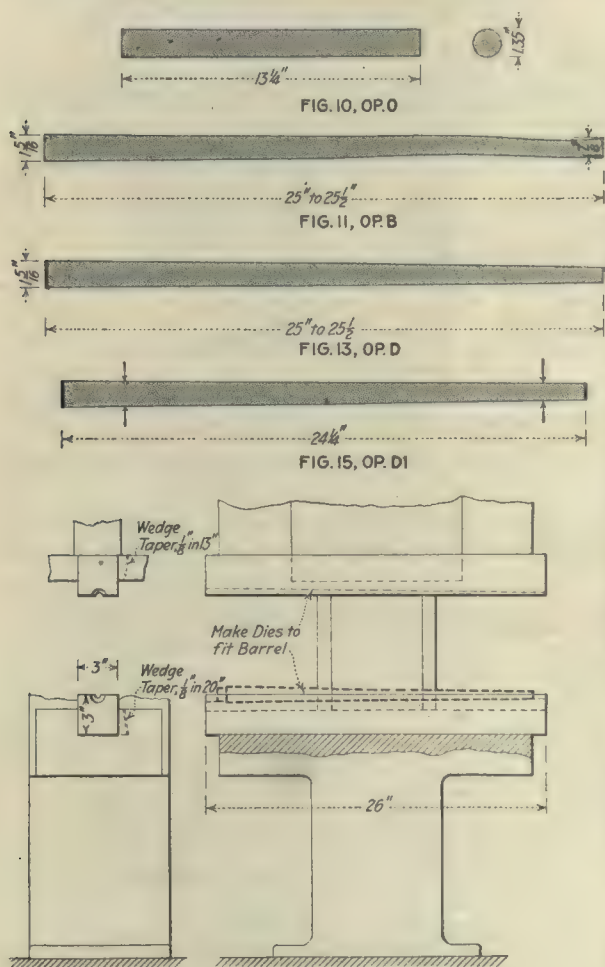


FIG. 14, OP. D

3 ft. square. Gages—Leeds & Northrup pyrometer. Production—Present capacity, 40 per hr.; 300 per day with two men; four men, 600 per day.

OPERATIONS B AND C. ROLLING THE BARRELS

Transformation—Fig. 11. Number of Operators—Two or four men to a machine. Description of Operation—The first operator takes blanks from the second furnace and passes them between the rollers; the second operator catches bars and passes them back over the rolls to the first operator (this is operation C. Apparatus and Equipment Used—A machine, modified type of Farrel Foundry and Machine Co.; rolls made at arsenal (see appendix); rolls will last from 15,000 to 20,000 barrels (Fig. 12); the rolls are 18 in. in diameter by 31 in. long and are provided with 11 grooves; the barrel passes through the last groove twice; this rolls the barrel from 25 to 25 1/2 in. long. Gages—Plain snap gages. Production—40 per hr. for two men.

OPERATION D. STRAIGHTENING BARRELS UNDER DROP HAMMER

Transformation—Fig. 13. Number of Operators—Same operator who "catches" barrel straightens and saws ends in suboperation D-1. Description of Operation—Barrels come from the rolls and are straightened under drop hammer at same heat; usually takes six blows. Apparatus and Equipment Used—400-lb. Bement drop hammer (see Figs. 4 and 14). Gages—None. Production—Same as barrel rolling.

OPERATION D-1. SAWING ENDS OF BARRELS TO ROUGH LENGTH

Transformation—Fig. 15. Machine Used—Special double-ended saw, Fig. 16. Number of Operators per Machine—Same as operations C and D; a suboperation of D. Work-Holding Device—Special clamp, Fig. 16. Tool-Holding Device—Saws on arbor. Cutting Tools—Special saws of tool steel 1/2 in. thick by 18 in. in diameter (see Fig. 16). Number of Cuts—One at each end. Cut Data—Saws run 1,500 r.p.m. Coolant—None. Average Life of Tool Between Grindings—600 barrels. Special Fixtures—None. Gages—None. Production—Same as rolling barrels.

OPERATION E. ANNEALING RIFLE BARRELS IN DRY LIME

Number of Operators—Operator C anneals. Description of Operation—After cutting off ends, barrels are placed in dry lime in the truck boxes, Fig. 17, and allowed to cool. Apparatus and Equipment Used—Boiler-iron boxes 16x47x16 in. deep,

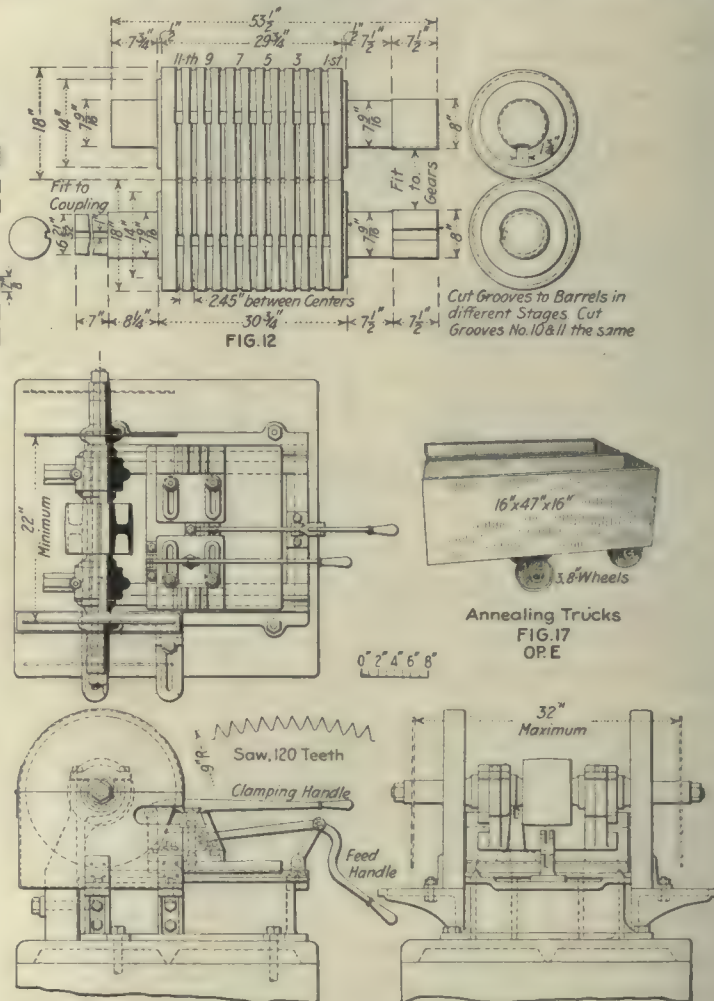


FIG. 16, OP. D1

mounted on three 8-in. wheels so that barrels can be moved to any desired point (see Fig. 17). Gages—None. Production—Same as operations B, C and D.

OPERATION 6. MILLING BOTH ENDS TO 24 1/2 IN.

Transformation—Fig. 18. Machine Used—Lincoln type miller. Number of Machines per Operator—Two. Work-Holding Devices—Special clamps, Fig. 19, hold two barrels side by side, one butt and one muzzle at each end. Tool-Holding Device—Standard cutter arbor. Cutting Tool—6-in. side-milling cutter, Fig. 19. Number of Cuts—Two. Cut Data—Spindle speed, 125 r.p.m.; hand feed, about 1/8 in. per min. Coolant—Triumph cutting oil. Average Life of Tool Between Grindings—600 barrels. Special Fixture—None. Gages—Length gage (see Fig. 20). Production—90 per hr., two machines.

OPERATION 6-A. STAMPING THE LOT NUMBER ON BARREL

Number of Operators—One. Description of Operation—This stamps the lot number on the butt end of the barrel in order to identify the maker of the steel. Apparatus and Equipment Used—Bench, hand stamp and hammer. Gages—None. Production—200 per hr. per man.

OPERATION 2. CENTERING

Transformation—Fig. 21. Machine Used—Whiton two-spindle centering machine. Number of Operators per Machine—One. Work-Holding Devices—Held in screw vise with V-jaws. Tool-Holding Device—Drill chuck. Cutting Tools—

Drill and separate countersink; Midvale high-speed steel used. Number of Cuts—Two. Cut Data—Speed, 400 r.p.m. Coolant—Triumph cutting oil. Average Life of Tool Between Grindings—300 barrels. Special Fixtures—None. Gages—None. Production—45 per hr.

OPERATION 1. STRAIGHTENING BARREL

Number of Operators—Same operator as centers. Description of Operation—Barrels are revolved by hand on ordinary bench centers and high spots noted; these are then straightened with a hammer and straightening block, same as bar stock. Apparatus and Equipment Used—Bench centers, straightening blocks and copper hand hammer. Gages—None. Production—Included in operation 2; 20 per cent. require straightening.

OPERATION 8. SPOTTING MUZZLE, TURNING END FOR DRILLING AND TURNING

Transformation—Fig. 22. Machine Used—Prentice barrel-turning lathe (see Fig. 6). Number of Machines per Operator—Four. Work-Holding Devices—Driven with dog

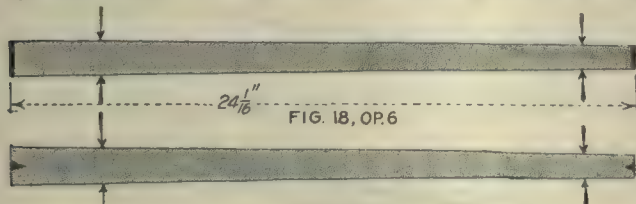


FIG. 21, OP.2

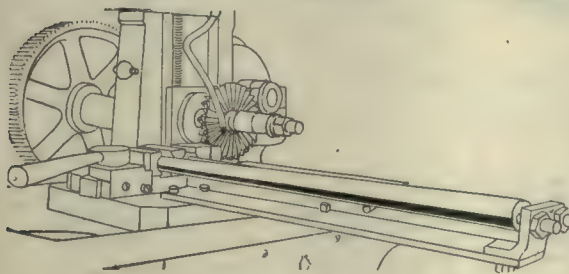


FIG. 19, OP. 6

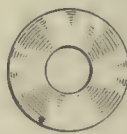


FIG. 24

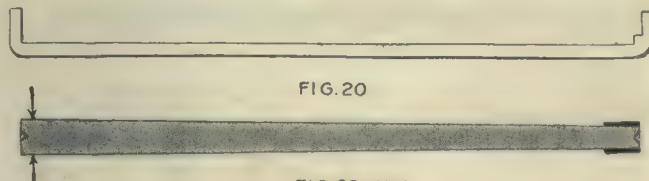


FIG. 22, OP. 8

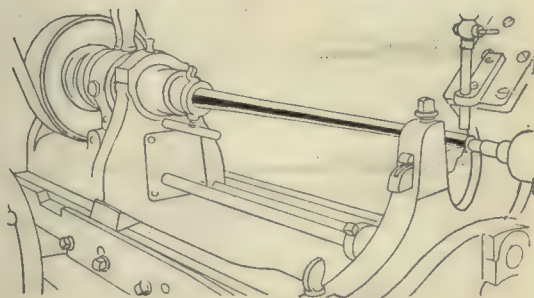


FIG. 23, OP. 8

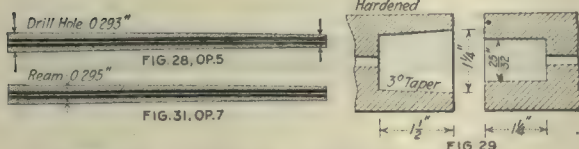


FIG. 31. OP.7

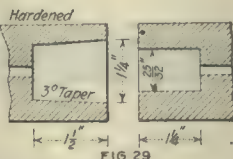


FIG 29

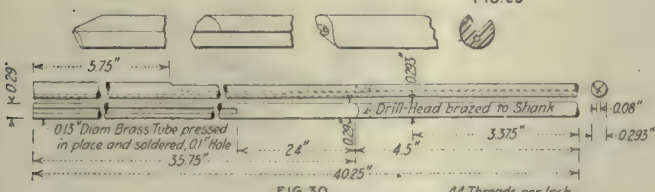


FIG. 3



FIG. 25

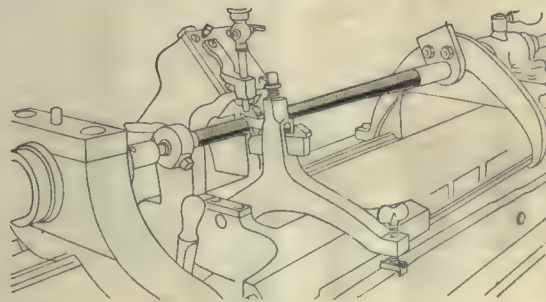


FIG. 26



FIG. 27

OPERATION 9

taper chuck at butt end; held in collet at muzzle end; drill guided close to muzzle, Fig. 29. Tool—Holding Device—Screw collet chuck; guided by bushing as in Fig. 29. Cutting Tool—Special barrel drill, 0.293 in. in diameter; see Fig. 30 for drill and shape of drill point. Number of Cuts—One. Cut Data—Barrels turn 1,800 to 2,000 r.p.m.; feed, $\frac{3}{4}$ in. per min. Coolant—Triumph cutting oil under 600 lb. pressure. Average Life of Tool Between Grindings—8 barrels. Gages—None. Production—30 min. per barrel, 4 barrels per hr. per machine.

OPERATION 7. REAMING

Transformation—Fig. 31. Machine Used—Ames Manufacturing Co. two-spindle barrel reamer (see Fig. 8). Number of Machines—One. Operator—Four machines, eight spindles. Work-Holding Devices—On V-block screw clamp at butt end (see Fig. 8). Tool-Holding Devices—Reamer held in collet by set-screw; collet held in two-jaw chuck. Cutting Tool—Reamer, 0.295 in., of Midvale high-speed steel, Fig. 32. Number of Cuts—One. Cut Data—Speed, 100 r.p.m.; feed, 10 in. per min. Coolant—Triumph cutting oil, forced in barrel by hand pump. Average Life of Tool Between Grindings—Sometimes 50 to 75 barrels; average, about 25. Gages—Fig. 33. Production—20 barrels per hr.

OPERATION 9. ROUGH-TURN

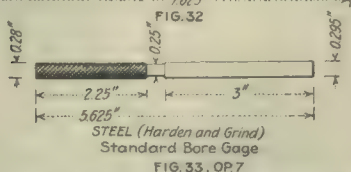
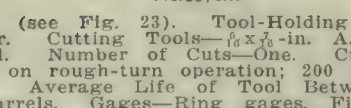


FIG. 33. OP. 7



g—Ring

OPERATION 19. CHAMBERING TO WORKING SIZE

Transformation—Fig. 34. Machine Used—Pratt & Whitney horizontal turret. Number of Operators per Machine—One. Work-Holding Devices—Draw-in collet, steadyrest at butt end. Tool-Holding Devices—Turret spindles. Cutting Tools—Drills, counterbores and reamers, shown in Fig. 35; these leave from 0.001 to 0.002 in. for finish. Number of Cuts—See tools, Fig. 35. Cut Data—Speed, 180 r.p.m. for counterbore, 150 r.p.m. for others; hand feed. Coolant—Triumph cutting oil, $\frac{1}{4}$ -in. stream. Average Life of Tool Between Grindings—25 barrels. Gages—Fig. 36. Production—20 per hr.

OPERATION 13. FIRST STRAIGHTENING

Number of Operators—One. Description of Operation—Straighten bore of barrel, taking out kinks; these are tested by sighting through the barrel and noting the eccentricity of the rings formed by the light; this is done in a darkened room and is known as the "ring system." Apparatus and Equipment Used—Similar to that shown in Fig. 70. Gages—None. Production—30 per hr.

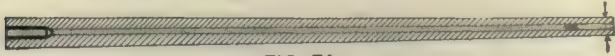


FIG. 34

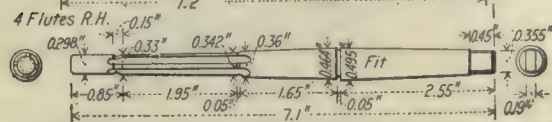
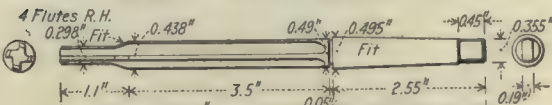
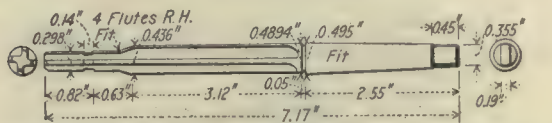
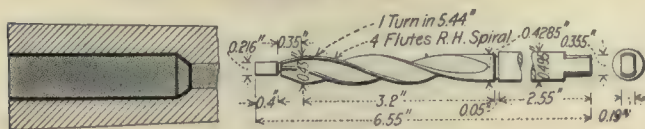


FIG. 35

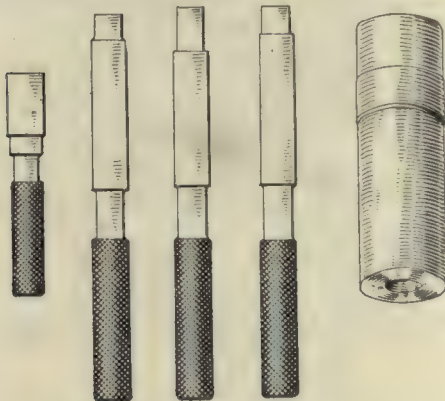


FIG. 36. CHAMBERING GAGES.

OPERATION 19

OPERATION 20. TURNING SPOTS TO RUN TRUE WITH BORE FOR HOLDING IN SKIVING OPERATION

Transformation—Fig. 37. Machine Used—Prentice lathe, 14-in. Number of Machines per Operator—Four. Work-Holding Devices—Work held on centers driven by dog, Fig. 38. Tool-Holding Devices—Tools held in tool post by setscrew. Cutting Tools—A. A. Rex high-speed steel. Number of Cuts—Two. Cut Data—Speed, 125 r.p.m.; feed, 100 to inch. Coolant—None. Average Life of Tool Between Grindings—12 to 15 barrels. Special Fixtures—None. Gages—Snap gages, Fig. 39. Production—21 per hr.

OPERATION 21. SKIVING OR FORMING BOTH ENDS OF BARREL

Transformation—Fig. 40. Machine Used—Pratt & Whitney Lincoln miller rebuilt. Number of Machines per Operator—Two. Work-Holding Devices—Draw-in chucks at each end, operated by ratchet wrench (see Fig. 101). Tool-Holding Device—Special vise on miller table (see Fig. 41-A). Cutting Tools—See Fig. 41-C for details. Number of Cuts—Two, roughing and finishing tools in same holder. Cut Data—Speed of work, 60 r.p.m.; feed of cutter, $\frac{1}{4}$ in. per min. Coolant—Triumph cutting oil; three $\frac{1}{8}$ -in. streams at each end of barrel. Special Fixtures—Revolving centers for ends of barrel (see Fig. 42). Gages—Ring and snap gages; for gage for front-sight stud, see Figs. 43-A and 43-B. Production—15 per hr. from two machines.

OPERATION 11. FINISH-TURN OUTSIDE OF RIFLE BARREL

Transformation—Fig. 44. Machine Used—Prentice barrel-turning lathe (see Fig. 6). Number of machines per Operator—Four. Work-Holding Devices—Work held on centers supported by backrest, same as in operation 9. Tool-Holding Device—Tool held in tool post by setscrew (see operation 9 and Fig. 6). Cutting Tools— $\frac{1}{8}$ x $\frac{1}{8}$ -in. A. A. Rex high-speed steel. Number of Cuts—One. Cut Data—125 r.p.m.; feed, 0.01 in. per min. Coolant—Compound, $\frac{1}{4}$ -in. stream. Average Life of Tool Between Grindings—About 8 barrels. Special Fixtures—Form or contour plates to bed of machine. Gages—Snap gages (see Fig. 46). Production—5 per hr.

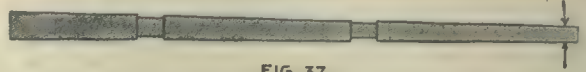


FIG. 37

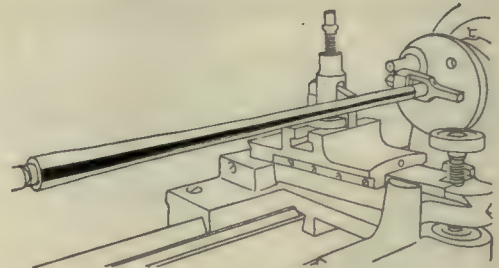


FIG. 38



FIG. 39

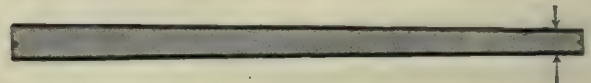


FIG. 44

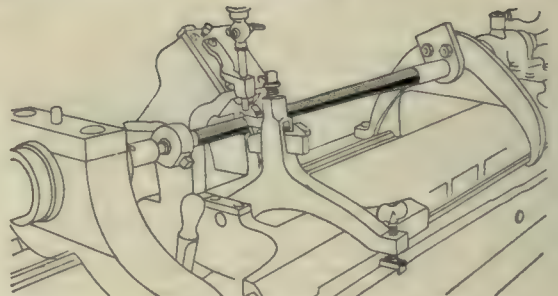


FIG. 45



FIG. 46

OPERATION 11

OPERATION 12. FILING TO GAGE, BLENDING CONTOUR BETWEEN CUTS

Transformation—Fig. 47. Machine Used—Prentice speed lathe (see Fig. 48). Number of operators per Machine—One. Work-Holding Devices—Held on centers. Cutting Tools—8-in. mill file and 6-in. pillar file. Number of Cuts—Two. Coolant—None. Special Fixtures—None. Gages—Fig. 49. Production—About 53 per hr.

OPERATION 11-A. STAMPING LOT NUMBER ON BARREL

Number of Operators—One. Description of Operation—Stamping lot number. Apparatus and Equipment Used—Hammer, block and stamp. Gages—None. Production—200 per hr.

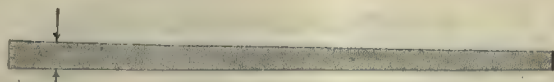


FIG. 50, OP.24

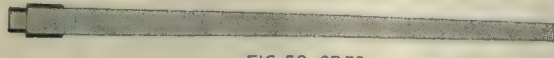


FIG. 52, OP.32

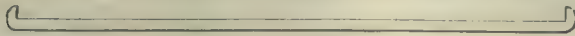


FIG. 51-A, OP.24

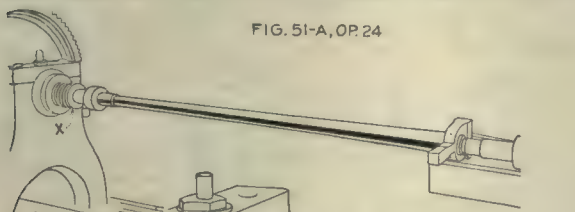


FIG. 51

Detail of X

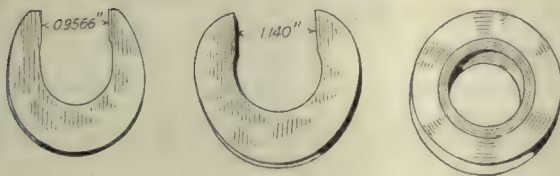


FIG. 53, OP.32



FIG. 40

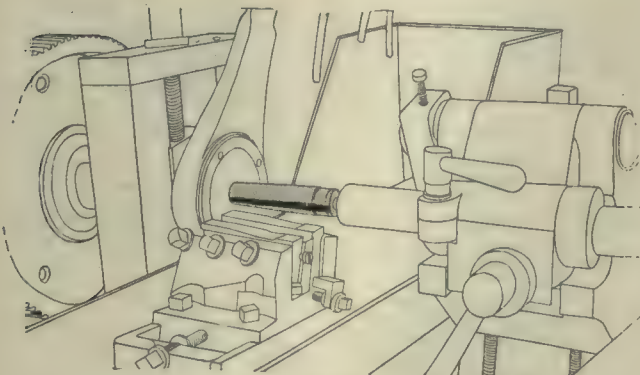
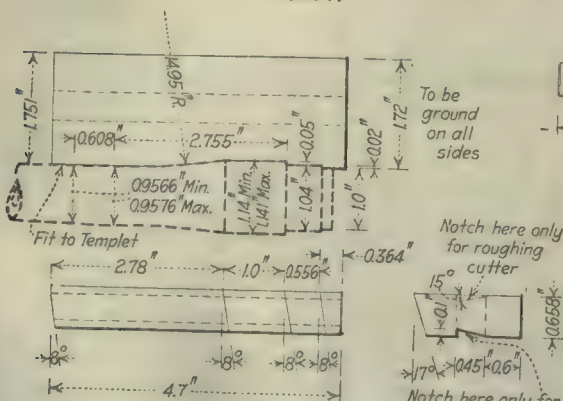


FIG. 41-A



Turning (Butt End)

FIG. 41-B

OPERATION 21

OPERATION 24. MILLING MUZZLE TO WORKING LENGTH.
24 $\frac{1}{16}$ -IN. LONG

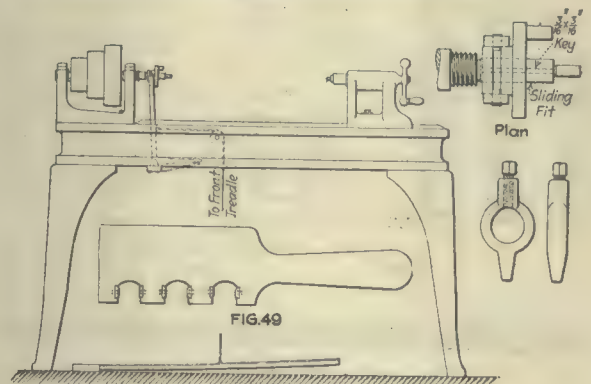
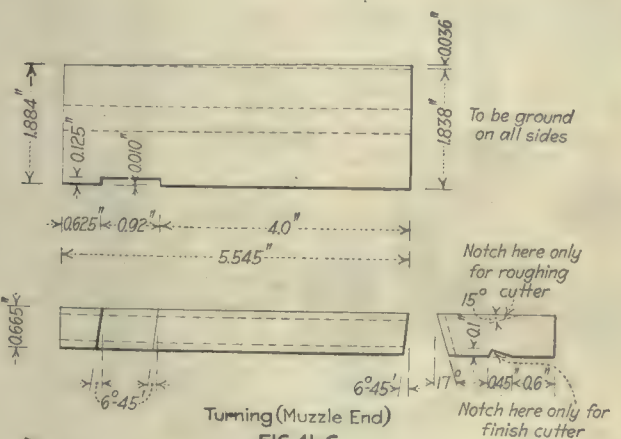
Transformation—Fig. 50. Machine Used—Springfield 24-in. lathe. Number of Operators per Machine—One. Work-Holding Devices—Work is held on pilot of end mill and on tailstock center; kept from turning by dog, Fig. 51. Tool-Holding Devices—Held in taper of spindle hole of lathe. Cutting Tools—End mill with 0.293 pilot. Number of Cuts—One. Coolant—Triumph cutting oil. Average Life of Tool Between Grindings—About 75 barrels. Special Fixtures—None. Gages—Length gage, Fig. 51-A. Production—100 per hr.

OPERATION 32. FILING BUTT AND TENON

Transformation—Fig. 52. Machine Used—Prentice speed lathe. Number of Operators per Machine—One. Work-Holding Devices—Work held on center, driven by dog (see Fig. 48). Cutting Tools—8-in. mill and 6-in. pillar file. Number of Cuts—Two. Cut Data—1,500 r.p.m. Coolant—None. Gages—Snap gage, Fig. 53. Production—28 per hr.



FIG. 47

FIG. 48
OPERATION 12

Turning (Muzzle End)

FIG. 41-C

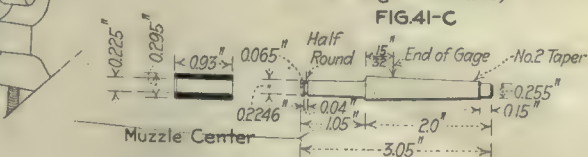


FIG. 42

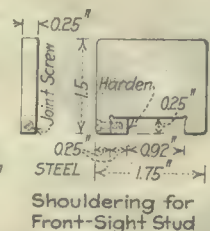
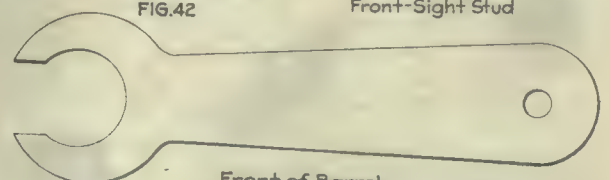


FIG. 43-A



Front of Barrel

FIG. 43-B

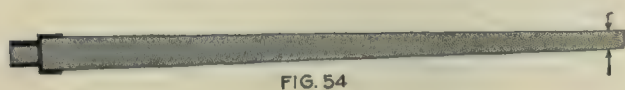


FIG. 54

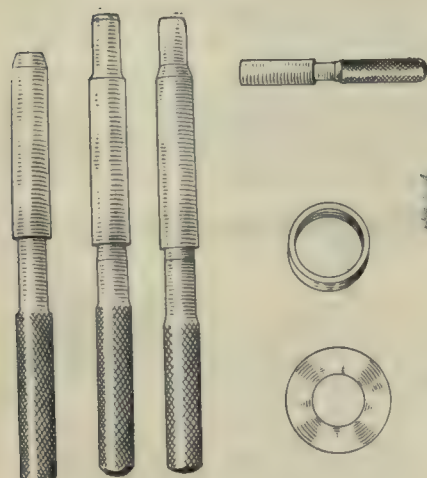


FIG. 57

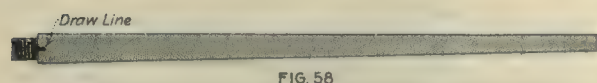


FIG. 58

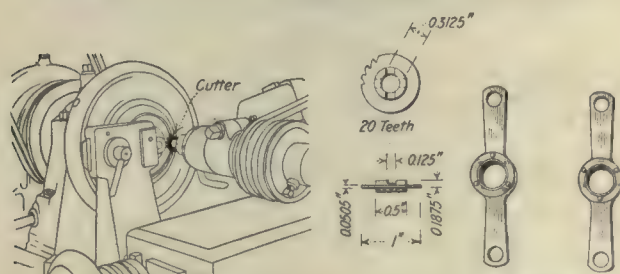


FIG. 59

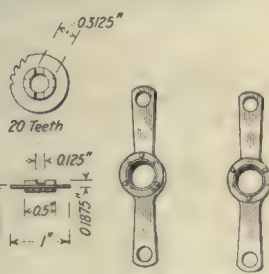
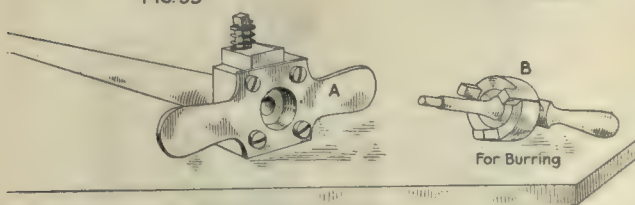


FIG. 60

FIG. 59-A
OPERATION 34

OPERATION 33. FINISH BUTT TENON SHOULDER, NECK, AND REAM REAR END OF CHAMBER FOR THREADING MACHINE CENTER

Transformation—Fig. 54. Machine Used—Pratt & Whitney 10-in. swing hand screw machine. Number of Operators per Machine—One. Work-Holding Devices—Work held in draw-in chuck with steadyrest at butt end. Tool-Holding Device—Regular taper shank. Cutting Tools—One hollow box mill, as in Fig. 55, together with facing and finishing mill, shown in detail in Fig. 56. Number of Cuts—Three. Cut Data—Barrel turns 150 to 180 r.p.m. Coolant—Triumph cutting oil, ¼-in. stream. Average Life of Tool Between Grindings—50 barrels. Gages—Ring gages for diameter and shoulder length; plug gages for length of butt with relation to chamber (see Fig. 57). Production—50 per hr.

OPERATION 34. CUTTING THREAD FOR RECEIVER AND MARKING FOR DRAW

Transformation—Fig. 58. Machine Used—Pratt & Whitney thread miller. Number of Machines per Operator—Two. Work-Holding Devices—Regular draw chuck in connection with special sleeves that fit over barrel near muzzle and butt. Tool-Holding Devices—Regular thread-milling arbor. Cutting Tools—Milling cutter, as shown in Fig. 59. Number of Cuts—One. Cut Data—Barrel turns 30 r.p.m.; milling cutter, 240 r.p.m. Coolant—Triumph cutting oil. Gages—Thread and marking gage, Fig. 60. Production—36 per hr. on two machines. Note—A suboperation marks what is called the "draw" line; a small fixture, Fig. 59-A, screws on the barrel, and when tight against the shoulder the chisel-pointed plunger is struck and marks the barrel; this becomes the working point in future operations; the tool B in Fig. 59-A removes the burr.

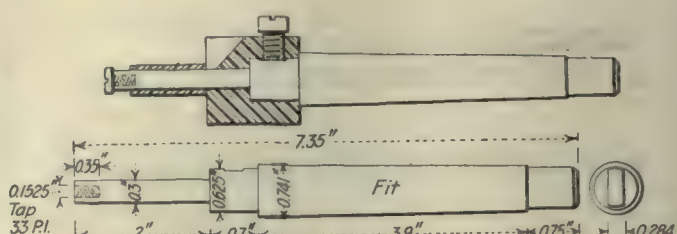


FIG. 55

OPERATION 33

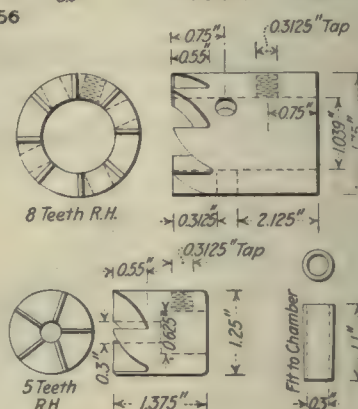


FIG. 56

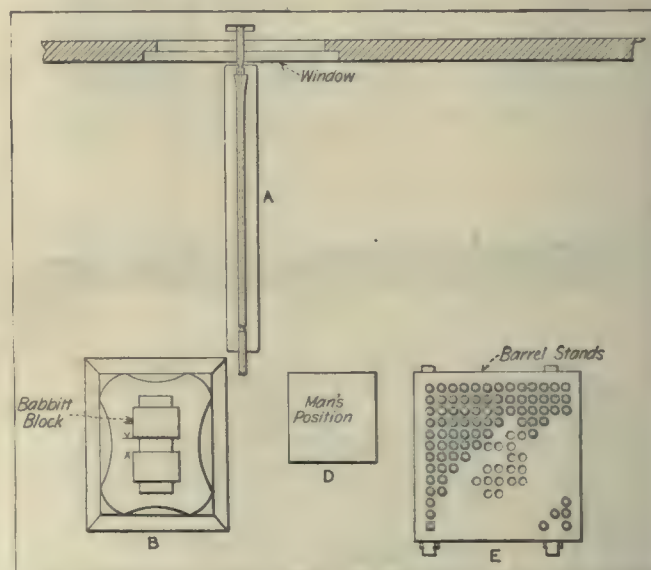
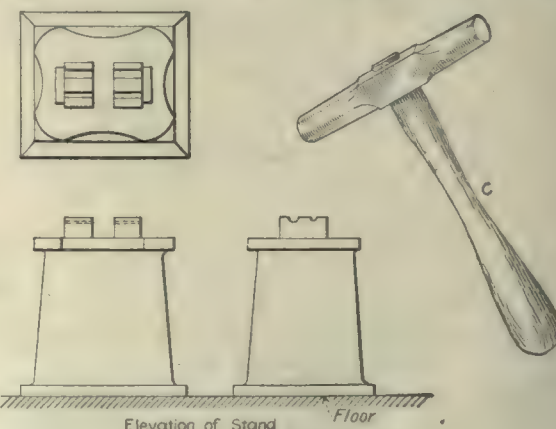
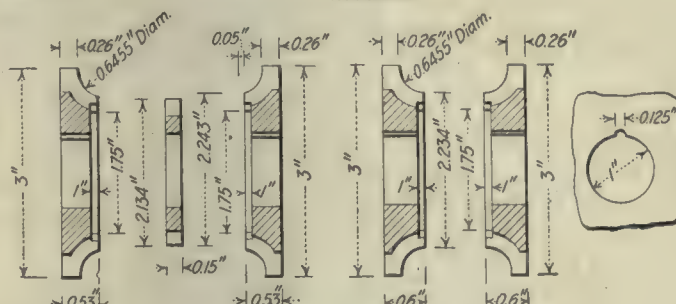
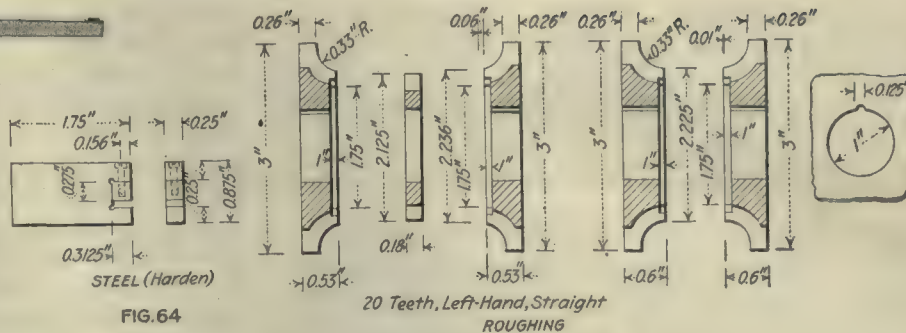
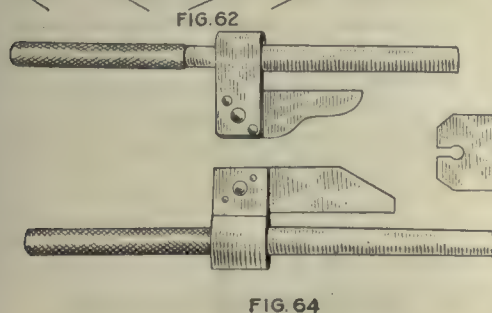
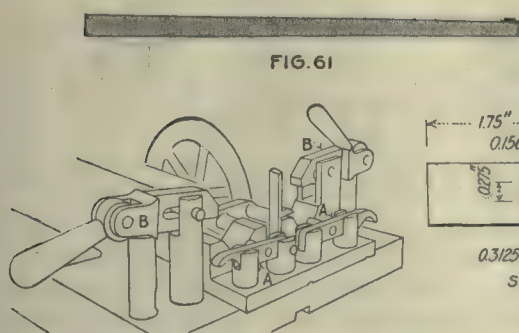


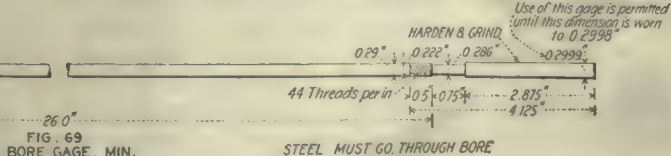
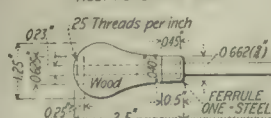
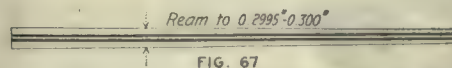
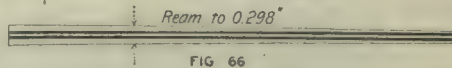
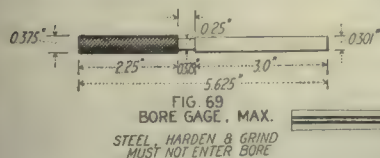
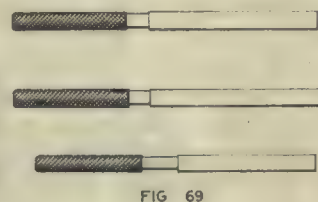
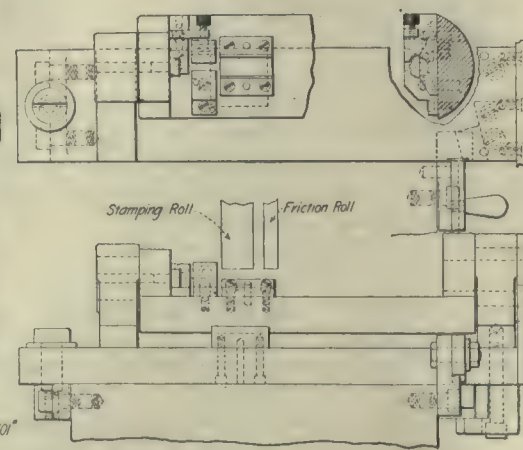
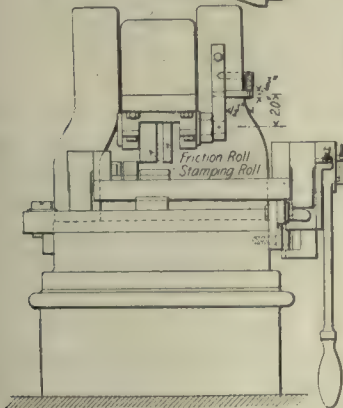
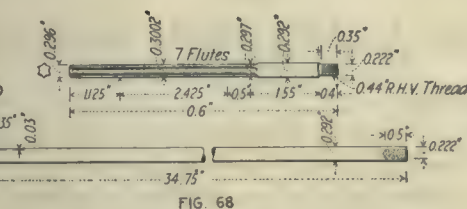
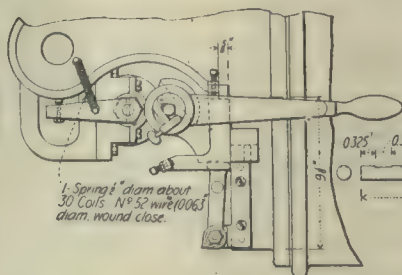
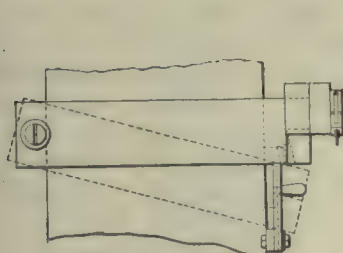
FIG. 70. OPERATION 25



Transformation—Fig. 61. Machine Used—Pratt & Whitney Lincoln miller. Number of Machines per Operator—Three. Work-Holding Devices—Special fixtures that hold barrels by studs entering bore and chamber; the back-end clamping fixture is shown in Fig. 62; the chamber plugs are mounted in the swinging levers AA; the lever and cams BB clamp barrels in place; a knife-edge stop which locates the barrel by draw mark put on as in Fig. 59-A; this locates the spline for



OPERATION 23



OPERATION № 391, 17 & 26

OPERATION 39½. ROLLING STAMP OF SHELL AND
FLAME, S. A. AND YEAR

front-sight stud at 90 deg. from "draw" mark; the other barrel is placed with the spline down and the under side of the stud base milled flush with the barrel; both are run through at one cut. Tool-Holding Devices—Standard milling-cutter arbor. Cutting Tools—Interlocking form-milling cutters, Fig. 63; Victor high-speed steel. Number of Cuts—Two. Cut Data—Speed, 60 r.p.m. Coolant—Triumph cutting oil. Average Life of Tool Between Grindings—250 to 300 barrels. Gages—Fig. 64. Production—50 per hr. per man.

Machine Used—Special rolling machine, Figs. 103 and 65. Number of Operators per Machine—One. Work-Holding Devices—Special chuck with lever for rotating barrel. Tool-Holding Device—Special arbor for stamp. Cutting Tool—Special stamp roll. Number of Cuts—One. Coolant—None. Gages—None. Production—150 per hr.

OPERATION 17. REAMING TO 0.298 IN.

Transformation—Fig. 66. Machine Used—Ames Manufacturing Co. two-spindle barrel reamer. Number of Machines per Operator—Four. Work-Holding Devices—Work is held on V-blocks by screw at butt end, Fig. 8. Tool-Holding Devices—Reamer held in collet with $\frac{1}{4}$ -in. setscrew. Cutting Tools—0.298-in. reamer, Midvale special high-speed steel. Number of Cuts—One. Cut Data—Speed, 100 r.p.m.; feed, 10 in. per min. Coolant—Triumph cutting oil forced into barrel by hand pump. Average Life of Tool Between Stonings—25 to 30 barrels. Gages—Similar to Fig. 33. Production—About 18 barrels per hour.

OPERATION 26. FINISH-REAMING TO 0.300 IN.

Transformation—Fig. 67. Machine Used—Same as operation 17. Number of Operators per Machine—Same as operation 17. Work-Holding Devices—Same as operation 17. Tool-Holding Devices—Same as operation 17. Cutting Tools—Scraping reamer, Fig. 68; this is maximum diameter for only a portion of its length near the center. Number of Cuts—Same as operation 17. Cut Data—Same as operation 17. Coolant—Same as operation 17. Average Life of Tool Between Grindings—Same as operation 17. Special Fixtures—Same as operation 17. Gages—See Fig. 69. Production—Same as operation 17.

OPERATION 25. FINAL STRAIGHTENING OF BORE

Number of Operators—One. Description of Operation—The operator places barrels on hollow centers, as shown at A, Fig. 70; the outer end is of smoked glass, having fine rings scraped on it; revolving the barrel by hand on the hollow centers shows whether the light rings are concentric or eccentric; if eccentric they are straightened by placing barrel across the babbitt block on top of the stands shown at B and striking with the copper hammer C; the operator stands at D, and the barrels to be tested are in the rack at E. Apparatus and Equipment Used—Testing centers as described above, straightening blocks and copper hammer. Gages—None. Production—20 per hr. Note—Some barrel straighteners use what is known as the "line" method, by which the barrel is sighted across a horizontal line in front of a window; if the two lines that show in the barrel are parallel, the barrel is straight; both the ring and the line methods are used in the inspection.

Mechanical Engineers Society Pays Off Its Debt

In a bulletin just issued to the membership, the officers of the American Society of Mechanical Engineers state that the last of the bonds issued by the society to finance its part of the Engineering Societies' Building enterprise was paid off on July 1, and the society is now out of debt. Many will recall that when, a dozen years ago, Andrew Carnegie electrified the engineering profession with his generous offer of \$1,500,000 to erect a great building in New York City as a home for the national engineering societies, he coupled with it the stipulation that the societies themselves should purchase the land on which the building was to be erected.

The cost of this land was about \$540,000, and this investment in itself seemed to many a large burden to be assumed by the three societies that accepted the offer. The immediate financing was made easy, however, by Mr. Carnegie, who advanced the money for the land purchase. For a number of years this loan was continued, the societies paying interest upon it. Each of the societies made energetic efforts to raise the money to pay off this debt by circulating subscription papers. It was hardly to be expected, however, that so large a sum would be raised by direct subscription, and there was a general opinion that the societies themselves should bear the burden. Principally through the efforts of the late Charles Wallace Hunt, who was for many years active in the council of the American Society of Mechanical Engineers, a plan was devised by which the money was raised to pay off the balance of the debt for the land in the following manner: The society issued interest-bearing bonds equal in face value to the amount of the debt, announced that the portion of its income derived from initiation fees would be segregated each year to pay off an installment of these bonds and invited subscriptions from the members of the society. The sum desired was promptly secured and, as announced above, the last of these bonds has now been paid off.

Another announcement in the bulletin issued to the society members is of general interest. There is a more or less general impression among the members of the national engineering societies that a large part of the money they pay in for their annual dues is expended in maintaining the expensive offices and headquarters in the big building in New York City.

To those who may have held such an opinion, it will be of interest to note the statement issued by Calvin W. Rice, Secretary of the American Society of Mechanical Engineers, that at the present time less than 5 per cent. of that society's annual income from dues is absorbed in paying its share of maintaining the building in New York City. If the society owned no property whatever and merely rented the space absolutely necessary for the clerical force required to carry on its work at its headquarters, in New York or any other large city, the annual rental would amount to more than 5 per cent. of its income from dues.

Design of Crossfeed Screws for Lathes

BY M. H. FERGUSON

As long as the human element enters into the operation of machinery, just so long must machines be designed to guard against breakage and the consequent loss in production while waiting for repairs. A number of breakdowns on engine lathes have been brought to my attention. The operator in using the power crossfeed remains away from his machine too long or fails to realize the limitations of his lathe until it is too late, thereby allowing the crossfeed nut of the tool rest to run against the end of the recess in the carriage. This of course strips the teeth from the crossfeed gears in the apron and frequently bends the crossfeed screw.

Most lathe builders now, I believe, either shorten the screw at the threaded end or extend the carriage slot through the bridge of the carriage to prevent the nut from striking. Either method is effective, but there still exists the danger of striking the carriage bridge at the front side when the tool is feeding toward the operator. To remove this possibility the crossfeed screw should be turned down to the root diameter of the thread or slightly less, a distance equal to the length of the crossfeed nut plus enough to make it certain that the nut will run off the thread before striking the carriage bridge.

As a necking is usually made for the threading tool to run into anyway, the small amount of extra turning required would be more than compensated for by the reduction in length of thread to be cut. The screw is not materially weakened, as the old necking was always made deeper than the root diameter of the thread.

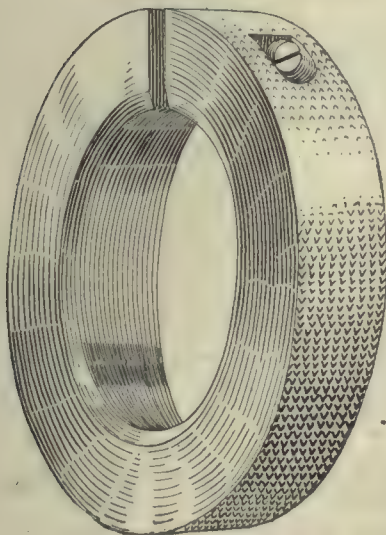
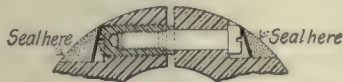
To Prevent Wheel Loading When Grinding Aluminum

When grinding aluminum, the wheel is apt to gather the particles of aluminum and prevent grinding. It is pointed out by E. J. Hansen that a little grease or lard oil on the face of the emery wheel will prevent the particles from sticking and thereby insure the wheel cutting smoothly and to its maximum efficiency.

Letters from Practical Men

Inspectors' Thread Gage

The illustration shows a ring thread gage that can be adjusted and sealed. I find that the bodies of these gages are preferably made of a good quality of casehardening stock annealed once or twice before working. It is then



RING-THREAD GAGE

worked nearly to size and casehardened deep enough for the final lapping. The knurling should be done before the final threading and an annealing operation should be interposed between knurling and threading.

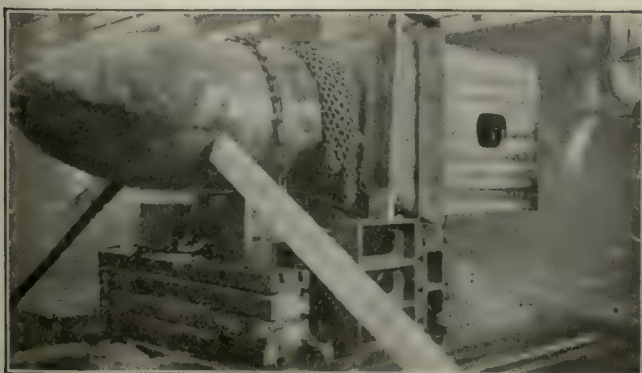
Chicago, Ill.

C. BLAIN.



Machining Large Spud Points

The Pelton Water Wheel Co. recently machined two large spud points used in the construction of the Yuba No. 16 dredge, the largest gold dredge in the world. The accompanying illustration shows how the spud point was



A HUGE DREDGE SPUD POINT MOUNTED FOR MACHINING ON THE FLOOR MILL

mounted on the bedplate of a large floor mill and gives some idea of the amount of material removed.

This spud point is a hollow steel casting, with the upper portion machined to fit into the socket of the spud, which is framed from structural-steel sheets. The overall length of the casting is 15 ft. 2 in. Its maximum width is 5 ft. and its broadest portion 3 ft. 2 in. The approximate weight is 10 tons.

It was necessary to remove about 2 in. of stock from the machined faces. The area of the machined surface, not taking into consideration the chamfers for fitting into the framed socket, was 4 ft. 8 in. by 5 ft. 2 in. on the broad faces and 1 ft. 11 in. by 5 ft. 2 in. on the narrow faces. Chips weighing 2,325 lb. were removed from the first spud machined, while 2,663 lb. of chips were removed from the second spud point.

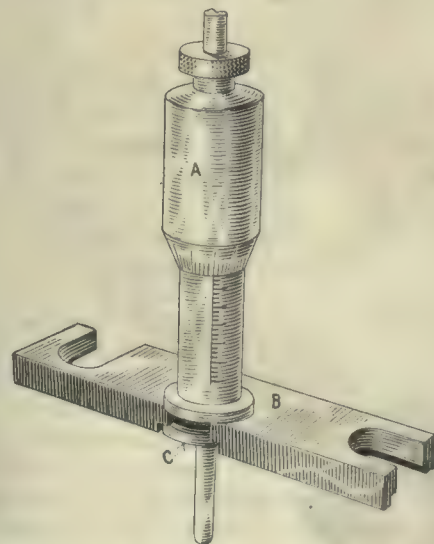
J. W. SWAREN.

Hayward, Calif.



Improved Micrometer Depth Gage

The illustration shows a depth gage that saved a good deal of time and money on a job upon which an ordinary depth gage could not be employed because the micrometer is in the center of the block. We ordered a special micrometer head *A* and made the block *B* of hard-



IMPROVED MICROMETER DEPTH GAGE

ened tool steel $2\frac{1}{2} \times 1\frac{7}{16} \times 1\frac{3}{16}$ in., ground and lapped on the wide surfaces. The three recesses were put in the block to receive the micrometer head, which is held by the nut *C*.

The advantage of the tool is that it can be used in corners as well as on open work. As its accuracy depends on the upper and lower surfaces of the block it cannot get out of adjustment.

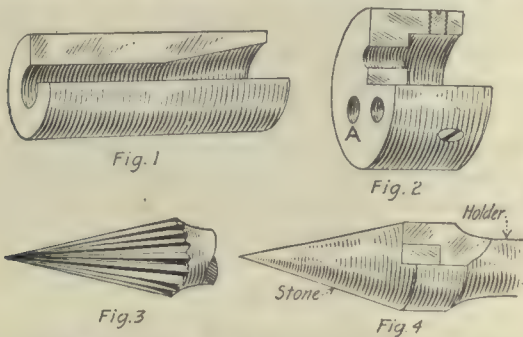
EDWARD HELLER.

Brooklyn, N. Y.

Bench-Lathe Milling

The milling attachment described in this article is so handy and useful that once a mechanic has used it he will sorely miss it when not obtainable.

In the milling of some very small job, the piece may be clamped either to the face plate or to an angle plate which is located on the face plate. The transverse and cross-slides of the lathe, together with the vertical slide of the attachment, will allow the operator to feed the cutter in any direction for straight milling; also the spindle of the attachment may be swung to any desired angle, the extent being determined by the graduated dial. As the transverse slide of the lathe may also be swung to any angle, and the face plate upon which the job is located may be



THE BENCH-LATHE MILLING ATTACHMENT

rotated either fully or to a stop allowing for the milling of a radius, the ways in which this accessory may be utilized can readily be imagined.

Small cutters, small reamers and similar work may be milled much faster than in the milling machine. To illustrate the simplicity and rapidity of use to be obtained with this attachment, I shall describe the making of a small cutter.

In Fig. 1 is shown a sleeve which I have on hand and which I use when making these small cutters, this sleeve serving to adapt the cutter to the Van Norman duplex milling machine. A piece of drill rod turned to fit the sleeve, which acts as a gage for the taper shank of the cutter, is tapped into the sleeve and held in the spring collet of the lathe. After the blank is turned to the proper shape, the turning tool is removed and the milling attachment mounted in its place. The blank is then speedily milled regardless of the shape. The making of a small cutter of this sort would be an awkward and difficult job for the milling machine as it takes too much time.

Small form cutters may be sharpened in the bench lathe by substituting a grinding wheel for the cutter. When a form cutter is sharpened by means of the spring stop commonly used in grinding plain cutters, the stop cannot locate the edge being ground by coming in direct contact with the same tooth, but must locate another tooth. If the teeth are unevenly spaced, this method is bound to result in error. The advantage of sharpening the cutters in this manner is the fact that accurate division is obtained through the division holes on the cone pulley of the lathe. If it so happens that the necessary divisions cannot be obtained through the cone pulley, a gear may be placed on the spindle in the same way as for cutting a thread, this gear containing a number of teeth equal to or a multiple of the number of teeth in the cutter. A stop is so fastened to the lathe that the gear can be utilized for obtaining the divisions for grinding the cutter.

In Fig. 2 is shown a simple jig for drilling the holes in small threading dies. It was essential when constructing this jig to have the holes *A* evenly spaced and also equidistant from the center. After the seat had been bored to size, the attachment was mounted in place of the turning tool and the piece soon spotted for drilling and reaming in the drill press. This is a good example, showing the amount of time that may be saved.

The attachment may be used to good advantage for backing off and sharpening small threading dies. The cutter and india oilstone used for these operations are shown in Figs. 3 and 4.

Summing up, it is well to note that the milling attachment in the bench lathe removes metal slowly and should be used only when small amounts of stock are to be taken off. The operator can readily see what he is doing, and if the dials of the various feeds are graduated in degrees and thousandths these may be used to good advantage. If the work has been turned in the bench lathe, it may be milled without being removed from the lathe. The job may be quickly located upon the face plate or angle plate in almost any desired position and the cutters, which can be cheaply made, can be applied at different angles or in any direction. If the attachment is a good one, it has hardened and ground bearings which are protected from dust and can be adjusted for wear. The spindle can be rotated at grinding speed, therefore wheels may be mounted and used for such jobs where other grinding attachments fail. Lastly, the tool maker can use his sense of touch to better advantage on this delicate apparatus than on a larger machine.

GUSTAVE A. REMACLE.

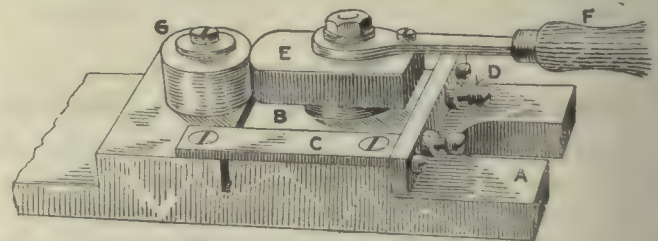
Newark, N. J.

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A Hand Marking Fixture

Trademarks and other designs can be impressed on work advantageously with the aid of a power marking machine, especially when the article to be stamped is sufficiently strong to resist pressure without distortion.

The accompanying illustration shows the design of a bench fixture for placing the trademark on the socket



THE MARKING FIXTURE

shell of electric attachments. With the use of this fixture a high rate of production has been attained, girls being employed as operators.

The base *A* is planed to receive the slide *B*, which is clamped in position by the locking strips *C* after being adjusted to give the proper depth of impression by the adjusting screws *D*. The design to be marked is cut on the face of the stamp block *E*, which is operated by the handle *F*. The work to be marked is dropped onto the locating plug *G*, which may be changed for different sizes of shells, as may the stamp block *E*.

The production from this fixture has run as high as 1,000 shells per hour.

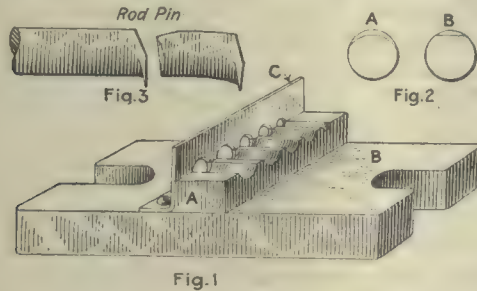
C. F. SCRIBNER.

Springfield, Mass.

Discussion of Previous Question

Cutting Rods in a Punch Press

The two shearing dies described by Mr. Valdes on page 388 are not so faultless or so inexpensive when compared with others as he may think. Dies such as these, that will be interchangeable and safe, can be made more eco-



FIGS. 1 TO 3. ECONOMICAL SHEARING DIES

nomically by securing a thin strip of steel (A, Fig. 1) with the necessary half-rounds in it on a standard cast-iron bedplate B, which also can carry the sliding distance stop. A bent plate C, of 12 gage with corresponding holes on the feed side, is not only a safety guard, but prevents the bending of thin rods. There is, of course, no objection to the use of a piece of steel with full holes, which will do away with the guard.

The labor involved in curving the cutting die might be saved, as I question its advisability and am convinced

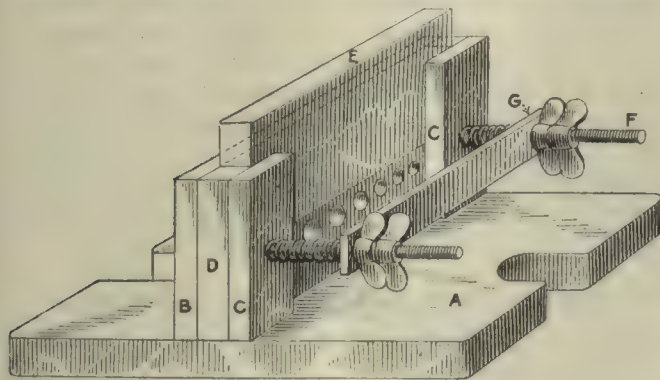


Fig. 4

FIG. 4. ROD-CUTTING DIES FOR THE PUNCH PRESS

that it is only practiced because others have done it before. I took the trouble to look into the deformation caused by different punches and found that a hollow punch deforms the section as shown by A (Fig. 2) and a straight punch results in section B. I cannot see, therefore, why a punch should be made hollow. Further, a straight punch shears cleaner.

The remark that the ends of the rods are cut square is only true as long as the bushings and punch are new and a tool maker has set the die. In any other case the cut will be as shown by Fig. 3, the feeding end showing a heavy burr, the pin being slightly curved and the shear of the pin, instead of being straight, is crooked and often

even hollow. A thin pin of soft material will demonstrate this very clearly.

It is poor practice to feed more than one rod at a time, as the best results are obtained by running the press constantly. This will give the operator enough to do to feed one rod against the stop. If he has to take care of many rods a large percentage of the pins will be short, because of the rods not being fed to the stop.

In the long run an expensive die is the cheapest. The die shown in Fig. 4 has none of the faults of the less expensive ones, guarantees a clean accurate cut free from burrs and, above all, any inexperienced man can set it under any press in two minutes. It consists of a base-plate A on which is a vertical plate B containing the holes or bushings. With strips C and spacers D it forms guides for the straight punch E, which is kept up by two springs (not shown) at the ends. Two screws F in the guides carry a sliding stop G pressed back by springs against two wing nuts. The nuts allow a ready adjustment of the stop.

JAN SPAANDER.

Brooklyn, N. Y.

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What Is a Gage, a Die, a Jig, a Tool, a Fixture?

The editorial on page 479, asking for definitions of familiar machine-shop tools, prompts me to write the following in regard to shop nomenclature. It seems the time is at hand when a dictionary of shop names and expressions should be compiled and adopted as a standard. A reader may come upon such expressions as "grinding a valve" or "lapping a hole." If he is unfamiliar with the process of grinding valves, or lapping holes, he will never dream that these two operations are alike and should be expressed by the same term. Wishing to understand the terms, he refers to the dictionary and finds that grinding is "wearing down, polishing, or sharpening, by friction." Upon referring to purely mechanical literature, he finds that the term grinding is used to signify "wearing down, or sharpening, with a revolving emery, or other abrasive wheel." Lapping he will discover to be "the process of wearing down by means of a loose abrasive worked between two surfaces."

Naturally, the seeker after knowledge will be at a loss as to why the process of wearing down the seat of a valve is termed "grinding," since the powdered-glass abrasive is not set in either surface, and the operation is so similar to the lapping operation. If a reader does not know how valves are ground and he reads the expression, "the valves were then carefully ground," he will gain the impression that the valves were ground with a revolving wheel.

Owing to the absence of a standard shop dictionary, writers are forever inserting explanatory phrases in articles, thus tending to distract and confuse the reader. There was one instance where a tool maker made a number of small valves for an outside firm. This tool maker

was unfamiliar with valve work, and in his efforts to obtain good results ground the valves very carefully, using a revolving wheel. Had this tool maker been instructed to lap the valves, using powdered glass as an abrasive, his work would not have been the failure it was. Of course an automobile mechanic understands just what is meant by grinding valves.

The cause of the error in the instance just cited was due to the fact that it was not explained to the tool maker, as a matter of caution, that while grinding is grinding at all times for some, it is polishing to the polisher, stoning to the man wielding a stone, and in some aspects, lapping to the tool maker.

Newark, N. J.

GUSTAVE A. REMACLE.

I am one of the many who will take up your suggestion to define gages, dies, jigs, tools and fixtures.

A gage is a form of measuring instrument. The name is applied to two widely differing forms. One type, the diaphragm needle and dial for measuring the pressure of a fluid, as steam or air, is of course outside of this discussion. As ordinarily used in the toolroom, the name applies only to tools for measuring, or to be exact, testing dimensions. Each gage is made to test one dimension, and only one: if it is adjustable it is only to take up wear. In other words, the name is not applied to micrometers nor indicators, though these may both be used for the same purpose.

The word "die" is applied to two widely differing classes of tools. The first class includes the tools used for cutting threads on the outside of cylinders, when they consist of two or more chasers set into a holder. The second class includes all the tools (shear blades excepted) which are used to cut or form material into definite shape, by means of pressure. This is divided again into three subclasses—dies for sheet-metal stamping, drop forging and die casting.

The word "tool," aside of course from its very broad general meaning, and within the limits of this article, is applied to the special cutting tools, often with several cutters, used in lathes, millers, etc. Each tool is made to do one single operation in the process of manufacture.

The names "jig" and "fixture" are synonymous. They apply to devices for holding work or guiding tools while at work, or both together. Each jig is made for one certain part, and sometimes for only one hole or cut; but more often several different operations are done in the same jig, with one setting of the piece. They are also used for devices for holding work or gages and indicators, or both, in inspecting; and in this case also each one is made for a certain piece only.

Plymouth, Mich.

W. B. GREENLEAF.

The Advantages of Machinist-Draftsmen

Having oversight of the engineering department of a firm of well-known machine-tool builders, I wish to add my opinion to the great number expressed on the subject of the machinist-draftsman, as advocated in Mr. Badge's article on page 31.

A man taken from the shop into the drafting room is more apt to have the qualities for the making of a draftsman than a large proportion of the graduates of our tech-

nical schools, inasmuch as he possesses the required knowledge of the proper methods of machining parts. He may detail, whereas the graduate cannot possibly acquire knowledge to do this in the short period of instruction, which he obtains in school. The man from the shop has usually served an apprenticeship of at least three years, and his ambition will cause him to delve into the whys and wherefores of mechanics and mathematics that pertain to his position.

It is not necessary for the machinist-draftsman to have a full working knowledge of the pattern maker's, the core maker's or the molder's trade, but he should be acquainted with the principles and methods employed in them, all of which he may obtain by personal contact with these trades. It is not necessary that he be able to make a glue joint, but to make an intelligible drawing he should know how a pattern is made and how it is used in the foundry.

He should also know by experience the difficulties a molder encounters with back draft, and know how to pick out loose pieces from inaccessible holes, also how not to set a core upon chaplets when it is possible to have sufficient on the core prints to avoid it. He should also have the experience of forging a frame and making square corners in order to realize the difficulties met by the blacksmith.

It will hardly be feasible for him to serve an apprenticeship in all the trades of which he should have a working knowledge, as it would be at least 10 or 12 years before he would have mastered all of them. But a small amount of experience in each of the above-mentioned trades and the burning of a large amount of midnight oil will put him on a par with the best.

He should make his advent into the drafting room in the small rather than the large shop, that his possibilities of obtaining the privilege of making the necessary experiments may be enlarged.

I have had my experience with both the shop and the school graduate draftsman. Give me the shop man every time, unless the school man has had an equal amount of shop experience. By expressing this opinion I do not intend to belittle the school graduate, but hope to point out to such graduates the necessity of shop experience before making a success in any drawing room.

Dexter, Maine.

E. W. TATE.

How Far Can Supervision Replace Skill?

The editorial on page 435, *American Machinist*, discussing the replacement of skill by supervision, is very interesting and graphically illustrates the extent to which efficient management can go in a successful attempt to keep production at normal under adverse conditions. Many, no doubt, after reading the editorial will claim that it is an impossibility to make a successful die sinker out of a chauffeur in two months' time. If I had read the article in a newspaper instead of in the *American Machinist*, I would promptly state that someone had been "stringing" the reporter who wrote the copy. A little thought, however, on the part of the man who knows anything about die sinking will convince him that the article rings true.

Die sinking, in this case making drop-forge dies, calls for considerable skill in two lines—operating a vertical-

spindle miller and using such hand tools as files, rifflers, scrapers, etc. The modern vertical miller is not a difficult machine to operate, as the cutters do practically all the work. Thus all the operator has to acquire is a certain amount of judgment in taking cuts and working to lines. Under the watchful eye of a competent supervisor who is possessed of patience and the ability to teach, any man who is mechanically inclined should make rapid progress, provided he is determined to succeed.

The handwork in finishing the dies, which calls for the use of files, scrapers, etc., is not as difficult as one might imagine, when we stop to consider that practically all the surfaces to be finished present curves. Now it is much easier to hand-finish a curved surface than a plane one. While it might be an utter impossibility to teach a man to file flat—finish up a blanking die, for instance—in a comparatively short time, the amount of skill necessary to finish up a drop-forge die is not too difficult to be readily acquired, as practically all the flat surfaces have been finished on the miller.

To what extent supervision could replace skill in other lines of tool making is a matter of speculation. Let us consider jig boring as an illustration. To bore jigs accurately calls for good judgment and a fine sense of touch, not to be acquired in two months or two years—that is, by the average man. Other machining operations on jigs—planer work on the shaper, for example—call for a degree of skill that cannot be developed in a short time. As a practical illustration of this fact we all know that an ordinary machinist can turn out fairly good work on the shaper if we are willing to tolerate allowances of from two to three thousandths. Suppose we give this man a jig casting 9 in. long, 6 in. wide and 4 in. high, with several surfaces to finish that must show both parallel and square when tested on a surface plate with a dial indicator. He would do a workmanlike job, no doubt, as far as outward appearances were concerned; but in nine cases out of ten his work would be neither parallel nor square, because he has not had the opportunity to develop the skill and judgment necessary to work to very close limits.

Another instance where extreme skill is necessary is found in the manufacture of subpress dies, either little ones for making watch wheels or large ones for making armature disks. That it takes a skilled mechanic to do work of this kind goes without comment; and it is very doubtful if a comparatively unskilled man could become proficient on this class of work in a short time, no matter how complete the supervision.

Some years ago, while traveling about the country as a tramp machinist, I often met mechanics with whom I had worked previously. The rate at which some of these men advanced was little short of marvelous. In one shop where I worked, a daredevil, good-natured sort of chap ran a hand screw machine. Nobody ever took him seriously; in fact, we considered him as a sort of joke. I met him again about a year afterward under very different conditions. The dirty overalls had given place to a white apron, and instead of running a screw machine he was boring jigs on a miller equipped with vernier slides. Where he picked up tool making I do not know; but he evidently was making good, as his work always passed close inspection. I recall another youth of twenty or thereabout who used to operate a punch press. Two years later I worked with him as an experimental hand

in a large shop in the East which is noted for the quality of its output. He was also making good, and he acquired his knowledge in two years. Let me state right now that experimental work, which is prosecuted from drawings alone, calls for both skill and judgment.

The two men above mentioned succeeded because they were natural mechanics who were fired with a determination to win. I strongly suspect that this factor has something to do with the success of the embryo die sinkers referred to in the editorial in question. Close supervision can no doubt replace skill to a certain extent within reasonable limits, but success in lines calling for extreme accuracy will always be governed by the factors of long experience or exceptional ability.

F. B. JACOBS.

Indianapolis, Ind.

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Precision Gage-Making Work

On page 390 is a letter from Mr. Remacle answering a previous article of mine, wherein I stated that the side of a grinding wheel should never be used for general tool and gage grinding.

In a few words I shall demonstrate, very clearly, just why this method is in error, from every point of view. In stating that I told how a "certain job should be done by using the side of the wheel," Mr. Remacle is very much mistaken. Suppose we are to consider as the pe-



FIG. 1. DISH WHEEL

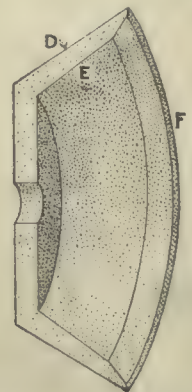


FIG. 2. CUP WHEEL

riphery that surface of the wheel farthest from the center and bounding the intermediate part of the wheel; that is to say, that part of the wheel between the farthest surface and the center. This, I take it, will be sufficient definition of the term "periphery" for the present case.

Now, if the dished wheel is presented to us in a plain or flat state, it will be found that Mr. Remacle's "side" will be but a more or less beveled periphery. To consider the dished wheel in its various forms, and in its dished state, let us employ a homely example: Suppose you cut your hand on the sharp edge of a brass cap. Would you say you cut your hand on the *side* of the cap or the *edge* of the cap? Which? Yet such a cap has two sides—an outside surface and an inside surface—the periphery being located at right angles to both sides, or surfaces, by the drawing dies. This angle is far greater than that found in any dished wheel, but the edge is still the edge, is it not? Thus we see that the "side" of a dished wheel *may* be merely the periphery of the wheel presented to the work at an angle, as I shall demonstrate. The dished wheel and the cup wheel were designed to enable us to get away from the inaccurate "side grinding" incidental to the use of a plain disk wheel. It is perfectly true, of course, that

many of the finest tool makers use the side of a grinding wheel for close work and actually get good results; but I am firmly of the opinion that a better way exists.

Take a plain disk wheel having no side clearance; in addition to the objections mentioned in my former article, page 121, there are other and fully as serious disqualifications to the use of the side of such a wheel for accurate work on fine tools and gages.

Suppose the face to be $\frac{1}{4}$ in. Now it is evident that if we are grinding in a slot $\frac{1}{2}$ in. deep, a corresponding amount of the side surface, or $\frac{1}{2}$ in., is cutting. This gives just twice as much surface to dress and keep true, producing double the amount of wear on the wheel, thinning it quickly and wearing it out in about one-half the regular time. I have not figured the extra time spent in dressing, wear and tear on diamond or dressing brick, etc.

Also, a consideration of the foregoing makes it easy to assume that the chances of error in the finished work will be about twice as great where the side of the wheel is used as would be the case if it were possible to use the periphery of the wheel. Owing to the greater cutting surface presented by the side of the wheel it may be presumed by many that a given form can be maintained for a greater length of time; but that is not, necessarily, the case.

The periphery of a wheel, running at a uniform speed, not only appears to hold a form as well, but is certainly far more easily redressed as the shape wears down. On the other hand, if the grinding is done on the side of the wheel, the nearer the cut approaches to the center of the wheel the more the speed is reduced, thus giving a wide range of speeds at one and the same time.

This condition is intensified or moderated, according to the depth of cut or width of surface being ground; but though the cut be only $\frac{1}{2}$ in. deep, this condition is still present, and the fact that the cut is fairly shallow makes the *method* none the less wrong—entirely wrong.

The evils of cutting at too slow a speed are several: most prominent among them being slow production, glazed wheels, burned work and very often a wavy, irregular surface of the work being ground, because the side of the wheel runs out of true.

I never said the side of a wheel is entirely useless. As a medium for holding the periphery to the center it has few, if any, equals. As to just what is the side of a wheel, consider the drawing, Fig. 1. I have chosen a Le Blond dished wheel as best suited to bring out the points I wish to make, although one may take any dished wheel, no matter how wide the grinding surface. If the wheel is of the dished variety, the cutting surface is but a bevel of the periphery, situated in the most convenient relation to the work—nothing more.

In the drawing it is apparent that *A* is one side of the wheel, *B* the other side and *C* the periphery, but presented to the work at an angle; for if *C* is also a side, we would have a wheel with three sides and no periphery, which would be an absurdity.

A dished wheel, by the way, appears to work better if it is not used just as it comes from the factory. Our practice is to dress a slight clearance on the flat cutting surface, producing in effect the wheel shown in Fig. 1. This dressing is intended to give only clearance.

In Fig. 2 is shown a cup wheel, known to the trade as a "Cincinnati No. 2." Properly speaking, this is no more a

side-cutting wheel than is the dished wheel. This wheel, if straightened out, will show a beveled periphery, as is patent to all.

Even if, for the sake of argument, I allow that these two wheels—shown in the drawings—*do* cut with their sides, it is still a side cutting vastly different from that of the plain disk wheel Mr. Remacle uses for grinding his snap gages. The fact that Mr. Remacle has no trouble in grinding first-class snap gages with a plain disk wheel shows him to be an unusually skillful tool maker. I am also quite certain that he will find a dished wheel superior for the job, assuming, of course, that he is not already familiar with all the details of toolroom grinding. When we have anything that *might* be ground with the side of the wheel we use a dished, cupped or beveled wheel instead. Our work embraces about two dozen different kinds of gages, including snap gages, jigs and general tool salvage.

Plainfield, N. J.

J. B. MURPHY.

✽

Mistakes in Advertising for Machine-Shop Help

A common fault with many advertisements inviting applications from workmen for positions such as tool makers, machinists, drilling hands, lathe hands, miller hands, etc., is in inserting the term "first-class." While this no doubt expresses plainly the real desires of those who write these requests, it nevertheless is a great deterrent in getting the right kind of help—men who undoubtedly have the desired qualifications.

The idea may be grasped more clearly in looking at an advertisement from the viewpoint of a workman who may be first-class in every sense and would fit well in the position open, but whose modesty or lack of confidence would hold him back from answering an advertisement containing this term. There are very few really first-class workmen engaged in any occupation who would willingly or openly parade their efficiency. The workman who would do this or does do it, is generally of the second grade. He is one of those whose habits of dissipation prevent them from holding jobs for any length of time or whose boastfulness exceeds their merits.

There are also a few young apprentices who, when they have finished their time, believe that they are fully experienced and first-class. They are apt to scorn their "first offer" unless it is accompanied by almost a salary.

There are many workmen who are reliable, steady, do good work, can be depended upon and seldom spoil work. They are generally in satisfactory positions. Even when they see an opportunity to better their wages they will hesitate a long time before they venture to make an application, for fear that they will not measure up to one of these misleading advertisements. Yet in nearly all cases they would (although unknown to themselves) meet the required conditions. Thus the term "first-class" as used in advertisements of this kind serves as a hindrance to getting good men and tends to destroy the confidence or desire of many workmen who really wish to answer the requests and secure the positions mentioned.

It seems advisable, therefore, to use terms other than "first-class," such as "a steady drilling hand," "a reliable miller hand," etc. Then one may be assured that the applicants are really competent, and less trouble will be had in securing the right kind of help.

Hartford, Conn.

J. E. COOLEY.

Editorials

United States Munitions

The leading article in this issue, by Howard E. Coffin, member of the Naval Consulting Board of the United States, and the technical article beginning on page 635 should be read together. Mr. Coffin points out with force that our great industries must be organized and educated that they may be in readiness to serve the nation in time of emergency. He also shows how important it is for the machine shops of the country to have a knowledge of machine tools and methods already in use in manufacturing United States munitions.

The article on page 635, under the department heading "United States Munitions," is the first of a series to show how American munitions of war are manufactured in the shops of the Army and Navy Departments. The beginning is with the manufacture of the United States service rifle. This is believed to be the first time that an attempt has been made to show in a technical journal all the detailed steps in the manufacture of a highly developed modern military rifle.

The great purpose behind this work is to put into the hands of the readers of the *American Machinist* accurate information to serve as a basis for the manufacture of United States munitions of war in private plants. Thus all the information will deal with what is actually being done today in producing the various articles that are taken up. With this knowledge as a starting point, private manufacturers can so plan the manufacturing methods in their own shops, with their own equipment, as to produce United States war material successfully and economically.

Another purpose behind this work is to show machines, small tools, gages, methods and processes that are the result of more than a century of development of machine-shop practice, for one article of our munitions—the army rifle—has been manufactured in the United States on an interchangeable basis for more than one hundred years. Many of these highly developed details of practice have applications in the making of other machine-shop products.

To handle this enormous volume of information successfully, a new method of presentation has been developed. It is shown by the first technical article. Purely descriptive text has been largely eliminated. An extensive use is made of drawings and dimensioned details, while for each operation there is a condensed statement of what it involves, how it is done, the machines and special tools employed, the number of operators needed, the speeds and feeds used and finally the production. It is perhaps needless to point out the magnitude of the work required to gather all these data for each detailed operation on such a complicated, highly developed piece of mechanism as a military arm.

For the convenience of the readers of the *American Machinist* all this information will be grouped under a department head. Each item of war material will be completed before another is taken up.

It is undoubtedly true that never before was such widespread authorization given for procuring technical details in regard to the manufacture of munitions of war as has been given to the *American Machinist*. Great credit is due to the far-sightedness of our War and our Navy Department officials in appreciating the value of this information to American machine shops and arranging for its collection and presentation. Each article will be scrutinized by ordnance officers before publication, in order to insure its complete technical accuracy.

■

Why Blame Welding Apparatus?

If welding be done in a hand forge, and a poor weld results, the man—not the forge—is criticized. Ages of forge welding have proved that such work can be done. In other words, precedent and experience are the guides for our opinion and decision.

However, when a weld is made with an oxyacetylene apparatus and the work fails, or is unsuccessful, the blame is too often placed on the apparatus—not the man. The reason for these two attitudes is no doubt owing to the fact that the oxyacetylene apparatus is comparatively new.

The *American Machinist* during the past three years has shown sufficient examples and given enough data to prove that welding can be and is successfully being done by the oxyacetylene method. These articles have not been limited to any one make or type of apparatus, but examples from high-, low- and equal-pressure apparatus have been illustrated.

With this evidence it seems that when cases of welding failure do occur, it would be fair to the makers of the apparatus to first prove that the fault is not with the man using it.

It is the business of the makers to produce an apparatus that will weld successfully, and in fairness it might be said that most of them do this for even the most exacting conditions. Often when a bad or insecure weld does occur, it is caused by an inexperienced operator using an incorrect type of flame obtained with the wrong mixture of gas, or perhaps through selecting the wrong size of welding tip.

■

The Quebec Bridge Accident and Stress Analysis

Everyone who sees under the surface of technical things was profoundly distressed by the second failure of the Quebec Bridge. It is only the frivolous-minded person who can find anything of humor in such destruction of the product of human labor and shattering of well-laid plans.

But the reason for the failure should be known as a warning and lesson to others. The following paragraphs are taken from an editorial in *Engineering News* and show the lack of care in making the stress calculations:

Because safety depends on strength of material and its proportioning to stress, calculation of stress is a vital

element in engineering and is bound to remain so. It was vital to the accident at Quebec. The bridge rocker casting whose breaking caused the fall of the suspended span on Sept. 11 broke under circumstances where no one knew how high a stress it carried. Both the builders and the Board of Engineers assumed that the stress could not go higher than 20,000 lb. per sq.in., but they had no assurance that it might not be twice as high.

The rocker casting that broke was too weak by its very design. It was unsafe. So also were its three brother rockers. Because one of the four broke it has been called defective—it was rendered weaker than the others by some internal condition. But calling this one rocker defective does not mean that the other three were safe and adequate.

It has been learned that one of the other rockers carried nearly twice normal load, and did so without breaking. This discovery is most noteworthy. In furnishing an illustration of how a structural member may develop very high strength, it supplements the demonstration of low strength given by the failed rocker. It recalls to mind in a warning way the fact that material is inevitably variable. That is why we employ factors of safety, and why we apply large factors to materials whose variations of quality are likely to be large, and smaller factors to more uniform material.

The stress analysis brings out the plain hard fact that the rockers at the time of failure were under very high stress. Figuring on neither the most favorable nor the most unfavorable basis of calculation, it is certain that the stress was higher than would be considered safe even in the very dependable rolled steel members of bridges. It was higher than the stress which the engineers of the Quebec Bridge permitted in the rolled steel bars of the great chains by which the span was being lifted, although these had been tested so thoroughly that their large factor of safety was amply established.

Moreover, the engineers *knowingly* allowed higher stress in the rocker castings than in the chains, although (by test) the chains could not fail until 60,000-lb. stress was passed, while the ultimate strength of the rockers was entirely problematical. They allowed the high stress to be applied as a tensile stress to a thin projecting edge of a casting, where, if anywhere, a crack might have its origin. Even worse, the thin edge carried its highest stress at the root of a reëntrant right-angle corner of the casting, where the fillet had been notched to make a carefully fitted seat for a centering plate.

Because the specifications permitted high unit stresses, a fair degree of definiteness of stress calculation was necessary to make them safe; guessing at stresses may be good enough with very low units, but with high units it is a bit like smoking in a powder magazine. In a truss or girder, or even in a single bridge member, the degree of approximation involved in stress calculation is pretty well recognized. The question stands otherwise with parts and assemblages of the kind represented in the shoe support of the suspended span on its lifting girders.

It is the stress calculation for the parts of this support that is under scrutiny, rather than the unit stresses allowed. The units may still be safe if the method of computation is reliable. That is an "if" which the designer must meet, and meet with no hesitation or frivolous conscience. Looking at the method of calculation actually employed, however, the best that can be said for it is that

it will hold true under certain conditions not definitely known. What is known certainly and definitely is that the calculation is wrong, and likely to be unsafe, under all other conditions.

The case of the pin and casting calculations affords a striking illustration of the old question whether a part may be stronger than the whole; whether a piece can be strengthened by cutting away some of it. The Quebec rocker would figure out to be strong enough if its longitudinal bracket arms were cut down one-half in length. Does this justify the conclusion that without such cutting down the part is also strong enough? The question is seductive, and one is tempted to answer yes, on the view that the smaller part is necessarily weaker. But in the case in hand such reasoning is a fatal error.

A bald statement of the method of the calculation employed will appear harsh and unfair. Viewed superficially at least, the calculation is absurd, since it plainly tempers the wind to the shorn lamb; that is, it adapts the load-distribution to the strength of the part, and therefore, while purporting to determine or verify the strength of the part, it does nothing of the sort. The Board's so-called check calculation presents itself as a verification of the strength of the rocker casting; but in reality it is no such verification, by any stretch of reasoning. All it shows is that, to make the shoe safe, the reaction on the base of the shoe ought to be concentrated on the middle half of the shoe length, and to make the rocker safe its reaction ought to be limited to similar ratio. It does not show that either the shoe or the rocker is safe. Yet, apparently, the rocker casting was approved because of some indefinite faith that the base pressure would concentrate itself in accordance with the limit which the calculation showed to be necessary. No attempt was made to compel the base pressure to respect this limit.

Simply regarded, the "stress calculation" for the Quebec rocker support is merely some formal and unimportant figuring to verify minor features of the design. It does not analyze or approve the design, but tacitly accepts the design as adequate and then deduces a few auxiliary figures from it. It is therefore chiefly significant as being an expression of complete faith in the trained eye and sound judgment of the designer who sketched out the proportions of the castings. Unfortunately that faith was not justified by the event.

■

Shop Floors and Health

In selecting a form of construction for a shop floor, consideration should be given to the liability of the various materials to retain germs of infectious diseases. This is an aspect of shop floors that is often given too little thought. Yet the question should always be asked, "How will such and such a flooring affect the health of the employee?"

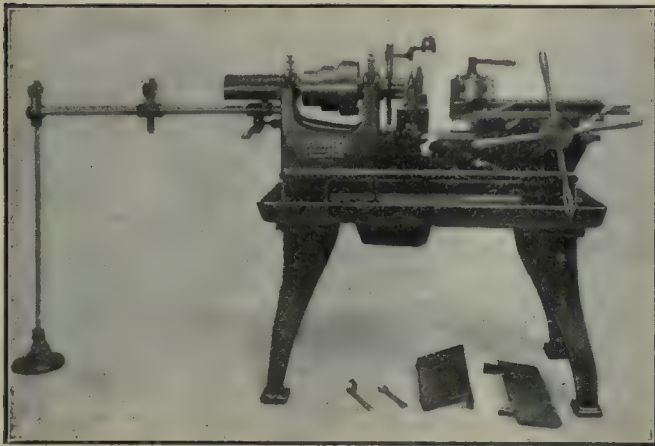
An ideal flooring will not only serve all the structural requirements of the shop building of which it is a part and of the industry which is to be carried on upon it, but it will also be composed of such material that it will not retain the germs of infectious diseases, will not hold dangerous or injurious products that may be used in the processes of manufacture and will not retain moisture. The floor temperature, its freedom from slipperiness, its drainage if liquids are likely to be spilled upon it, and its elasticity should also be considered.

Shop Equipment News

Hand Screw Machine

In the design and proportioning of the hand screw machine shown, to secure rigidity the head and bed are cast integral.

The spindle is mounted in phosphor-bronze bearings, grooved and provided with sight-feed oil cups. The stock feed is operated by a conveniently located hand lever.



HAND SCREW MACHINE

Capacity of automatic chuck, round, $1\frac{1}{2}$ in.; square, $\frac{11}{16}$ in.; hexagon, 1 in.; capacity of threads on steel, $\frac{5}{8}$ in.; capacity of threads on brass, $1\frac{1}{8}$ in.; capacity drilling in steel, $\frac{7}{8}$ in.; hole in spindle, $1\frac{1}{2}$ in.; length that can be turned, 8 in.; swing over bed, 13 in.; swing over cutoff slide, $7\frac{1}{4}$ in.; greatest distance, end of spindle to face of turret, saddle flush, 13 in.; diameter of turret, round, $6\frac{1}{4}$ in.; across flats, hexagon, $6\frac{1}{4}$ in.; size of tapped holes in turret face, $\frac{3}{8}$ in.; distance center of turret holes to top of slide, $1\frac{1}{2}$ in.; travel of cutoff, cross, 5 in.; travel of cutoff, longitudinal, 10 in.; diameter of driving cone pulley, 12 in., $10\frac{1}{2}$ in., 9 in.; diameter of driving cone pulley on spindle, $8\frac{1}{2}$ in., 7 in., $5\frac{1}{2}$ in.; width of driving belt, $2\frac{1}{2}$ in.; floor space, 2 ft. by 4 ft. 5 in.; weight, 1,300 lb.

The cutoff rest is fitted with a locating clamp provided with an adjustable stop and screws, and is equipped with rack and pinion lever. The two tool posts have step-wedges to give height.

The turret is furnished hexagonal or round and is fitted with binder bushings. The turret is indexed automatically by the backward movement of the slide. The locking bolt, of chrome-nickel steel, works in hardened and ground bushings let into the solid turret. Independent stops operate automatically for each position of the turret.

The machine shown is a recent product of the Turner Machine Co., Danbury, Conn., and was built for the Macnab Machinery Co., New York City.

Ball-Bearing Bench and Floor Grinders and Buffers

In the illustrations are shown two machines representative of a new line of grinding and buffing machines developed by the Hisey-Wolf Machine Co., Cincinnati, Ohio.

The machines are made in both bench and floor types and are equipped throughout with ball bearings, which

are mounted in motor end caps in close proximity to the wheels. Each machine is fitted with a quick-acting switch, the larger sizes with automatic starters. The operating handle is conveniently located in front of the motor, with the switch proper completely inclosed in the base. The

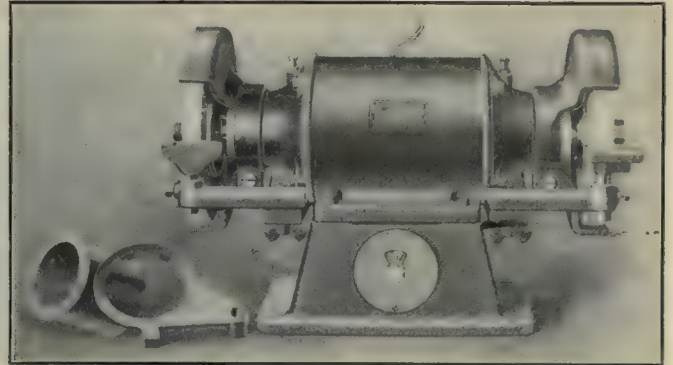


FIG. 1. GRINDING AND BUFFING MACHINE, BENCH TYPE

wheel guards are made of steel, and they surround the grinding wheels for three-quarters of the circumference.

When so ordered, a combination guard can be furnished. It has fittings for regulation size of suction pipes and can be connected to a blower system. The backs are made of heavy steel and fitted with baffle plates to prevent

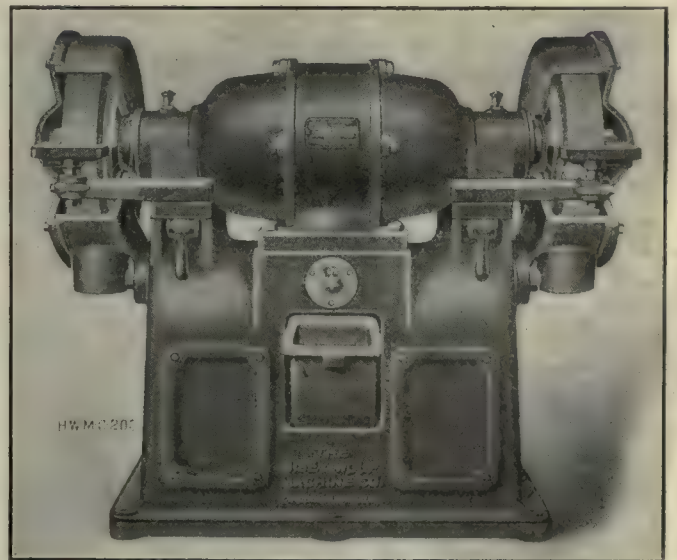


FIG. 2. FLOOR-TYPE GRINDING AND BUFFING MACHINE

broken wheel parts and emery sparks from escaping from the hood. A hinged door with lock is provided, so that the wheel can be renewed without disturbing the guard. The grindings can be removed from the hood by means of a sliding door.

The grinding rests are adjustable and can be taken off if desired. They are held in position by a clamping nut and bolt with concealed head. The grinders are available for connection with alternating- or direct-current circuits.

Five-Spindle Horizontal-Rail Drilling Machine

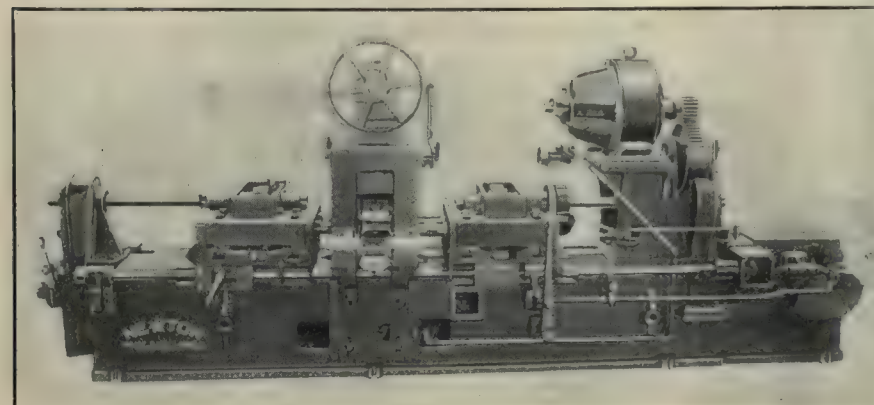
The five-spindle horizontal-rail drilling machine shown is a recent development of the Newton Machine Tool Works, Philadelphia, Penn. The machine was designed to permit drilling close centers and at the same time to retain a powerful drive.

The central spindle is fixed, the two outside spindles being adjustable from the operating side by means of a screw. Either spindle on the two-spindle head can be brought within 1 in. of the center line of the central or

This instrument, in conjunction with a table of natural sines and cosines, is employed for the accurate determination of angles. It measures 5 in. from center to center of the disks and forms a useful adjunct to a tool maker's kit.

Combined Milling and Grinding Attachment for Lathes

The accompanying illustrations show the mechanism of a combined universal milling and grinding attachment built by Edward N. Moor, 765 Kingston Ave., Oakland, Calif., for use on any lathe. Its range covers all work that can be done on the centers or on the faceplate of the lathe. In Fig. 1 the attachment is shown with the spindle set vertically and milling the flutes in a reamer. The device is attached by a bolt through the column to the carriage or to the compound or plain cross-slide. The interchanging of spindles for grinding or milling is accomplished by releasing and tightening two nuts on the sleeve. The ability to use it right or left in front of or back of the column, at any elevation and at any angle makes it universal in every way. The overhead motor is from $\frac{1}{2}$ to $\frac{3}{4}$ hp. and is carried on a single track. It is within



FIVE-SPINDLE HORIZONTAL-RAIL DRILLING MACHINE

Range of adjustment on three-spindle head, 4 to $10\frac{1}{2}$ in., between centers: two-spindle head, 4 to 19 in.; maximum distance between ends of spindles, 26 in.; length of feed motion to each spindle, 12 in.; speed range, 400 to 1,200 r.p.m.

fixed spindle in the three-spindle head, thus making possible the drilling of holes within 1-in. center distance.

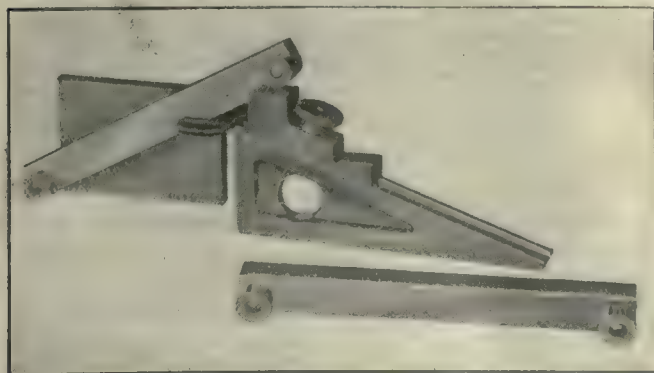
The spindle saddles have a full bearing on the base, with strap and taper shoes to compensate for wear, and are operated from a common pair of feed screws with right- and left-hand threads, so that both heads operate simultaneously.

The spindle heads have four changes of feed with rapid power traverse in both directions. The saddles are supplied with adjustable automatic stop to the feed motion, with rapid power return, having a safety limit to prevent jamming at either end of the saddle movement.

An adjustable elevating table to take care of the different sizes of rails is provided.

A Sine Bar

The illustration shows a sine bar manufactured by the Model Tool and Gage Co., 187 John St., Bridgeport, Conn., and marketed under the trade-name "Simplex."



SIMPLEX SINE BAR

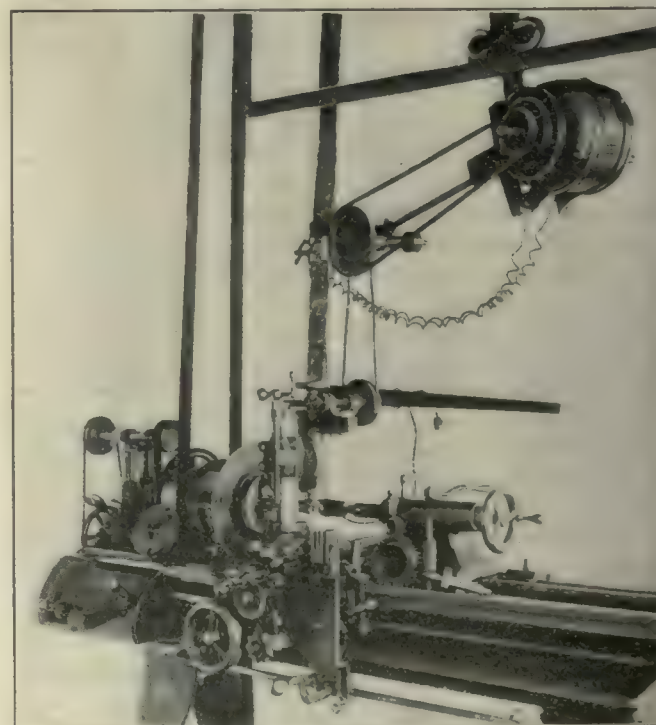


FIG. 1. THE COMPLETE OUTFIT

easy reach over the lathe and about a foot off center. A housing on the back bearing of the lathe carries a spindle that slides to a position over or out of the way of the small cone pulley. The outer end of this spindle carries a V-grooved pulley, with a round belt connecting with a V-grooved pulley on the stud, thus transmitting motion to the lead screw or feed rod.

In Fig. 2 the attachment is shown grinding the interior of a gear. This view also illustrates the holder for the diamond dresser for the abrasive wheels. This holder serves to carry a spring stop for use in grinding cutters and reamers.

In milling, it is possible to get all speed changes that are necessary for cutters from $\frac{1}{2}$ -in. keyway cutters to

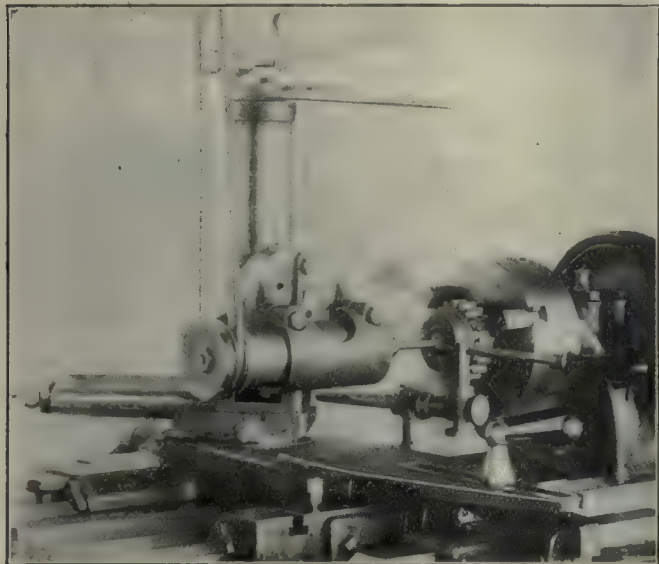


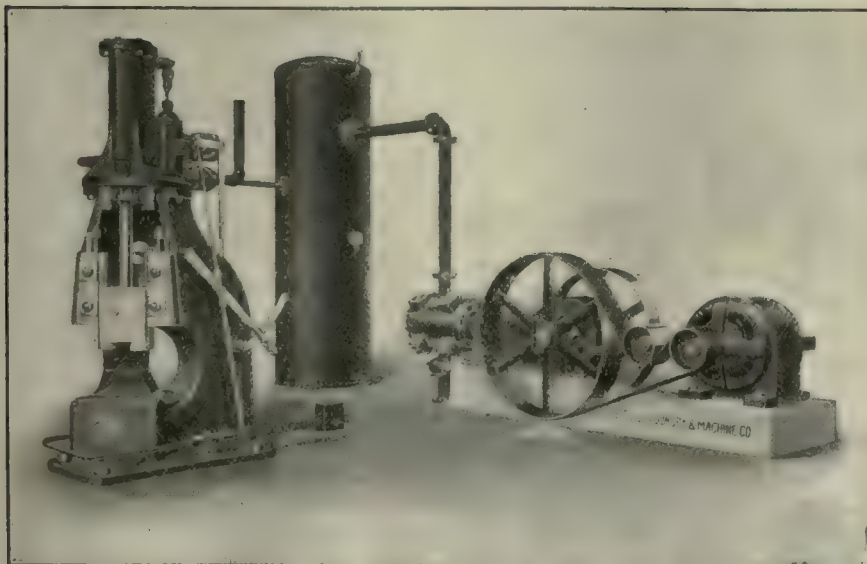
FIG. 2. INTERNAL GRINDING

$2\frac{1}{2}$ - or 3-in. standard cutters and mills or 6- or 8-in. saws. The speed of the grinder is from 1,100 to 11,000 r.p.m., enabling the use, at the correct speed, of any size of wheel required.

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Air-Operated Steam Hammer

The illustration shows a steam forging hammer recently developed by the Buffalo Foundry and Machine Co., Buffalo, N. Y., and arranged to be driven by an air compressor. The compressor can be equipped for plain belt drive direct from an individual motor furnished with the compressor; the receiver tank can be placed in either vertical or horizontal position at any convenient location near the hammer and compressor to best accommodate itself.



AIR-OPERATED STEAM FORGING HAMMER

By the use of compressed air sensitive control is provided: the force, position and rapidity of the blow are under absolute control and can be instantly varied by the operator.

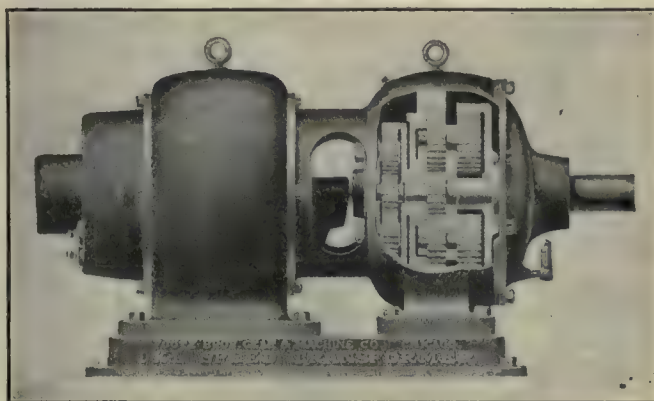
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Spur-Gear Speed Reducer

The speed reducer shown is adapted for machine-tool application and is designed to be especially valuable in places where dust and grit are so voluminous as possibly to affect the drives.

The form illustrated is of the double-differential type, in which the first part is nonplanetary and the second planetary. It is claimed to eliminate the objectionable feature of the first set of idlers being fastened to the flat plate and rotating on the high-speed shaft.

The first king pinion is keyed directly to the motor shaft, doing away with the flexible coupling between the



SPUR-GEAR SPEED REDUCER

motor and the reducer and making a short connection by using a thimble between the two. This thimble connection is counterbored to go over the standard cover of the motor and is a part of the front side of the reducer case. The first set of studs and idlers is rigidly fastened to this frame, which gives a rotary motion to the internal gear that is partly journaled on the slow-speed shaft and receives an outer support from the hub on the planetary cage carrying the planetary pinions. On the hub of the first internal gear is rigidly fastened a pinion that gives a planetary motion to the second set of idler pinions; and the outer periphery of these pinions, meshing with the stationary rack, rigidly fastened in the case, gives them a planetary motion around this king pinion. A shaft that is introduced into these planetary pinions is keyed rigidly and carries another set of idler pinions that mesh with the last gear that rotates on its bearing. This is the slow-speed shaft, which has long and ample bearings in the cover of the reducer case. This combination makes it possible to get a very large reduction in the two last sets of gears by having a few teeth less in the last internal gear than there are in the stationary rack. The cages carrying the planetary idlers are amply supported in two kinds of

bearings. These cages also find an outer bearing in the L-shaped partition of the main body of the case.

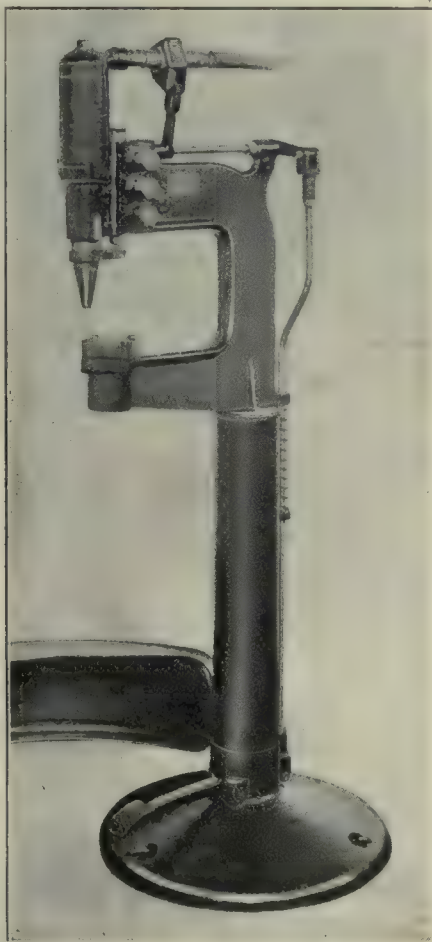
This double differential can also be furnished with a self-contained case to take a coupling between the motor and the reducer, the one illustrated being merely a more compact form of the attachment to the motor. This speed reducer is a recent development of the Foote Brothers Gear and Machine Co., Chicago, Ill.

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Pedestal Pneumatic Riveter

The pedestal pneumatic riveter shown is a recent product of the Chicago Pneumatic Tool Co., Chicago, Ill., and was designed for riveting small light parts that can best be handled in a stationary machine. It is constructed so that the machine can be operated by a foot lever, leaving the operator's hands free to handle the work.

The yoke consists of a crucible-steel frame mounted in the end of pipe column, all of which is supported on a cast-iron base and held together with a $\frac{3}{4}$ -in. bolt. The base



PEDESTAL PNEUMATIC RIVETER
Yoke gap, 8 in.; reach 11 in.

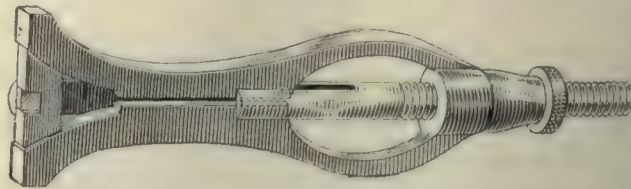
is provided with anchor bolt holes to permit its being fastened to the floor.

Where it is desirable to handle more than one size rivet a special dolly may be supplied that will accommodate four different size rivets. This dolly is made to permit of its being used in very close corners and is replaceable.

The riveter head is held in a clamp, which permits of its being adjusted to take care of the wear on the dies or the variation in length of rivets.

Adjustable Male Gage

The illustration shows an adjustable male gage that has been developed by Nils E. Larson, Chicago, Ill. The



ADJUSTABLE INSIDE GAGE

body of the gage is made of steel, spring tempered. Adjustment of the measuring points is by means of a wedge actuated by a knurled nut.

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Some Employment Statistics

Here are the amazing figures for a group of twelve factories scattered over six states:

Employees on payroll at the beginning of 1912.....	37,274
Employees on payroll at end of 1912.....	43,971
Increase in working force during 1912.....	6,697
Employees hired during 1912.....	42,571
Employees hired in excess of required increase.....	35,874

In other words: In order to maintain a total working force of 37,274 persons and to effect an increase of 6,697, it was necessary to engage 42,571, or about $6\frac{1}{2}$ times as many people as constitute the increase of the working force.

Theoretically, only as many persons ought to have been hired as were needed permanently to increase the force; practical allowances, however, must be made to compensate for the following factors applicable to workers generally. It may be assumed:

1. That 1 per cent. of the regular force of employees under investigation die within a year and must be replaced.
2. That 4 per cent. are incapacitated for work by sickness for more than two weeks and must be replaced temporarily or permanently.
3. That 8 per cent. withdraw from service from whatever reason or are discharged in the course of a year and must be replaced.
4. That 8 per cent. of the normal force must be added for temporary work and for normal fluctuations in production.
5. That 80 per cent. constitute a satisfactory efficiency of a hiring department.

It follows, therefore, that without any permanent increase in the working force, $26\frac{1}{4}$ per cent. of the total force would have to be rehired during the year. The same allowances must be applied to the number of employees required to give a permanent increase in the working force.

Applying these factors to the problem in hand we find that the engagement of 13,843 persons, in addition to the 6,697 for permanent increase, or the total engagement of 20,540 persons, would have been justified to cover withdrawals by death, sickness, resignation and discharge, and to allow for production fluctuations and practical employment results. But 42,571 persons, however, were engaged, or 22,031 above the apparently necessary requirements.—M. W. Alexander, in *The Nation's Business*.

Col. Robert C. McKinney

Col. Robert Cochran McKinney, chairman of the Board of Directors of the Niles-Bement-Pond Co., for many years its active president and the dominant figure in the consolidation of the enormous machine-tool interests involved, died at his home in Belle Haven, Conn., on Oct. 3, after a long illness. Failing health caused Colonel McKinney's retirement from active work two years ago.

The career of Colonel McKinney is truly reflected in the Niles-Bement-Pond Co., for this huge American cor-



COL. ROBERT C. MCKINNEY

poration, one of the largest manufactories of the world, not only represents his technical and expert mechanical knowledge, but typifies his greatest gift—the gift of organization. To have conceived, planned and executed an organization of such magnitude, without in any way raising a question as to business morals or personal integrity, is the monumental achievement for which Colonel McKinney will be long remembered in the machinery-building world.

Colonel McKinney was born in Troy, N. Y., in 1851, at a time when that community was especially distinguished for manufacturing interests associated with machinery, iron and steel products, stoves and ranges. He was a son of Robert and Mary (Smyth) McKinney, and his father was presumably identified with certain lines of hardware manufacture; for when, in 1861, Colonel McKinney's parents removed from Troy to Cincinnati, the senior McKinney became a member of a firm engaged in manufacturing hardware. Although young McKinney attended the public schools, and Woodward High School in Cincinnati until 18 years of age, he must also have

received constant information respecting hardware manufacture while still a youth. Two of his brothers, older than himself, had established a manufacturing company at Hamilton, Ohio, and the fact that the brothers were engaged in manufacturing there justifies the inference that young McKinney's early associations were such as to bring him into constant touch with manufacturing.

He must have discovered a strong bent for mechanics, for he took a partial course in mechanical engineering in Cornell University in the early seventies. His student life was followed by employment in the drafting room and office of a company which manufactured steam-pumping machinery at Hamilton.

The City of Hamilton had already gained especial distinction as a manufacturing center, greatly if not chiefly occupied in producing machinery, steam pumps and machine tools. There had been established there a company engaged in manufacturing machine tools, which had not yet gained its high reputation for the quality and the finish of its product. The Niles Tool Works, for that was the name, was unique, since it was the first manufactory of that kind established and operated west of Philadelphia.

In 1877 Colonel McKinney became associated with the Niles Tool Works. It was at a critical and yet opportune time. The country was just upon the verge of resuming specie payments, and financial conditions were still somewhat chaotic. The country was also recovering from the demoralization of business and impairment of credit consequent upon the panic of 1873.

It was undoubtedly at this time that Colonel McKinney first impressively revealed his qualifications for seizing the opportunity that was opening in the West, especially for a business of this kind; for within two years he was elected secretary of the company, and a little later treasurer and general manager. In addition to Colonel McKinney's technical and expert knowledge as a mechanical engineer, he showed himself possessed of great energy in extending the business and increasing the capacity of the plant. So great was this expansion that it was found to be imperative that there be reorganization of the business and enlargement of the capital, so that greater facilities could be obtained and a high quality of product at the lowest possible cost of manufacture secured. The capital of the reorganization was increased to \$2,000,000. In this expansion were involved, first, expert and technical knowledge of manufacturing itself; second, ability successfully to finance a reorganization, and in the third place, the difficult but vital feature of organization, the perfecting of a symmetrical machinery of organization and the securing of competent, highly skilled subordinates for the direction of the various departments.

In all of this work Colonel McKinney was preëminent: he had gained while with this company the title of colonel through his service on the staff of Governor Bushnell, of Ohio. It was realized soon after the reorganization that it was essential to secure additional property if the Niles works were to be wisely expanded. For that purpose the plant and the business of the Cope & Maxwell Manufacturing Co., whose products were steam pumps, were purchased. Later the machinery and business of the Cope & Maxwell Co., as bought by the Niles Tool Works Co., were sold to another corporation and became a part of the International Steam Pump Co. Colonel McKinney perceived that even with the large organization and facilities which the new Niles Tool Works Co. represented there

could not be the higher development and the acceptance of the magnificent opportunities which he saw opening without much greater expansion. Colonel McKinney also realized that this expansion should be of a kind which involved reasonable combination and far-reaching co-operation. To accomplish this was to do the work of the higher order of constructive business genius.

In 1898 the first step was taken through the purchase of the control of the widely known Pond Machine Tool Co., of Plainfield, N. J., this purchase being supplemented by the obtaining of options on the works of Bement, Miles & Co., of Philadelphia, Penn., as well as the Philadelphia Engineering Works. This involved the organization of one sponsoring corporation, capable of taking over the various properties, of harmonizing the plants and perfecting production and marketing. The company thus created is now known the world over as Niles-Bement-Pond Co., organized 17 years ago.

Colonel McKinney's achievement in creating this company and perfecting its organization was recognized by his election as president of it. Other opportunities came, and if they were to be met and the company was to handle the great business that came to it, it was necessary to secure other properties. For that reason the great Pratt & Whitney Co. (of Hartford), the Bertram Co. (of Canada) and the Ridgway Machine Co. (of Ridgway, Penn.) were bought in addition to numerous other smaller establishments.

Colonel McKinney was a member of the Union League Club, Lotos, Engineers' and Cornell Clubs, of New York; the Hartford Club, of Hartford, and Queen City Club, of Cincinnati; a member of the American Society of Mechanical Engineers, and was a past president of the Machinery Club, of New York. Besides his wife, whom he married at Hamilton, Ohio, in 1879, and a daughter, Colonel McKinney is survived by two brothers.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, ETC., REQUIRED BY THE ACT OF CONGRESS OF

AUGUST 24, 1912.
of American Machinist, published weekly at New York, N. Y.,
for October 1, 1916.
State of New York } ss.
County of New York }

Before me, a Notary Public in and for the State and County aforesaid, personally appeared Chester W. Dibble, who, having been duly sworn according to law, deposes and says that he is the Vice-President of Hill Publishing Co., Publishers of American Machinist, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor and business manager are:
Publisher, Hill Publishing Company, 10th Ave. at 36th St., New York, N. Y.
Editor, Leon P. Alfrod, 10th Ave. at 36th St., New York, N. Y.
Managing Editor, John H. Van Deventer, 10th Ave. at 36th St., New York, N. Y.
Business Manager, Mason Britton, 10th Ave. at 36th St., New York, N. Y.

2. That the owners are:
Hill Publishing Company, 10th Ave. at 36th St., New York, N. Y.
Owners of 1% or more of Stock Issued.

Estate of John A. Hill, 10th Ave. at 36th St., New York.
Arthur J. Baldwin, 10th Ave. at 36th St., New York.
Fred R. Low, 10th Ave. at 36th St., New York, N. Y.
John McGhie, 10th Ave. at 36th St., New York, N. Y.
Fred S. Weatherby, 1600 Beacon St., Brookline, Mass.
Frederick A. Halsey, 356 W. 120th St., New York, N. Y.
G. Eugene Sly, 50 Union Sq., New York, N. Y.
Frederick W. Gross, 215 E. 11th St., Erie, Penn.
Emma B. Hill, 80 Munn Ave., East Orange, N. J.

The remaining stock is owned by 91 stockholders who own less than 1% each, 73 of whom are employees of the company.

3. That the known bondholders, mortgagees and other security holders owning or holding 1 per cent. or more of total amount of bonds, mortgages or other securities are: Mortgage on building, Dime Savings Bank, Brooklyn, N. Y.

4. That the two paragraphs next above, giving the names of the owners, stockholders and security holders contain not only the list of stockholders and security holders as they appear upon the books of the company, but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association or corporation has any interest direct or indirect in the said stock, bonds or other securities than as so stated by him.

CHESTER W. DIBBLE,
Vice-President, Hill Publishing Co.
Sworn to and subscribed before me, this 29th day of September, 1916.
[Seal.]

RICHARD L. MURPHY,
(My commission expires March 30, 1917.)

Personals

George L. Hoyt, superintendent of the George W. Swift Machine Works, Bordentown, N. J., has resigned.

P. W. Gilbert, for several years assistant sales manager of the Standard Welding Co., has been appointed sales manager, succeeding H. A. Flagg, recently resigned.

B. A. Quayle, who has had charge of the Chicago office of the Standard Welding Co. for many years, becomes general representative, with headquarters at the home office.

Benton G. L. Dodge, who has had charge of advertising and publicity of the Standard Welding Co. for several years, has taken up the larger duties of manager of sales promotion.

Frank E. Krause has been appointed manager of the Welmar Chain Works, Avon, Penn., succeeding George Holly, resigned. Mr. Krause was formerly assistant to Edgar A. Welmar, president.

Ross Anderson, manager of production of the Poole Engineering and Machine Co., Baltimore, Md., has assumed general management of the shops and has been given the title of works manager.

Walter C. Voss, until recently in charge of the Cleveland district of the Standard Welding Co., has been transferred to the Detroit office, where he will succeed Charles E. Miller, recently resigned.

B. D. Gray, by action of the board of directors taken on Oct. 6, succeeds F. E. Bright as president of the Hess-Bright Manufacturing Co. Mr. Bright remains identified with the company as chairman of the board.

Joseph Spring, for the past seven years piece rate inspector, factory layout and cost department expert for the Aurora Automatic Machinery Co., Aurora, Ill., has been promoted to the position of superintendent of the Chicago plant.

B. M. W. Hanson, vice-president and works manager of the Pratt & Whitney Co., is one of the

two civilian members of the board appointed by Secretary of War Baker to investigate the machine-gun controversy and recommend the best method for the Government to adopt for the future development and purchase of machine guns.

Business Items

The Ready Tool Co., Bridgeport, Conn., has just moved into its new factory, corner of Iranistan Ave. and the railroad.

The Union Gear and Machine Co., Boston, Mass., is moving into larger quarters at 27 Purchase St., that city, giving it about four times its present floor space, where considerable new machinery will be installed.

The Edgewater Steel Co., recently incorporated, has completed its organization and has purchased the plant of the Kennedy-Stroh Corporation at Oakmont, Penn. The officers of the new organization are: F. B. Bell, president; M. R. Jackson, vice-president; W. H. Schoen, treasurer; J. H. Bally, secretary; F. C. Riddle, general manager. General offices will be maintained in Pittsburgh.

Trade Catalogs

Power Presses: The Cleveland Machine & Mfg. Co., 4938-4952 Hamilton Ave., Cleveland, Ohio. Catalog. Pp. 120; 6x9 in. Describes also shears, dies and other metal working machinery.

Catalogs Wanted

The Eastern, Flexible Conduit Co., 41 Gardner Ave., Brooklyn, N. Y., would like to receive for their purchasing department catalogs, price lists, etc., from manufacturers.

Forthcoming Meetings

National Machine Tool Builders' Association. Annual convention, Oct. 24-25, Hotel Astor, New York City. Charles E. Hildreth, general manager, Worcester, Mass.

American Society of Mechanical Engineers. Annual meeting, Dec. 5-8, Engineering Building, New York City. Calvin W. Rice, secretary, 29 West 39th St., New York City.

American Society of Mechanical Engineers. Monthly meeting, first Tuesday. Calvin W. Rice, secretary, 29 West 39th St., New York City.

Boston Branch National Metal Trades Association. Monthly meeting on first Wednesday of each month, Young's Hotel. W. W. Poole, secretary, 40 Central St., Boston, Mass.

Providence Association of Mechanical Engineers. Monthly meeting, fourth Wednesday of each month. J. A. Brooks, secretary, Brown University, Providence, R. I.

New England Foundrymen's Association. Regular meeting, second Wednesday of each month. Exchange Club, Boston, Mass. Fred F. Stockwell, 265 Broadway, Cambridgeport, Mass.

Engineers' Society of Western Pennsylvania. Monthly meeting, third Tuesday; section meeting, first Tuesday. Elmer K. Hiles, secretary, Oliver Building, Pittsburgh, Penn.

Rochester Society of Technical Draftsmen. Monthly meeting, last Thursday. O. L. Angeline, Jr., secretary, 857 Genesee St., Rochester, N. Y.

Superintendents' and Foremen's Club of Cleveland. Monthly meeting, third Saturday. Philip Frankel, secretary, 310 New England Building, Cleveland, Ohio.

Western Society of Engineers, Chicago, Ill. Regular meeting, first Wednesday evening of each month, excepting July and August. J. H. Warder, secretary, 1785 Monadnock Block, Chicago, Ill.

Philadelphia Foundrymen's Association. Meetings first Wednesday of each month. Manufacturers' Club, Philadelphia, Penn. Howard Evans, secretary, Pier 45 North, Philadelphia, Penn.

Twenty Years' Progress in Die Making and Using

BY EDWARD DEAN*

SYNOPSIS—This article is the first of four that, taken together, record the study and results of twenty years of punch-and-die design, making and using. The progress during this time has modified the selection of the steel, the proportions and construction of the dies, methods of die making, furnaces and instruments for die hardening, and, finally, the construction of subpresses and power presses. During this period the working life of the dies has steadily increased, the first cost has decreased, the number of punchings between grindings has increased, the number of grindings per die has increased, and, as a result, the die cost per thousand punchings has greatly decreased.

More than twenty years ago I was impressed—as many other tool makers, pressroom foremen and shop superintendents have been impressed—by the great difference in the life and service of all kinds of cutting tools,

In other cases one set of dies made in a particular way would give good service, while a similar set, as regards design, would be almost worthless. Perhaps the first set would be duplicated time after time without any losses due to cracks and breakage. On the other hand it would seem almost impossible to harden one of the second set without loss through damage in the hardening room.

Everyone who has had anything to do with pressroom tools has met with just such discouraging conditions. But the fact that some of the tools were good and gave excellent service showed the possibility of success if the underlying reasons could be found. This was my own starting point some twenty or twenty-two years ago. I wanted to be able to make punches and dies so that every one turned out would be equal to the best of those that apparently came from a chance combination of proper design, suitable steel and proper die making and hardening. I wish I could say that this goal has been completely reached. I cannot do this. However, I have been able to make progress. And in this and the three

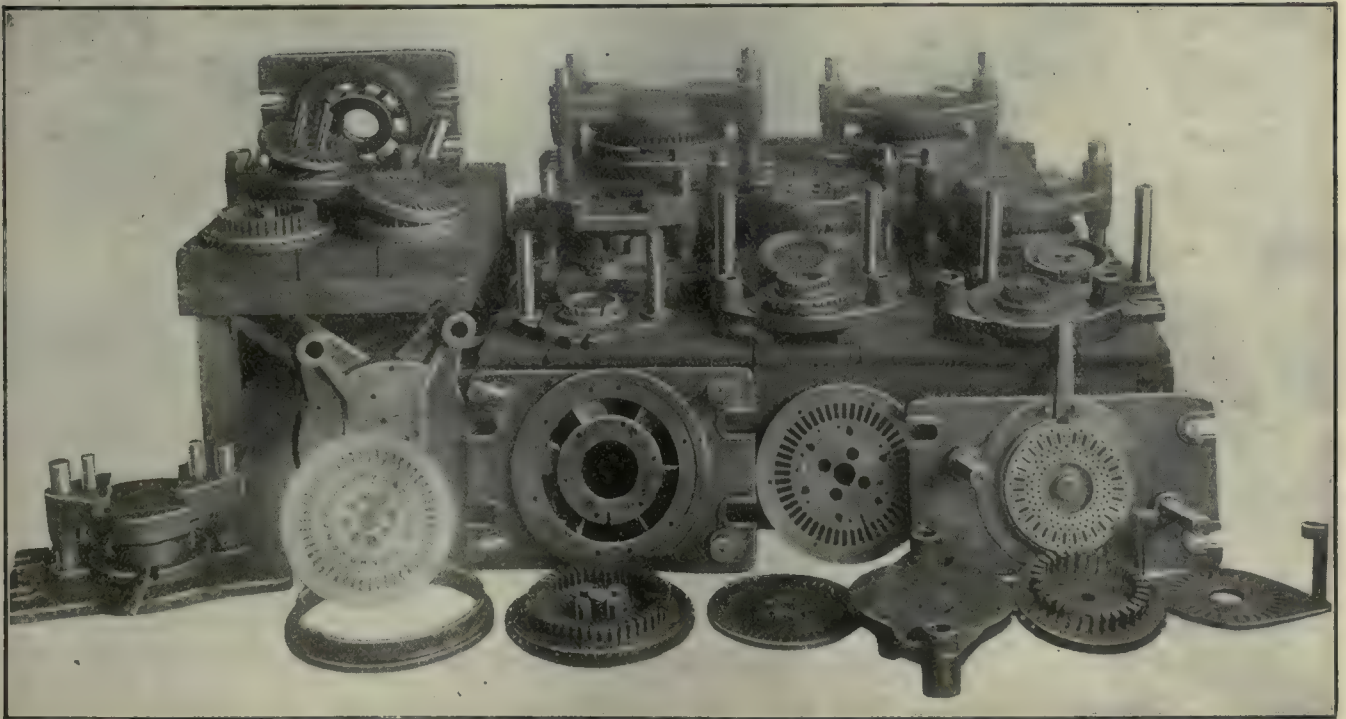


FIG. 1. GROUP OF RECENTLY MADE DIES AND SUBPRESSES

especially punches and dies. When I first began to think about this matter it was not unusual to have one set of press tools stand up for several hours between grindings and turn out many thousand pieces. Perhaps the next set of tools tried would run only a few minutes and produce only a few hundred blanks. So far as we could see the two sets of tools were identical. They were made from the same bar of steel, perhaps by the same die maker, and hardened by the same man. Yet the service was as different as the difference between success and failure.

following articles I will give my methods and results. All that I have discovered is easily applied in die drafting and die making. It is my hope that the information will be of practical use to many tool designers and tool makers.

One of the first results of my study was the establishing of practical punch and die clearances. A little table giving this information was published in the *American Machinist*. Many die makers are using these clearances today, and in my own work they have had the test of some fifteen years of constant use.

*Superintendent, Century Electric Co.

My first work was of course done in carbon steel; in fact, most of my work has been done with plain carbon die steels of from 96 to 115 points carbon. Some work has been done with steel having as high as 140 points carbon. A limited amount of work has also been done with high-speed steel. But the results from the high-speed steel studies have not been satisfactory. Carbon steel is by far the better material for punches and dies with the exception of some forms of forming and drawing dies where density of metal rather than a keen cutting edge is required. In fact, in my own shop practice I am continually restricting the use of high-speed steel.

with this viewpoint. It is possible to get much greater service out of carbon steel than we usually believe. Comparative records of service as obtained today, compared with similar records of ten years ago, show the possibilities of improvement in this direction.

I must again express my firm belief in the value of carbon steel for many kinds of machine-shop cutting tools. In my own experience the places where high-speed steel is necessary seem to be growing less as time goes on.

During my study of the past twenty years there has been a great development in equipment, particularly in furnaces and instruments for the hardening room, and in



FIG. 2. GROUP OF TEST PIECES AND RECORDS ACCUMULATED DURING STUDY OF DIE STEELS

At present it is hardly used at all except for single-pointed tools—lathe, planer and shaper tools—and for milling cutters, counterbores and some screw-machine tools.

The grade of steel that I have used, of both American and English manufacture, is sold for 16c. to 18c. per lb. base. As there has been no difficulty during the recent months in obtaining steels of this quality, we have had none of the trouble that has been so disturbing to the users of high-speed steel. A few weeks ago an editorial in the *American Machinist* called attention to the fact that the present scarcity of high-speed steel might prove beneficial, by stimulating a more careful study of the possibilities of carbon steels. I agree fully

apparatus and instruments for the laboratory. In the beginning of my work there was no way to keep uniform furnace temperatures, or in fact to measure those temperatures with any degree of accuracy. I found that a variation of 40 deg. F. was not at all uncommon between various parts of the best furnaces that could be bought for hardening tools. I also found that commercial pyrometers would not register uniformly within some 25 deg. F. Finally, after investigating several different makes and trying out some twenty instruments, I was able to obtain a device that will indicate temperature changes as small as $2\frac{1}{2}$ deg. F.

If the instrument is connected to a cold furnace, and a lighted match is held in the open oven door, the in-

strument will show the slightest change in temperature inside the furnace. The equipment of the hardening room where my work is now being done will be described in one of the following articles.

In a similar way my continued studies have made it necessary to procure high-powered microscopes and apparatus for preparing specimens and making microphotographs. I now have a microscope equipment that will magnify up to 1,800 diameters, and arrangements for making both full-size and greatly enlarged scale photographs of any specimen of steel or part of a tool that it is necessary to study.

The broad results can be grouped under nine general heads. These apply more particularly to punch and die making, although the principles and laws apply to all kinds of tools made of carbon steel. These nine results are:

A. Blanking dies that are originally $\frac{1}{8}$ in. to $1\frac{1}{8}$ in. thick are now used by repeated grindings until they are

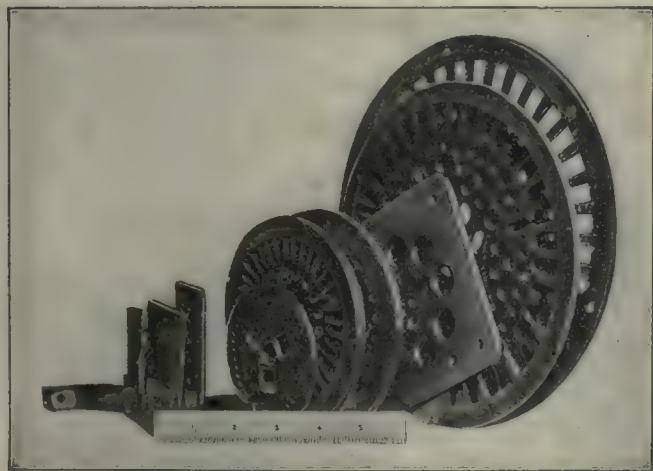


FIG. 3. GROUP OF WORN-DOWN DIES. SHOWING HOW VERY THIN THEY BECOME BEFORE BEING DISCARDED

only $\frac{1}{8}$ or $\frac{1}{16}$ in. thick. That is, they are used until they can no longer be securely held.

B. Many complicated dies, such as those used for the armature and field punchings of electric generators and motors, are now built up in sections of such shapes as allow easy milling, to avoid drilling and filing of any except round holes. They are assembled when soft, hardened while still assembled, and put to work without disassembling.

C. This sectional construction makes it possible to repair a die very easily and cheaply should it be accidentally injured or broken in use.

D. The service of a die between grindings has been greatly increased, and the amount of service after each grinding has been made more uniform.

E. It has been demonstrated that carbon steels of from 96 to 115 points carbon, having a base price of 16c. to 18c. per lb., are excellent die steels if properly hardened.

F. Three laws have been formulated to control die design, making and hardening. These are called the laws of proportion, finish, and hardness penetration. It has been discovered that if the first two laws are properly followed there is but little danger of losing dies in the hardening room.

G. Many modifications have been found necessary in general features of die, punch, stripper plate, subpress,

and power-press design. Subpresses and power presses should be built around the cutting tools. The reverse process is the usual one.

H. Through a study of die-making methods handwork has been very largely eliminated. In fact, it is almost true that dies are made today without the use of a file. The accuracy of the dies comes from the machine tools.

I. The initial die cost and the die cost per thousand blanks has been materially reduced.

Fig. 1 shows a group of several kinds of dies and subpresses used in making parts of electric motors at the plant of the Century Electric Co., St. Louis, Mo. The

TABLE 1. RECORD OF MISCELLANEOUS NOTCHING DIES

Die Number	Date	Number of Grindings	Average Number of Punchings per Grinding
507 Q	Nov. 1, 1912	3	40,560
507 P	Nov. 1, 1912	3	36,504
274 U	Dec. 12, 1912	5	28,179
274 L	Dec. 12, 1912	3	28,272
274 H	Dec. 12, 1912	3	22,320
274 B	Dec. 12, 1912	5	24,452
457 B	Dec. 21, 1912	9	26,182
457 A	Dec. 21, 1912	9	19,468
374 E	Jan. 8, 1913	2	26,784
452 D	Jan. 15, 1913	4	29,016
961	Jan. 15, 1913	2	36,704
421	Jan. 15, 1913	1	15,624
452	Jan. 15, 1913	2	23,222
374 E	Mar. 8, 1913	2	26,784
348 P	Mar. 29, 1913	3	25,792
348 Q	Mar. 29, 1913	3	26,784
348 U	Mar. 29, 1913	1	22,568
348 O	Mar. 29, 1913	1	32,736
348 W	Mar. 29, 1913	3	32,736
348 V	Mar. 29, 1913	1	32,736
1014 B	July 12, 1913	1	31,842

Average 27,143

larger dies shown in front and at the left are 11 in. in outside diameter. Some of the smaller ones are only 4 in. in diameter. These two dimensions give an idea of the range of rather complicated dies that have been and are now being produced by the methods very briefly outlined above. As some of these dies will be described in further detail in one of the succeeding articles, it is unnecessary to comment on them further in this place.

To give a hint of the extent of the study and research work that was gone through in developing the methods now in use, Fig. 2 is shown. The collection contains many of the test pieces made for the purpose of finding out the laws of die steel as they affect die making. Some of these pieces which are now quite thin were originally from 1 to $1\frac{1}{2}$ in. thick and were ground away in a study of the internal hardness of the specimens. The thicker pieces shown are standard test blocks, many of which have been polished for microscopic study. Other pieces are from broken dies which were carefully followed up in order to find out, if possible, the cause of the failures. The large record book on the back of the table at the right contains the history of tests that were carried through on only one class of dies during a period of two years.

During one part of the study about 200 pieces of carbon steel were tested. Surprising as it may seem, not a single one broke or proved defective in hardening, and no reason could be found in the case of any brand justifying a complaint to the steel makers because of poor material. About 1,100 dies were also made from one brand of American steel without any breakage. About 1,000 dies were made from a single brand of foreign steel without a single breakage that could be charged to the steel itself. Many of the other brands tried out seemed equally as good as the two leading brands that were used.

Mention has been made of the fact that dies are now regularly produced that wear down from $1\frac{1}{8}$ in. or $\frac{1}{16}$ in.

to $\frac{3}{16}$ or $\frac{1}{8}$ in., giving satisfactory results after all of the grindings. A group of these worn-down dies is shown in Fig. 3. A group of sectional dies showing some of the forms of construction is illustrated in Fig. 4. Fig. 5 shows a portion of one such broken die and Fig. 6 the same portion of the same die after it had been repaired.

The object of this entire study was to improve the service of dies. To show what has been accomplished in this direction Tables 1 to 6 are given. The first gives the history of several notching dies made and used during the

themselves. At the present time I never buy a standard punch press, but always insist that it shall be modified to meet the needs of successful operation of my own dies and subpresses.

Coming finally to the matter of die cost, a hint as to the reduction can be gained from the viewpoint of pieces produced by studying Tables 1 to 6. An idea of the reduction in initial die cost can be obtained from the fact that one type of notching die that originally required 112 hr. to make now has a time limit of 15 hr. and a tool

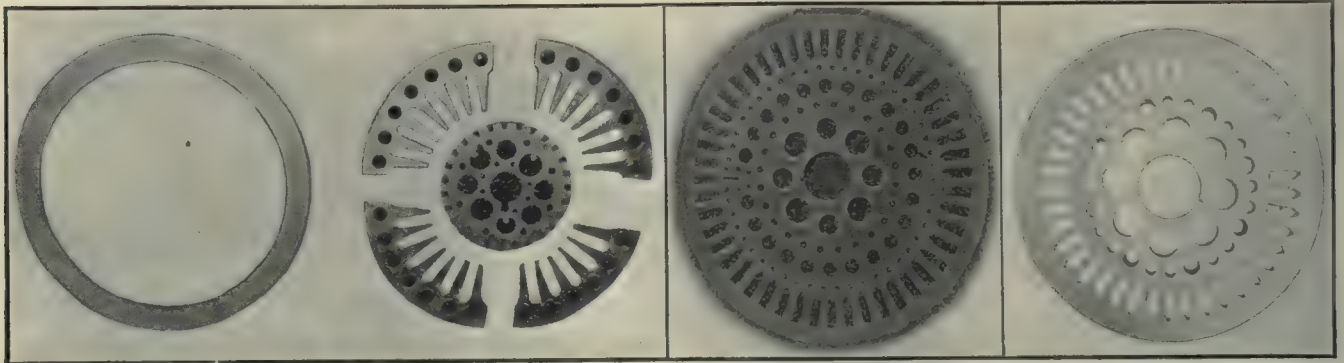


FIG. 4. GROUP OF SECTIONAL DIES, SHOWING CONSTRUCTION

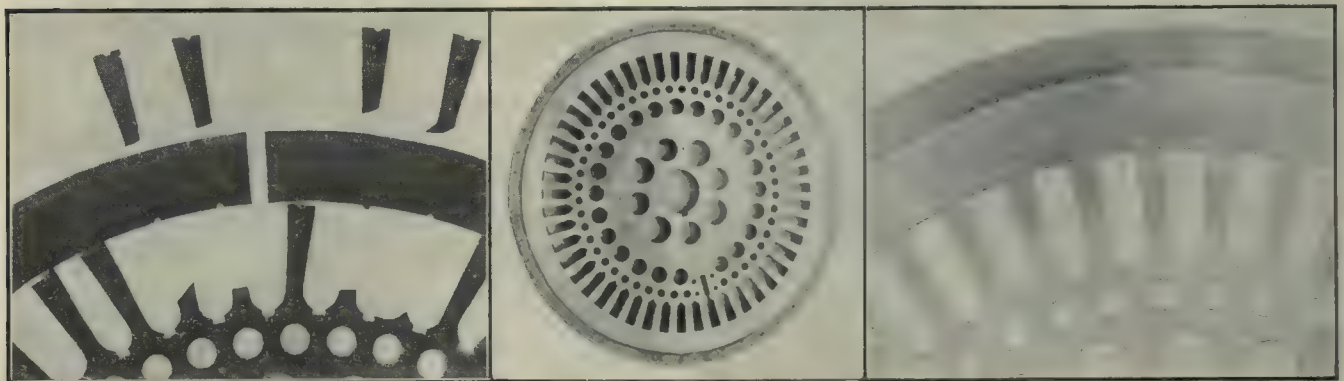


FIG. 5. BROKEN PORTION OF A SECTIONAL DIE

FIG. 6. SAME DIE AS SHOWN IN FIG. 5, AFTER BEING REPAIRED

years 1912 and 1913. Tables 2 to 6 give the same record for notching dies made and used during the years 1913 and 1914.

The average number of grindings of a die that is reduced in thickness from 1 in. to $\frac{1}{8}$ in. is about 100. To sharpen a die properly it need not be ground away more than 0.004 in., but as a matter of fact this amount is usually doubled in practice.

The average number of punchings produced per grinding has increased from 27,143 in Table 1 to 161,345 in

maker regularly produces it in about 8 hr. One size of sectional die that is frequently duplicated now takes from 50 to 70 hr. to complete, while a conservative estimate for the time required to make the same die in solid form under the usual toolroom conditions would be from three to four weeks.

With further reference to the cost of notching dies, the following figures are given from records stretching over the period from 1906 to 1914: One solid notching die finished Oct. 1, 1906, required 120 hr. to produce; 15 split

TABLE 2. RECORD OF NOTCHING DIES NO. 275

Die Letter	Date	Number of Grindings	Average Number of Punchings per Grinding
275 D	Jan. 31, 1914	4	167,311
H	Feb. 14, 1914	2	136,448
I	Feb. 14, 1914	2	159,900
G	Apr. 4, 1914	1	151,375
G	Apr. 11, 1914	1	117,260
F	Apr. 11, 1914	1	189,748
F	Apr. 18, 1914	2	123,656
G	Apr. 18, 1914	2	159,900
			Average 152,495

TABLE 3. RECORD OF NOTCHING DIE NO. 329-O

Date	Number of Grindings	Average Number of Punchings per Grinding
Feb. 28, 1914	2	182,390
Mar. 7, 1914	3	159,120
Mar. 14, 1914	3	167,596
Mar. 21, 1914	3	153,892
Apr. 4, 1914	1	174,460
Apr. 6, 1914	3	139,336
Apr. 18, 1914	2	152,256
May 2, 1914	2	159,048
May 16, 1914	4	103,060
		Average 149,306

Table 6. We now consider a die poor if it does not produce more than 60,000 punchings per grinding.

The modifications in design have reached all parts of the dies and holding devices and even the machines

dies finished Oct. 27, 1910, required 197 hr. to make, or an average of $13\frac{2}{15}$ hr. each; 2 split dies finished Feb. 7, 1913, required 18 hr. to make, an average of 9 hr.; 4

split dies finished May 19, 1913, required 51 hr. to turn out, an average of $12\frac{3}{4}$ hr.; 2 split dies completed Sept. 1, 1914, required 10 hr. to make, an average of 5 hr.

This shows a reduction in tool maker's time from 120 to 5 hr., partly brought about, of course, by a change in die design from the solid to the split type. The advantages of the latter type are more forcibly brought out when we consider that the solid die was used at a press speed of 220 r.p.m., would stand up only a maximum of $3\frac{1}{2}$

TABLE 4. RECORD OF NOTCHING DIE NO. 329-N

Date	Number of Grindings	Average Number of Punchings per Grinding
Feb. 28, 1914	3	156,485
Mar. 7, 1914	3	116,307
Mar. 14, 1914	2	100,712
Mar. 21, 1914	3	124,765
Apr. 4, 1914	2	180,804
Apr. 6, 1914	3	159,657
Apr. 18, 1914	2	160,186
May 2, 1914	2	116,192
May 16, 1914	3	108,905

Average 135,397

TABLE 5. RECORD OF NOTCHING DIES NO. 329

Die Letter	Date	Number of Grindings	Average Number of Punchings per Grinding
M	Jan. 24, 1914	3	107,848
L	Jan. 24, 1914	3	152,793
M	Jan. 31, 1914	1	190,320
L	Jan. 31, 1914	2	171,288
L	Feb. 7, 1914	1	183,976
M	Feb. 7, 1914	2	107,848
L	Feb. 14, 1914	3	135,339
M	Feb. 14, 1914	3	152,789

Average 143,270

TABLE 6. RECORD OF MISCELLANEOUS NOTCHING DIES

Die Number	Date	Number of Grindings	Average Number of Punchings per Grinding
1014 A	June 21, 1913	3	156,240
1014	June 21, 1913	3	171,864
348 W	June 28, 1913	2	167,232
348 W	July 3, 1913	3	157,248
329 P	July 3, 1913	2	171,288
384 W	July 12, 1913	2	142,272
348 Z	Dec. 6, 1913	2	124,800
348 A	Dec. 6, 1913	2	186,952
348 A	Dec. 20, 1913	2	185,848
348 A	Dec. 28, 1913	2	188,448
384 C	Feb. 14, 1914	3	159,412
384 C	Feb. 28, 1914	4	168,896
1014 B	Feb. 28, 1914	3	127,088
1014 C	Feb. 28, 1914	4	187,200
937	Mar. 28, 1914	2	162,864
1045 A	Mar. 28, 1914	3	121,680
1045 B	Mar. 28, 1914	3	154,376
374 W	Mar. 28, 1914	1	168,480
973 A	Apr. 4, 1914	1	184,832
973	Apr. 4, 1914	2	149,760
278 H	Apr. 25, 1914	1	179,350
713 F	Apr. 25, 1914	1	141,440
278 H	May 2, 1914	1	188,804

Average 161,345

hr. between grindings, and would wear only $\frac{1}{4}$ in. before losing size. By contrast the split die is used at a press speed of 450 r.p.m., can run 8 hr. between grindings and can wear $\frac{1}{8}$ to $\frac{7}{8}$ in. before losing size.

Turning now to the cost of full circle dies, one of an average diameter of 10 in. with 40 punches has been reduced from an average cost of \$600 to about \$200. This item includes everything about the die necessary to make it ready to go into the press.

✱

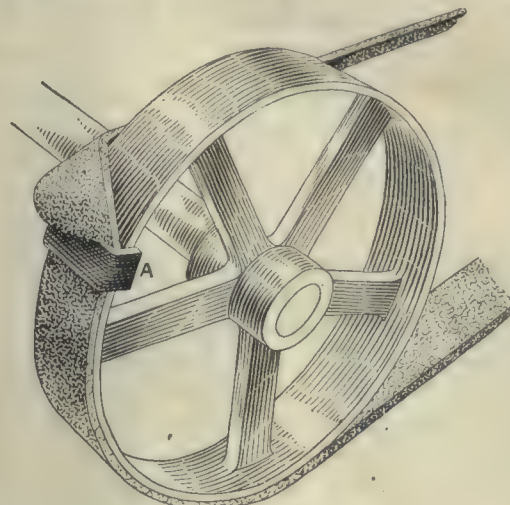
Placing Tight Belts on Pulleys

BY A. E. HOLADAY

We have a number of belts that are used very tight and in consequence are difficult to place on their pulleys. The small device shown at A in the illustration makes the task of placing a tight belt an easy one

The device is made of $\frac{1}{8}$ in. flat steel about 2 in. wide. It is bent at right-angles at the ends, the bends being made

so that the contrivance will fit the width of the pulley face. The ends are about 2 in. long. By starting the belt on the pulley and holding this angle iron over the



BELT "PUTTER-ON"

belt, the belt can be run on without difficulty. To avoid accidents the belt should be run on either by hand or at a very slow speed.

✱

Medical Supervision of Employees

Health is the workingman's capital, his stock in trade. Without health his earning capacity is limited, and those dependent on him suffer as well as he. The workingman has a right to demand that he be not required to work beside men who are diseased or mentally deranged. All candidates for employment and all men already employed should be examined in order that those physically or mentally defective may be detected and given medical attention. Moreover, a system of medical supervision is necessary in order to prevent the introduction and spread of infectious or contagious diseases. Experienced, hard-working and valuable employees may not be working at their full capacity because of some defect of which they are unaware. Should such conditions be brought to light and remedied, these men will be restored to full efficiency.

Again, a progressive disease may be affecting a person, so that his working period is being rapidly shortened. With a system of physical examination his condition is discovered, treatment is instituted at an earlier date, and relief made more certain. An efficient force cannot be maintained with constant substitution of new men for old, especially if the duties of the workers are in sequence, for the efficiency of the whole force will be lowered to meet the ability of the new and inexperienced men.

Aside from purely business considerations, medical supervision has a humanitarian aspect. Few abnormal conditions resulting from harmful industrial environment are themselves fatal; they are underminers. The most common terminal disease is tuberculosis. Out of 140 classified occupations tuberculosis is the leading cause of death in 110. Many diseases, if discovered in their incipency, are amenable to treatment. The affected person is usually unaware of the abnormal conditions.—J. A. Watkins, Passed Assistant Surgeon, United States Public Health Service.

Methods Used in Manufacturing Textile-Machine Parts

BY ROBERT MAWSON

SYNOPSIS—Some of the tools used in machining parts for hosiery machines are described and illustrated in this article. It will be observed that on two of the milling fixtures an index pin that fits into bushings is used to obtain the correct position of the casting in relation to the cutter. On another milling fixture a swinging plate is employed to bring the casting into the correct location.

In this article are shown some of the jigs and fixtures used by the Jenckes Knitting Machine Co., Pawtucket, R. I., in machining parts for hosiery machines. It will be seen that the tools are of modern design and are produc-

ing results satisfactorily both as regards quality and quantity.

It will be seen that the fixtures here illustrated, have been constructed for a definite purpose, are of good design and produce interchangeable parts.

The fixtures used when milling the cams are provided with indexing devices consisting of hardened bushings and a pin. The sub-base is then swung around to the two positions until the pin drops into the bushing when the fixture and casting are in the correct alignment for the operation.

The milling fixture for the shear slide is provided with a swinging plate to obtain the position for the part to be machined, as will be readily noted in the illustration.

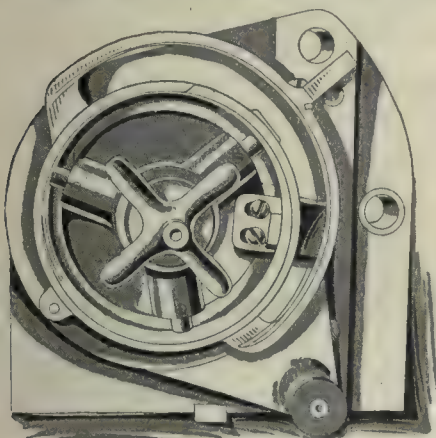


FIG. 2



FIG. 6

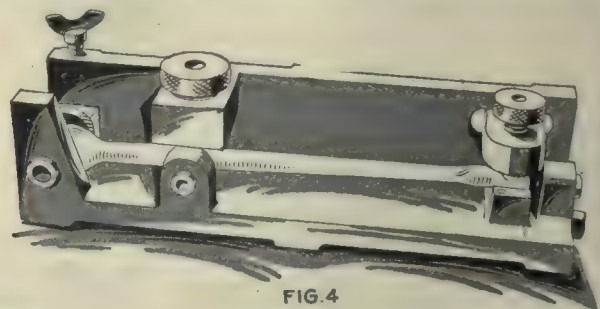


FIG. 4

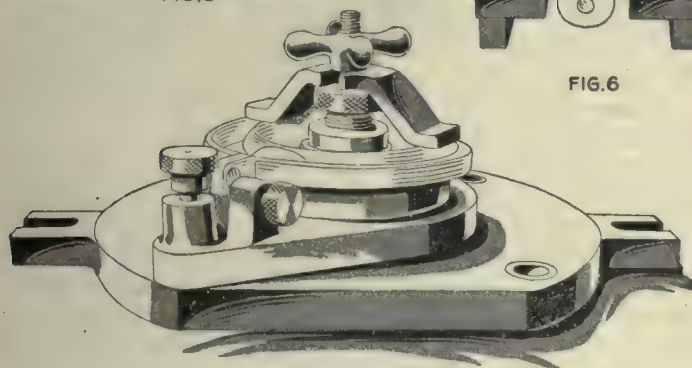


FIG. 8

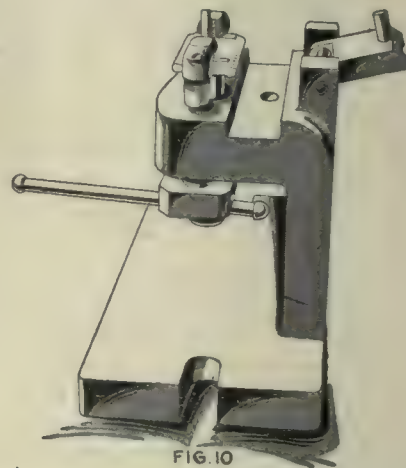


FIG. 10

JIGS AND FIXTURES USED IN MACHINING TEXTILE-MACHINE PARTS, WITH WORK SHOWN IN POSITION

FIGS. 2 AND 2-A

Operation—Milling needle cam, Fig. 1. The casting is located by three pins that are forced out simultaneously by a knob screw. The two positions are obtained to bring the casting in the correct location to suit the cutter by an index pin fitting in bushed holes.

Surface Machined—Two places on upper edge, using a special cutter $\frac{1}{2}$ in. in diameter and $1\frac{1}{4}$ in. long, operating at 190 r.p.m.

FIGS. 4 AND 4-A

Operation—Drilling take-up controller, Fig. 3. The rough casting is placed in a V-block against a stop. The other end of the piece rests on a height block.

Holes Machined—One hole drilled for 10-24 threads; two $\frac{1}{4}$ -in. drilled, one No. 15 drilled, and one hole drilled to suit No. 12-24 threads.

FIGS. 6 AND 6-A

Operation—Drilling lever, Fig. 5. The casting is located on a pin that fits into a $\frac{1}{4}$ -in. machined hole. The lower end is forced against an adjustable screw by a thumb-screw.

The lever is held in position with an open washer and a nut.

Holes Machined—One $\frac{1}{8}$ -in. drilled and one $\frac{1}{16}$ -in. drilled.

FIGS. 8 AND 8-A

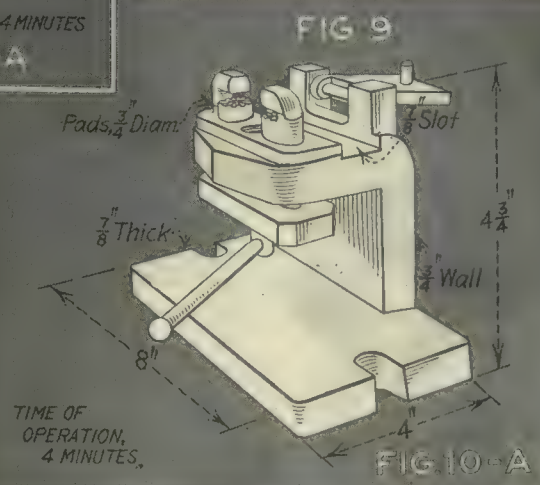
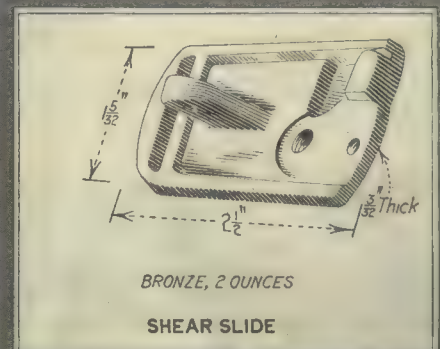
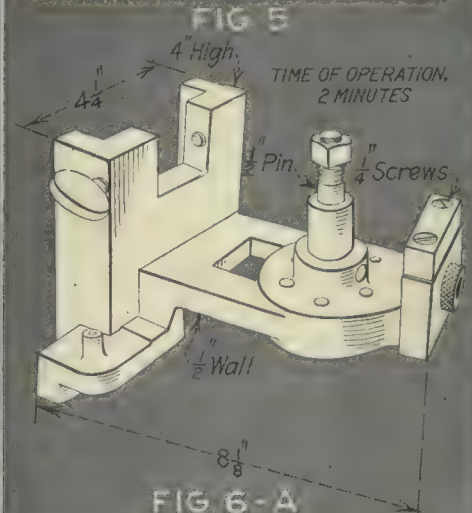
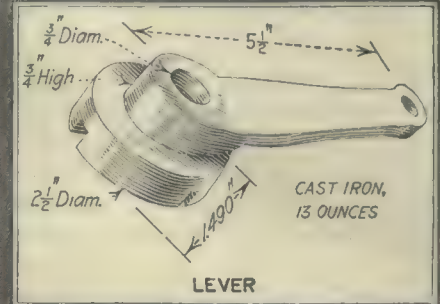
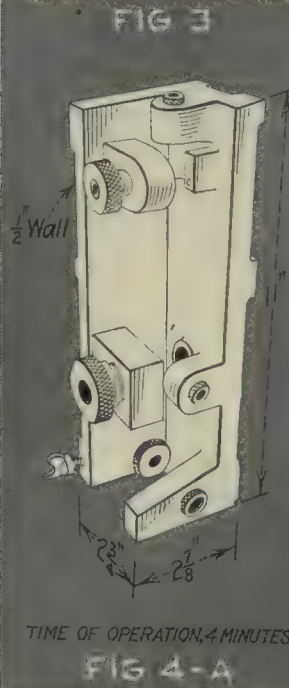
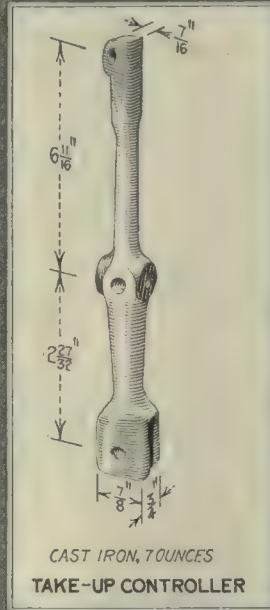
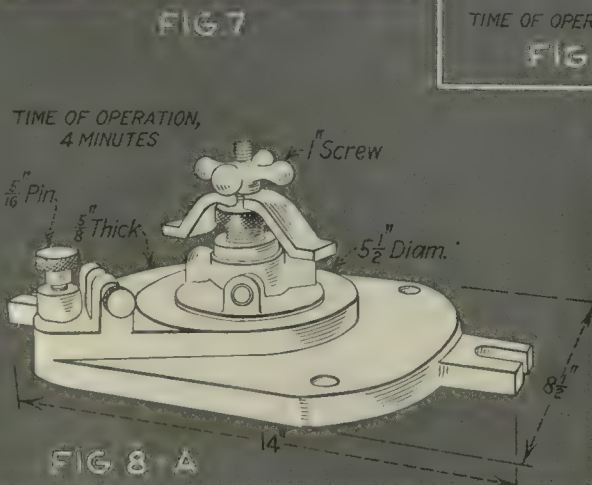
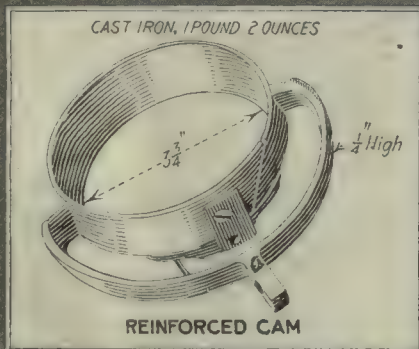
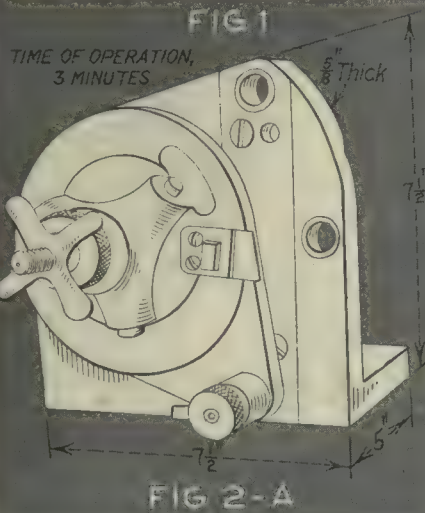
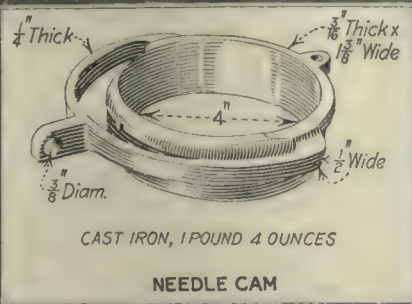
Operation—Milling reinforced cam, Fig. 7. The casting is located by three pins that are forced out in unison by the center screw and thumb nut. The lug of the casting is located between an ear of the fixture and the knurled head screw. An open clamp is tightened on the part to hold it in position.

Surface Machined—Outer edge, using a cutter $\frac{1}{2}$ in. in diameter and $1\frac{1}{4}$ in. long, operating at 190 r.p.m. The positions are obtained to suit the milling operations by means of an index pin fitting in steel bushings.

FIGS. 10 AND 10-A

Operation—Milling shear slide, Fig. 9. The casting is located against a stop pin and held down with two hook bolts actuated by a handle. The locating plate is then swung back out of the way.

Surface Machined—V-surfaces on both edges, using special-form gang cutters operating at 430 r.p.m. with a feed of 0.004 in. per revolution.



ALL BUSHINGS USED FOR GUIDING TOOLS ARE BLACKENED. ALL JIG AND FIXTURE BODIES ARE CAST IRON, STRAPS AND FASTENINGS, MACHINERY STEEL; GUIDE BUSHINGS ARE TOOL STEEL, HARDENED AND GROUND

Tests of I-Beam Trolleys

By P. B. LIEBERMANN*

The pull that a man can exert ordinarily for any great length of time is between 50 and 100 lb. It follows that if a trolley takes close to 200 lb. to start it, the man must exert a pull considerably in excess of the average. The result is rapid tiring and a material reduction in work done during the day. The lower the pull necessary to move a trolley, the more satisfactorily can the laborer perform his tasks.

I have recently run comparative tests on various types of I-beam trolleys. All were of the same capacity—two tons—and were arranged for operation on an 8-in. I-beam. The trolleys were without geared mechanism; that is, they were designed to be pulled along the beam by hand. One had cast-iron bearings, another brass bearings and the third flexible roller bearings.

A standard 8-in. I-beam was fastened to the ceiling, care being taken to have it well supported so as to be straight and level throughout its length. One trolley at a time was placed on the I-beam and a load of 4,000 lb., made up of pieces of cast iron, was applied. Two different methods of moving the loaded trolleys were employed: A cotton rope fastened to the trolley was run over a pulley and different weights were suspended from the end of the rope. (See Fig. 1.) A spring balance was also used. At first it was fastened directly to the trolley. Then it was fastened to the load itself. (See Figs. 2 and 3.)

Before any test was made the bearings were taken apart, thoroughly cleaned and filled with fresh lubricant. The

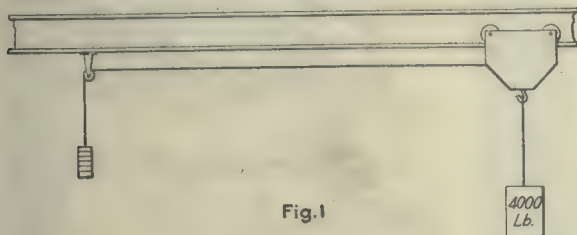


Fig. 1

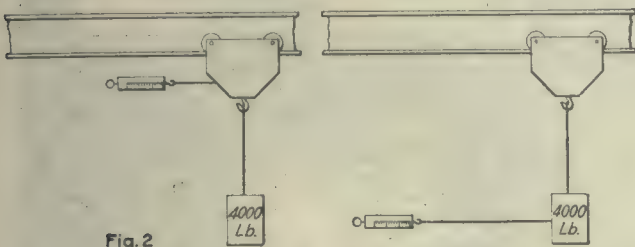


Fig. 2

Fig. 3

THREE METHODS OF MOVING THE TROLLEYS

lubricant used was the same as used by each type under operating conditions. The roller bearings were packed with grease, while the other bearings were filled with machine oil.

It is well to note here that the test conditions favored the plain bearings. That is to say, the small amount of lubricant these bearings held soon squeezed out under load. The fact that this could be observed made it possible to replenish it.

The following table contains the results of the tests, each individual figure representing the average of a large

number of readings of the three methods shown in Figs. 1, 2 and 3.

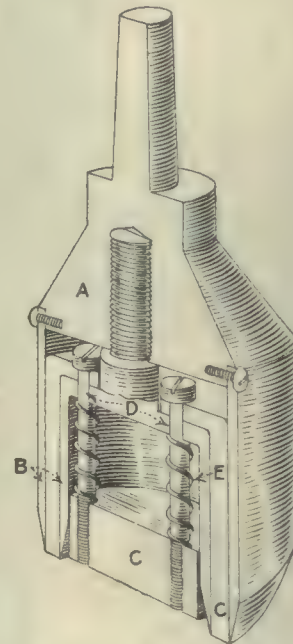
Type of Bearing	Load, Lb.	Starting Effort, Lb.	Tractive Effort, Lb.
Hyatt	4,000	62	50
Plain brass	4,000	122	94
Plain cast iron.....	4,000	185	150

From these results it can be seen that cast-iron bearing trolleys required three times more pull to start and to keep in motion than flexible roller bearings, and brass bearings require about twice the pull that is necessary for roller bearings.

Leather-Washer Cutter

By A. J. GARGH

The accompanying illustration shows a washer cutter that I have used with much success. The washers are of $2\frac{1}{2}$ -in. external diameter and 2-in. internal diameter. With the drilling machine running 900 r.p.m., I have cut 270 in an hour. The leather is slid between the cutter



LEATHER-WASHER CUTTER

and a block of end-grain wood. The cutter is fed down by hand. The shank A is Morse taper to fit the machine spindle. The two cutters are shown at B; the ejectors at C; the ejector springs at E and the ejector screws at D. The cutters are the only pieces of tool steel, and they are tempered only on their edges. The rest of the tool is of mild steel.

Reclaiming Junk Metal was made the subject of a paper presented at the annual meeting of the American Institute of Metals, in which the methods of the Western Electric Company in its Hawthorne Works were described. In these works the monthly averages of scrap are: Brass, 100 tons; copper, 180 tons (125 from cable, rubber and insulating shops); german silver, 17.5 tons; iron and steel, 89 tons; solder skimmings, 4 tons; lead, 833 tons. Sheet metal from which special forms have been punched is compressed into bales with other large scrap pieces. Small chips and metal shavings are freed from dust and dirt by a mechanical sifter, and the iron and steel are separated from brass and the like by a magnetic separator similar to the Ball-Norton type. The products are sacked. Junked cable is heated in gas ovens until the lead is melted and the insulation burned off. The lead is run into a furnace, which separates the ash and dross from it by gravity, and then cast into pigs for sale to refiners. The copper wire remaining in the ovens is compressed into brick form by means of a hydraulic press.

*Engineer of tests, Hyatt Roller Bearing Co.

Manufacturing a Self-Locking Sheet-Metal Seal

By ETHAN VIALI

SYNOPSIS—The various operations on this seal are done by automatic machines; even the small locking spring is placed in the seal head automatically. The floating-carrier method of registering the work correctly over the follow dies is interesting. For subsequent operations an unusual application is made of spiral feed screws.

While the type of seal described in this article is very easily locked, it cannot be opened or removed without destroying it for further service. Its more familiar use

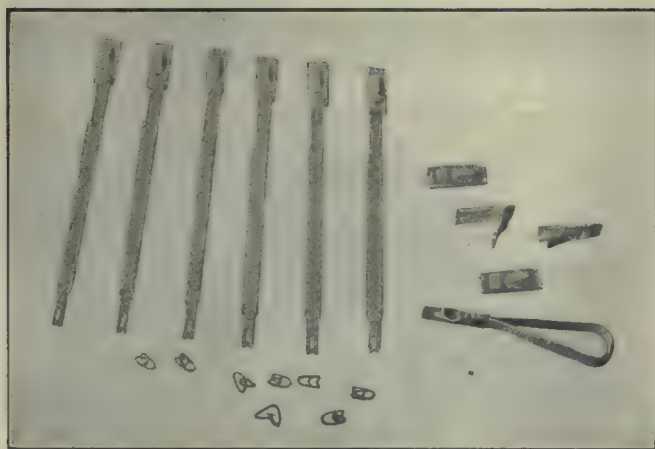


FIG. 1. SELF-LOCKING SEALS AND PARTS

A number of seals and parts are shown in Fig. 1. At the right are four heads that have been cut off and laid in various positions to show the formation. Just below these is a closed seal with the side of the head partly cut away to show the inside. Below the six long seals are eight of the small locking springs. Details of the construction of a seal are given in Fig. 2.

FORMING THE SEAL HEADS

The seals are not made from metal strips, as one might at first suppose, but are cut and formed from sheets of roofing tin $14\frac{3}{4} \times 19\frac{1}{4}$ in. in size. The press through which these sheets are first run is shown in Fig. 3. The sheet is clamped in a carrier at *A* by means of a hinged bar *B*, locked at the free end by a spring latch. The carrier then is fed in, taking the sheet over the set of follow dies and out at the left.

The carrier and its action will be better understood by reference to Fig. 4. Here the clamping bar *B* is

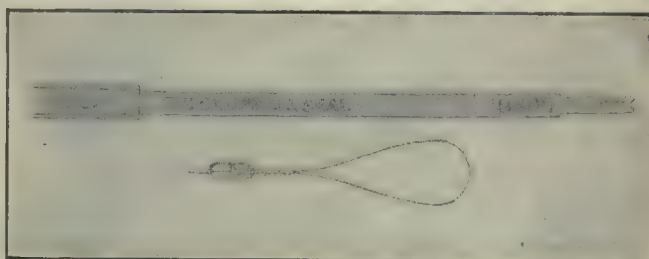


FIG. 2. DETAILS OF A SEAL

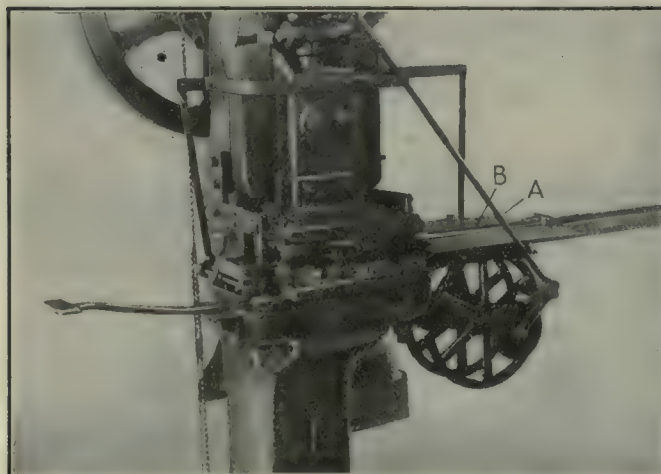


FIG. 3. AUTOMATIC HEAD-FORMING MACHINE

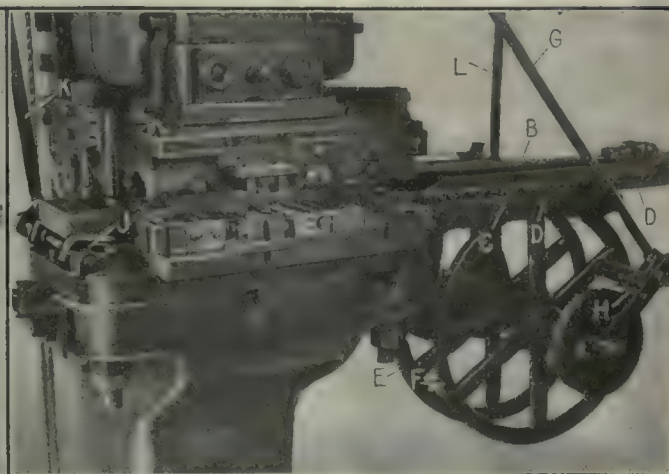


FIG. 4. FEED-MECHANISM DETAILS

is in sealing freight cars, but meters, chests, doors, switches or other things may be as effectively secured. These seals are made by the Campbell Industrial Co., Chicago, Ill., and consist of a single piece of tin formed into the desired shape, and a small special-shaped spring set with the seal head for locking purposes. The automatic machines employed in making these seals were designed and built by L. J. Campbell, of the Campbell Manufacturing Co., and form an interesting study in machine design.

shown without the sheet in place. The work holder rests on a long slide, to which it is so fastened as to have a limited amount of "float" lengthwise, but none crosswise. On the under side of this floating holder a coarse-toothed rack is cut, as shown at *C*. The spacing of these rack teeth corresponds exactly to the spacing of the follow dies. The long slide on which the work holder is placed has rack teeth cut on the under side of it, as at *D*. The teeth on the wheels *E* and *F* mesh with the rack teeth of the slide, so that when these wheels are

rotated in proper position the slide will be fed to the right or left according to the direction of rotation.

The feeding movement is obtained from the press shaft by means of a cam and the rod *G* connected to the pawl

tically so that the spacing teeth are dropped in turn over a stationary V-shaped locating pin.

This action accurately registers the work over the follow dies at each feed movement, regardless of any slight

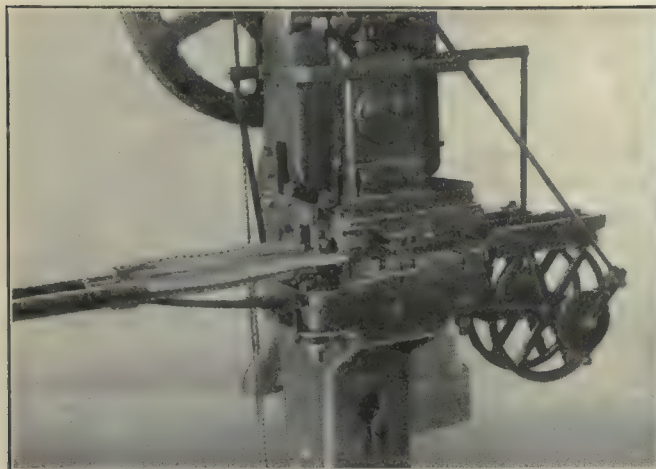


FIG. 5. SHEET FED THROUGH MACHINE

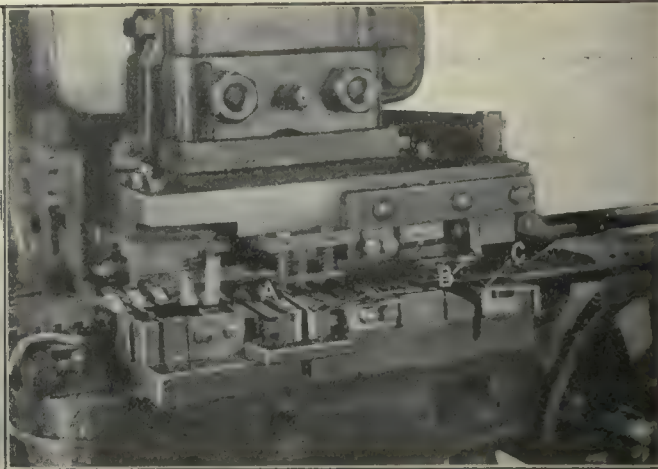


FIG. 6. SOME DIE DETAILS

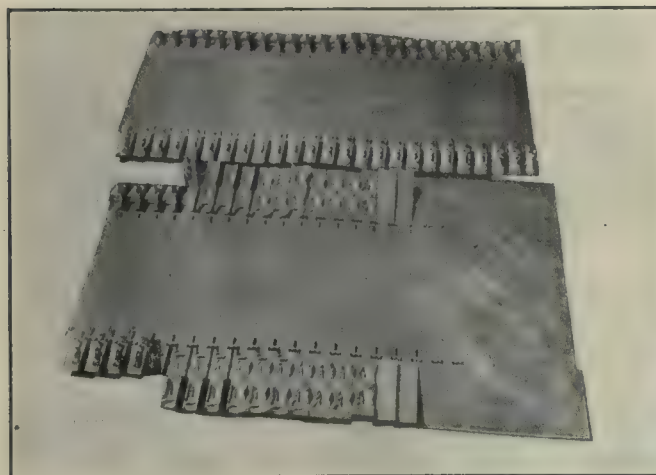


FIG. 7. PARTLY FINISHED SHEET

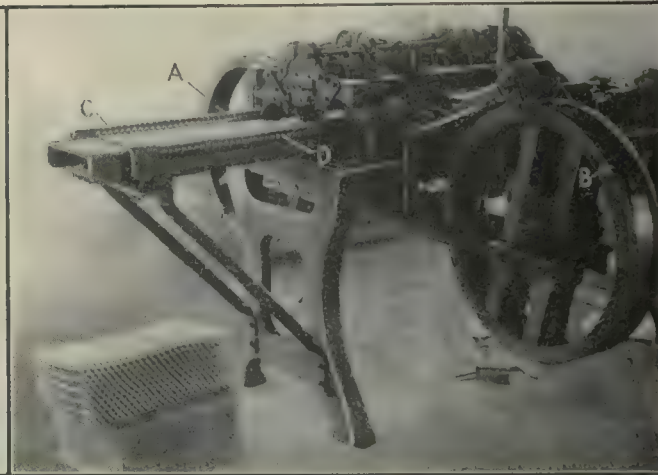


FIG. 8. LOCK-FORMING AND PLACING MACHINE

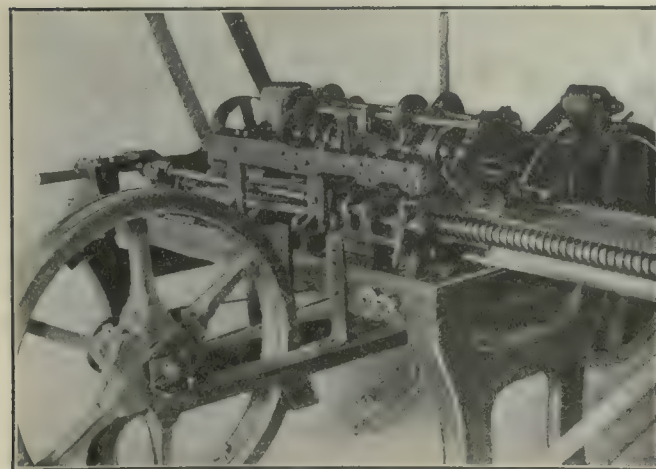


FIG. 9. REVERSE VIEW OF LOCK-FORMING AND PLACING MACHINE

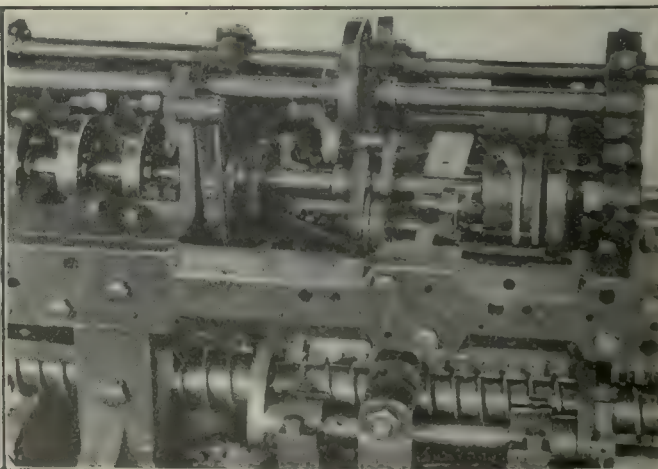


FIG. 10. SHEET FEEDING THROUGH MACHINE AND ARRANGEMENT OF WORM FEED

H, which acts on the ratchet wheel *I*. The teeth in this ratchet wheel are cut so as to feed the slide forward approximately the distance between the follow dies at each forward stroke of the pawl. As the slide and work holder feed to the left, a cam action lifts the holder ver-

inaccuracy of the ratchet wheel or pawl movement, since the work holder is allowed enough float lengthwise to overcome the possible errors, as it drops onto the stationary locating pin. The lift of the work holder necessary for this action is obtained by means of cams *J*

at each end, operated by short cranks and the rods *K* and *L* fastened to the press ram.

It will be noticed that there are blank spaces on both the feed wheels and the ratchet wheel. These make it

After a sheet has been fed past the follow dies, it is carried out to the left of the machine, as is clearly illustrated in Fig. 5. This operation slits and forms the heads of the seals and pierces for the other ends.

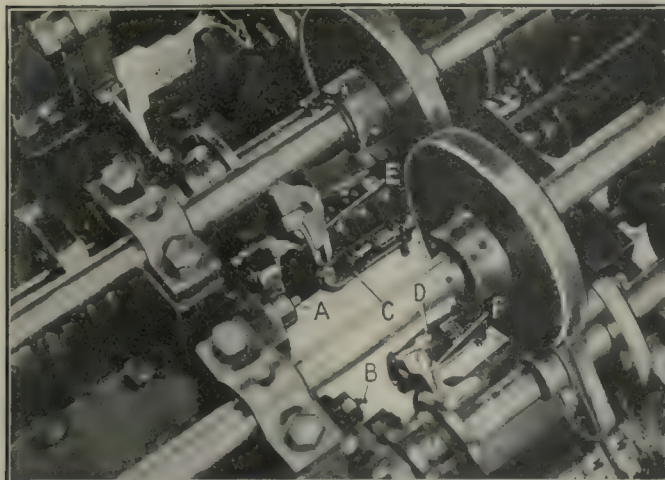


FIG. 11. FORMING MANDRELS FOR THE SPRING AND PLACING FINGERS

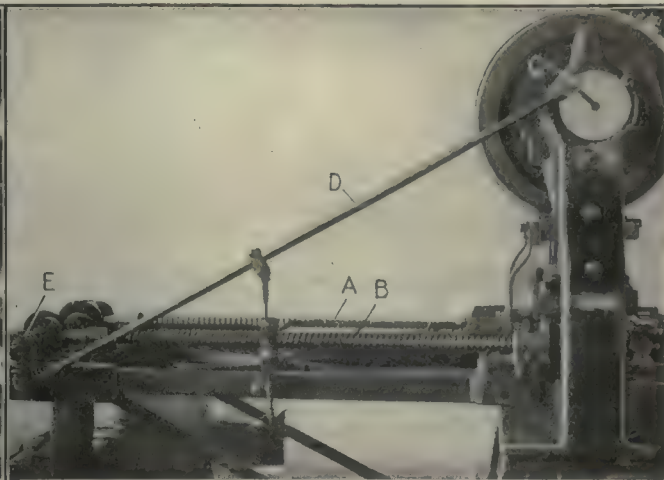


FIG. 12. LETTERING, NUMBERING AND SEPARATING MACHINE

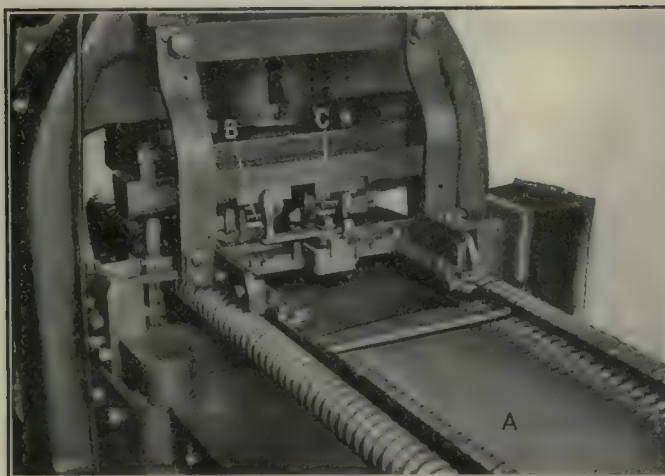


FIG. 13. CLOSE VIEW FROM BACK

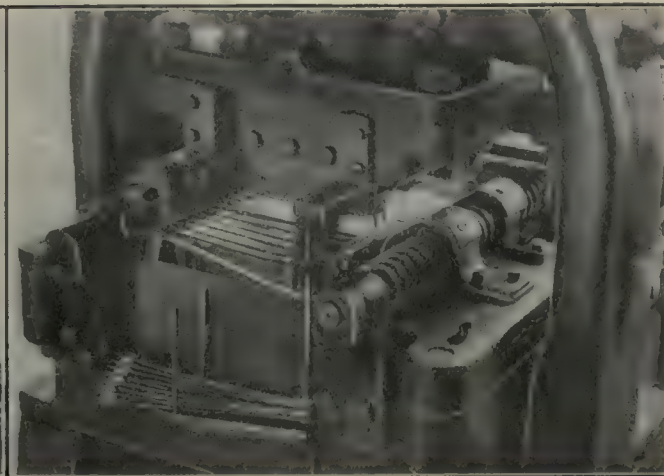


FIG. 14. DROPPING SEALS INTO HOLDER

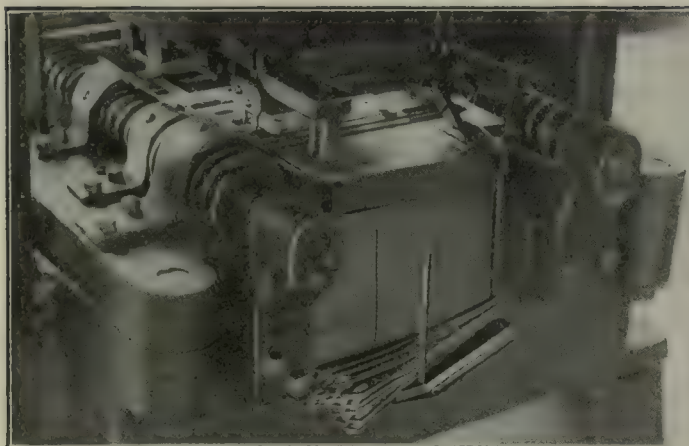


FIG. 15. DIES WITH WORK REMOVED

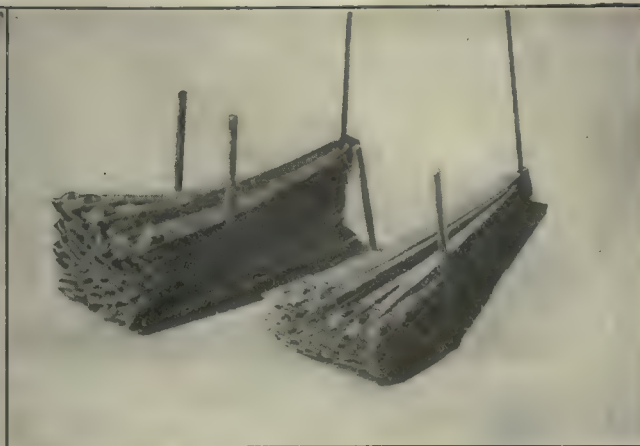


FIG. 16. TWO OF THE WORK HOLDERS

possible for the slide to stop after the work has fed past the dies, without any other throw-off mechanism. The slide may then be run either way by hand. Movement of the feed wheels or slide may also be obtained by means of the handle.

A sheet fed partly through the machine is shown in Fig. 6. A feature of these dies is that those for slitting or shearing are set in edgewise so as easily to be kept sharp or adjusted. This will be noticed by observing the setting at *A*, *B* and *C*.

A sheet with the work partly completed is seen in Fig. 7. In all there are 12 operations on each seal head, as shown. Each edge of the sheet is operated on at once, so that the set of dies represent 24 operations. The duplicate dies are not set exactly opposite each other, but are staggered, the difference in center lines being $\frac{3}{8}$ in., as the feed is $\frac{3}{4}$ in. This arrangement makes it possible to cut and form 50 seals from each sheet with no waste of material except the small amount from piercing. One press like this is capable of producing about 80,000 seal heads per day.

AUTOMATIC MACHINE FOR PUTTING IN THE LOCKING SPRINGS

The small locking springs are automatically formed from wire and placed in the seal heads, in the machine shown in Fig. 8. Owing to the smallness of the work and the complication of the parts, it is practically impossible to illustrate the action except in a general way. The wire for the spring is fed in from each side from the large spools *A* and *B*. The feeding of the sheets through the machine is done by means of the worms *C* and *D*, which form an accurate and positive method of feeding.

A view of the machine from the opposite side is given in Fig. 9. A close-up view, showing the position of the seal heads along the feed worm as they move through the machine, is presented in Fig. 10. Fig. 11 is a view from above. The forming mandrels for the springs are shown at *A* and *B*. These not only revolve, but have a partial in-and-out movement to allow for the various bends without interference. After forming and cutting off, the springs are seized by the automatic tongs *C* and *D*. From these they are carried by the fingers *E* and *F* and pressed in between the parts of the seal heads on each side.

LETTERING, NUMBERING AND SEPARATING

One big advantage in making seals as shown is that large quantities may be partly finished and stacked for the filling of special or rush orders.

The special firm lettering, consecutive numbering and separating are done in the machine seen in Fig. 12. The work is fed in by means of the worms *A* and *B*, which obtain their intermittent movement from the crank disk *C* through the rod *D* and the ratchet *E*.

A close-up view of the machine from the rear is given in Fig. 13. Here the sheet of seals is shown between the feed worms at *A*. As the sheet feeds in, the special lettering, if any, is stamped on in the correct positions for the seal strips. The consecutive numbering is done with the automatic stamps *B* and *C*. By shifting a lever these stamps may be thrown out of action whenever it is desired to do so.

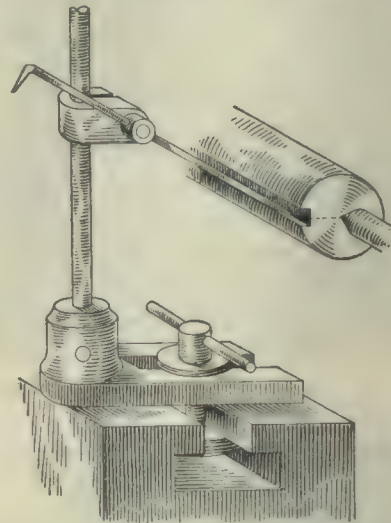
As the stamped and numbered sheet feeds on through, it is cut into separate seals, which drop off into special holders, as at *A*, Fig. 14. The seals from the left drop into the holder shown, while the ones from the right are punched down through the die and drop into a similar holder under the press platen.

Fig. 15 shows part of the die after the work has all fed out. It will be noticed that the end of the left-hand feed worm is larger. This is made so as to keep the heads feeding out evenly. Two holders are seen in Fig. 16. About all that remains to be done on these seals now is to inspect them and pack for shipment.

Surface Gage with Slotted Base

By H. H. PARKER

The illustration shows a surface gage of the ordinary type provided with a slotted cast-iron base. This is very convenient for some kinds of work around lathes and other machines—for instance, when bolted to the tool slide of a lathe for testing or marking work between



SURFACE PLATE WITH SLOTTED BASE

centers. The base should be heavy enough so that the surface gage may be used without being bolted down, which would also require that the bottom of the base be machined smooth and true.

❖

Preparedness and Thrift

Our manufacturers of all kinds, that have become used to ever-increasing prices for their products, will have to readjust their output and prices as the demand falls off, as it surely will. Prices—war prices, that have gone up by leaps and bounds—will in many cases come tumbling down at a rate to cause dismay. Those who recognize that such times as we are now living in cannot last, and will put their houses in order to meet the changed conditions will not be the losers.

This is not preaching panic, but caution and foresightedness. We cannot expect to forever grow rich while Europe is destroying hundreds of millions daily that can never be recovered. In the final adjustment of the war we will, like every other part of the world, have to bear our share of the tremendous cost. All branches of industry will be included in the adjustment and the employee who today is receiving two to three times what he got a year ago, should practice thrift, and remember that wages go down as well as up. With this change in conditions, our industries will need all the care, protection and encouragement that Government and legislation can give. In times of great and general prosperity we are apt to live in the present alone and permit or overlook matters that are harmful and would not be tolerated were conditions otherwise. Those who would seek to gain by the loss of others, or who are misled, take advantage of this carelessness; and many laws that are harmful and unjust are saddled upon the country.—*American Industries.*

Cam Design and Construction

BY CHARLES F. SMITH

SYNOPSIS—In this article five types of cams are discussed. The method followed in designing them is made clear by the illustrations. The first cam is one having a flat-surface lever and a rotary cam. The next is a cam the motion from which rotates a cam-shaped lever. Two types of cams are then described for driving oscillating levers. The motions of these are similar, the only difference being that one is the reverse of the other. The last example is a cam to transfer motion to a bell crank. The article should prove of value to engineers, designers and machinists.

In submitting this article I would call attention to a series that ran a few years ago in the *American Machinist* and that is now published in book form, called "Design and Construction of Cams." The following may

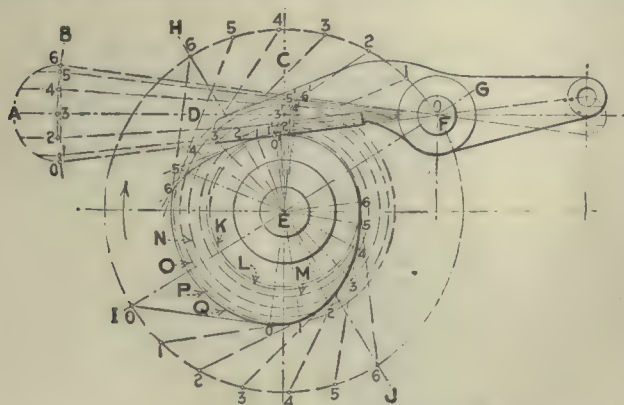


FIG. 1. FLAT-SURFACE LEVER CAM

be considered a supplement of the earlier presentation of the subject. In the previous articles the only cams dealt with pertained to cam-driven rolls and arms, except in one instance where the construction of a cam for lifting the valve rod on paddle-wheel steamers was shown.

Fig. 1 deals with a flat-surface lever and a rotary cam instead of an oscillating member to operate it. The method of construction is as follows: First, determine the diameter of the cam and the amount of throw required, then the length of lever that is to be used. Construct the throw circle at A, which in this case is two and one-half times the throw of the lever at the point of contact with the cam, also the working end of the lever, as the lever is of equal length each side of the fulcrum. It is better to use a multiplied throw circle where it can be used, as the construction lines from it will be more accurate. It is also necessary to multiply the length of the lever from the center to the point of throw by the same multiple as for the throw circle to find the radius of the arc B and to locate the throw circle at the proper distance from the center of the lever. Another object in multiplying the throw circle and lever is to get the lines outside of the drawing proper and to avoid confusion. This must be kept in mind, as this part of the subject will not be mentioned again in connection with the following illustrations.

After the throw circle has been divided into as many parts as desired, cut the arc B with the divisions and draw radial lines through the points 0, 1, 2, 3, 4, 5, 6. The next operation is to locate the center of the cam. This is done by taking the large radius of the cam minus half the throw of the lever. With this radius, set the dividers to the length of the radius with the point where C and D intersect and establish the center of the cam on C at the point E. From this center draw tangent circles K, L, M, N, O, P, Q, with the radial lines of the lever, 0, 1, 2, 3, 4, 5, 6. Then erect radial lines 0', 1', 2', 3', 4', 5', 6' from the center of the cam E to the point of tangency of the circles with the radial line of the lever.

Having determined the number of degrees in which the cam is to do its work, which in this case is 90 deg. dwell, 90 deg. raise, 90 deg. dwell, 90 deg. drop, draw a circle

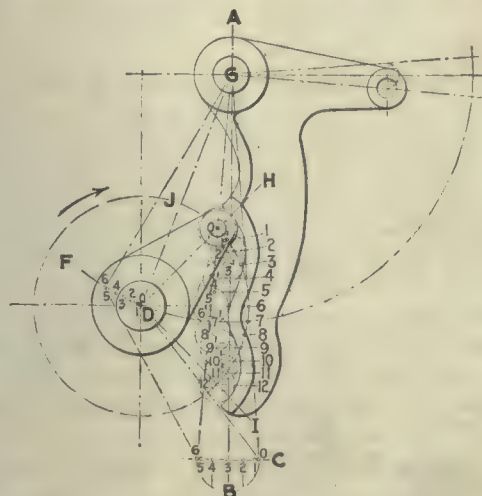


FIG. 2. ROTATING LEVER FOR OSCILLATING CAM-SHAPED LEVER

from the center of the cam E through the center of the lever F and divide the circle into four parts, or 90 deg.; starting at F divide G — H into as many parts as the throw circle A has, which is six for the rise of the cam, and the opposite 90 deg. I — J into six parts for the drop of the cam. From these points set the trammels on point F on the circle passing through the center of the lever and set to a length equal to the distance between the cam radial 1' and F. Then from point 1 on the circle, cut the tangent circle L at 1.

For the next point of tangency set the trammels on F again the distance between the cam radial 2' and F. From point 2 on the circle cut the tangent circle M at 2, and so on until the last point has been found. These points locate the points of tangency on the tangent circles K, L, M, N, O, P, Q, from point 1. As the radial lever line 0 has already been established, draw a line touching the tangent circle L at 1, or at right angles to the line 1, and so on until all the lines have been drawn. Then draw a curve touching all these lines. For the return motion, to find the points of tangency the reverse is necessary. The trammels are set on F and 6'. With this distance, with the point of the trammels set on I point 0 on the lever circle, cut the tangent circle Q

at 0. For the next point set the trammels on F with the distance equal to F and $5'$ and with the point of the trammels set on the lever circle 1 cut the tangent circle P at 1, and so on until all the points have been found. Then join these points by tangent lines, as before, and make the curve.

The next illustration, Fig. 2, deals with an entirely different proposition. Instead of a cam acting on a

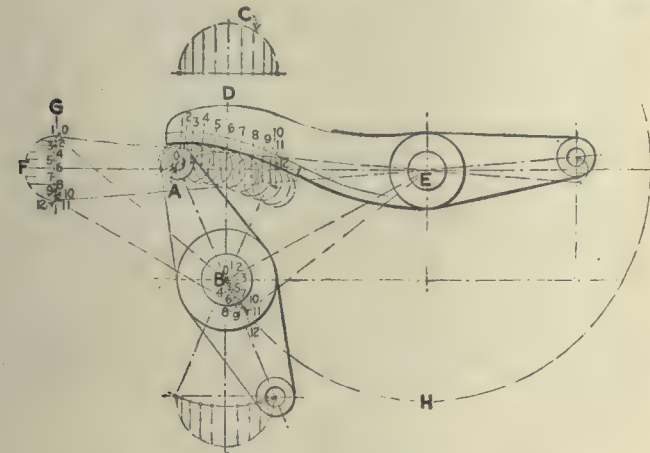


FIG. 3. CAM FOR OSCILLATING ARM

roll lever, the lever rotates and operates a cam-shaped lever. While its use would be very limited, it might be serviceable in some cases. I have illustrated it principally to show how to plot out the curves to produce an action for a portion of time that a cam of the same number of degrees of time would do.

To get the full benefit of the cam action of the roll lever itself, after finding out the amount of throw required, place the center of the fulcrum of the lever the distance of half the throw of the lever from the center of the roll at starting point 0 and draw the center line A . In this case the throw is the same at that point as the lever

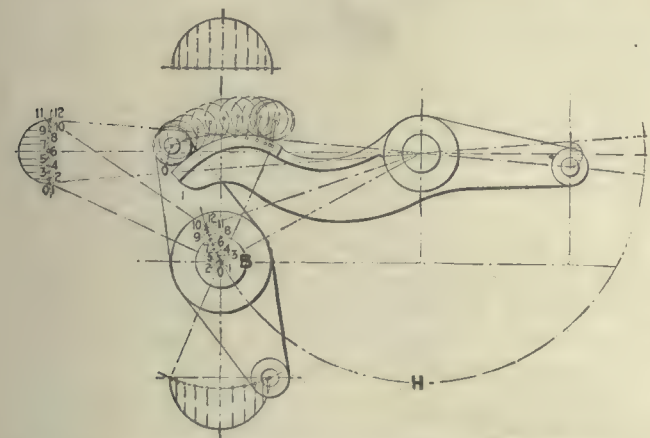


FIG. 4. CAM FOR OSCILLATING ARM—REVERSED MOTION

is on the working end. Next draw the circle B . In this case it is two and one-half times the throw of the cam lever. Divide the circle B into equal divisions and from these divisions cut the arc C . From these points 0, 1, 2, 3, 4, 5, 6, with the trammels set on 0 with a distance equal to $0 - D$, transfer the points to the lever circle F , which is struck from the center of the lever G .

The next operation is to divide the roll center circle J between H and I into twice as many parts as the throw

circle has. Through these centers, with the point of the trammels set on G , draw the arcs 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12. On these arcs the centers on the circle F are transferred by placing the point of the trammels in the center D with a distance equal to $0 - D$ on the line H . Then move the trammels point along the points on circle F from D to point 6 and cut each arc corresponding to the numbers such as 1 — 1', 2 — 2' and so on until 6 is reached. Then from 5 start back and cut the arcs 5 and 7', 4 and 8' and so on until 12' has been reached, which completes the cam. On the points found, draw circles the diameter of the roll required and construct a curve touching each roll circle tangentially. This gives the proper shape for the movement required.

CAM WITH OSCILLATING ARM

In Fig. 3 conditions change again. Instead of a rotary moving roll arm, it is oscillating, which limits its usefulness to a greater extent than a rotary moving member. To plot out a curve to move the lever a required distance, determine the length of the roll lever and the amount of movement it is to make. Then strike the arc A from the center of the lever B . After this has been established,

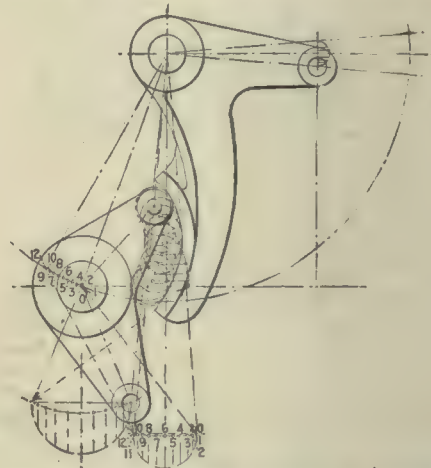


FIG. 5. CAM FOR MOTION CHANGED BY BELT CRANK

draw above it the circle C on the line D , which has the same divisions as the driven end of the roll lever. The circle is placed above so as not to have such a great distance to transfer the points from as if it were taken direct from the driven end of the lever. From the points on the circle C cut the arc A . Through the points found draw the arcs 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 from the center of the cam lever E . To find the position of the fulcrum of the cam lever, take minus one-half of the throw of the lever from the radius of the roll lever. From the center B of the roll lever and with this radius cut the line D . Where they intersect is the center of the throw of the cam lever, the throw of the lever and the length, of course, having been determined before.

On this line at its intersection with the line D measure back the distance determined for the fulcrum E . In this case the leverage is equal when the roll has reached its extreme position toward the fulcrum. Next draw the circle F with as many divisions as the circle C has. Cut the arc G . With the trammels set on B with a distance equal to $B - G$, transfer the points found to the circle H , with the center struck from the center E . From these points with the distance equal to $B - 0$ on line A or the radius of the roll lever, cut the lines 1, 2, 3, 4, 5, 6, 7,

8, 9, 10, 11, 12. Then draw circles on the intersection of these lines equal to the diameter of the roll determined. Join the circles by a curve touching them tangentially, thus completing the operation.

Fig. 4 is the same as Fig. 3, except that the action is reversed. The only difference in plotting out the curve is that on the circle *H* the centers *B* are transferred above the center of the roll lever instead of below as in Fig. 3, and the cam lever is below the roll instead of above the roll as in Fig. 3.

CAM FOR BELL-CRANK ARRANGEMENT

The cam in Fig. 5 is laid out by the same method as that in Fig. 3, except that the roll lever does not pass the center line as Fig. 3 does, and the direction of action is changed by using a bell lever instead of a straight lever. The straight cam lever in Fig. 3 starts its action

at the extreme end of the lever, while Fig. 5 begins its action nearest the fulcrum of the lever and the center of the throw is located differently. It is located the same as in Fig. 2. The difference in the shape of the curves is that Fig. 5 has the benefit of the full cam action of the roll lever, due to the lever not passing an equal distance by the center line of its throw, as the roll lever in Fig. 3 does. When the roll lever throws an equal distance by the center of its throw, the cam action is only to the center line. The last half of the throw is dropping away from the cam lever, so that the cam curve has to have more angularity to make up for the difference in the dropping away from the cam lever than one in which the throw of the roll lever is only one side of the center line and the throw is only to the center line or to its highest point. The shape obtained may be seen by reference to the illustration.

Timekeeping in Shipyards

By R. D. GATEWOOD*

SYNOPSIS—Needs and requirements of a checking system for shipyard plants where men are in and out of the shops and are spread over a large territory. Specimen time tickets used in operating a system that has had four years' trial.

It is remarkable, but nevertheless true, that practically all the large shipbuilding plants in this country—certainly all navy yards—have different methods for checking in their employees and assigning them each day to their work. This matter has undoubtedly received care-

It is, however, true that the shipyards are all more or less the same; that is, they employ the same trades, the number of men does not differ between wide limits, and the volume of work is not dissimilar. Yet the system of checking men into work and assigning them to their daily tasks is different. No one knows this any better than the workmen themselves, who occasionally remark upon it, wondering why it should be so.

This article is an attempt to arrive at certain primary requirements to be met by a system for checking men into work and assigning them each day to a given job. (Going still farther, it is an attempt to define what in

SHOP		STARTED		STOPPED	
J.O. No. 54		8:00		2:30	
112-A-2765		TIME		2:30	
CHECK NO.	NAME	TRADE	PER HOUR	GROSS	
1356	J. REED	SHIP	JOINER	3.36	
SUBJECT		Mosquito screens.			
DRAWING NO.		BETCHER NO.			
OPERATION					
Install.					
TIME CARD					
IF OPERATION IS DEFERRED, REENTER OUT					
IF OPERATION IS FINISHED, REENTER OUT					
SEEK OVER FOR REMARKS APP'D BY ENTERED ON BACKS CARD					

FIG. 1. INDIVIDUAL TIME TICKET

PIECE WORK TIME TICKET		DATE		5/12/16	
J.O. No. 2-1-7K SHOP 14		8 hours.			
CHECK NO.	NAME	TRADE	PER HOUR	GROSS	
2670	C. G. Black	Rvtr M	4/8	5.33	
2767	T. G. Barnes	Wld-on	3/4	4.00	
2467	A. Mason	Rvtr M	2/4	2.66	
					12.01
TOTAL FOR JOB					
12.01					

FIG. 2. GANG TIME TICKET

FORM 118		Shop		Date	
Check No.		Name		Pay Per Hour	
Amount					
OUT					
Planner					

FIG. 4. BLANK FOR NOTIFICATION THAT MAN IS OUT

This blank is printed on blue stock of a striking shade

FORM 117		Shop		Date	
J.O. V 221		Name		Pay Per Hour	
Amount					
LEAVE					
Planner					

FIG. 5. BLANK FOR NOTIFICATION THAT MAN IS OUT ON LEAVE

This blank is printed on bright-red stock

ful attention at each plant, and the number of systems in use is a tribute to the diversity of human opinion and the ingenuity of the engineering brain.

Not only is the system of checking in employees and controlling their assignment to work essentially different in each plant, but the preëminence of each over its rivals is more or less complacently taken for granted by each firm. Of course, it is understood that each system is a part of the firm itself, just as its good name, its output or its peculiar method of handling its advertising. The mention of the fact that each plant chooses to employ a different method is in no case a reflection on the management.

*Naval Constructor, U.S.N.

many ways seems to be the "one best system" for such a set of similar plants.

The primary need for any checking-in system is to furnish information that certain employees have reported for duty at or before a definite time. This information furnishes early data to the supervisory force as to what employees have reported for work on time and early information to the accounting or time department to enable the clerical work of cost keeping and making up the payrolls to be proceeded with expeditiously.

Of course, we can require a checking-in system to furnish other data to serve other purposes more or less valuable. But the one additional purpose of primary necessity

is that of assigning an employee to his job. It then seems logical to conclude that the ideal checking-in system should fulfill the following three fundamental requirements: It should give a double record of each man—one for attendance and one for cost returns; and it should also be an instrument for assigning a man to his particular day's work.

At the outset it is clearly understood that the perfect system is not attainable. This is a matter of compara-

5. The system should be an economical one when considered in three lights: (1) Initial cost (includes purchase cost and installation); (2) operation (includes the number of timekeepers, attendants and supervisors required); (3) maintenance and repairs.

6. At navy yards and at shipyards where a large proportion of the work is outside the shops a single central checking-in station, preferably near the entrance to the plant, is desirable and eliminates the loss of time incurred

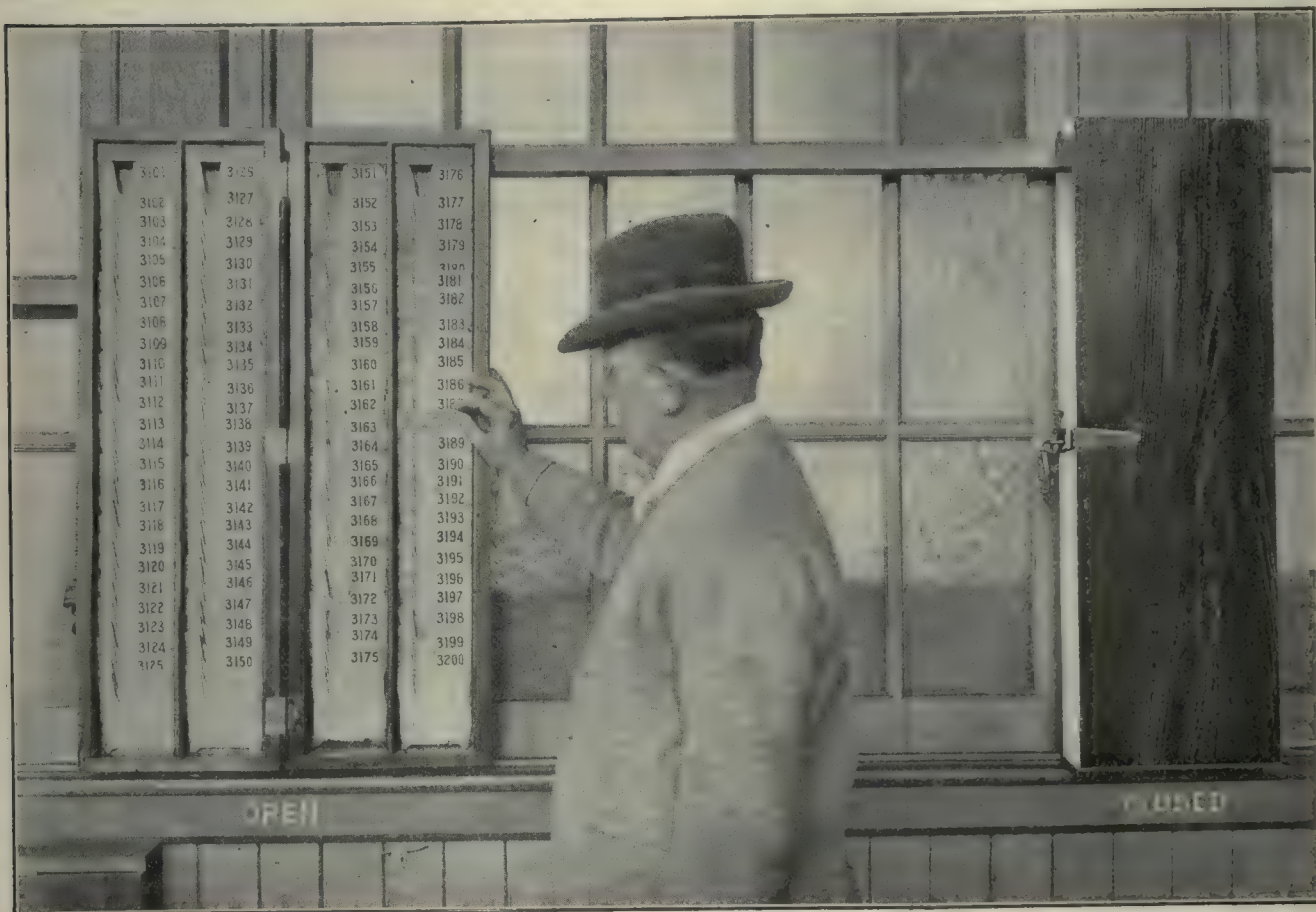


FIG. 3. "IN" AND "OUT" TIME-TICKET RACKS

tive judgment, time and place. It is impossible to invent a system for all conditions of time and place. Furthermore, it is impossible to devise an infallible system or one that cannot be outwitted. We can, however, make "faking" so difficult that, if not impossible, it will be hardly practicable.

GENERAL REQUIREMENTS OF SHIPYARD TIMEKEEPING SYSTEM

As the result of investigating the details of a number of different systems the following statement of those requirements which seem applicable to them all may serve as a valuable criterion with which to compare any proposed or existing system:

1. The system should be such as to eliminate errors as far as possible and to make accurate timekeeping and charging easy.

2. It should be easy to discover error, trace it rapidly and inexpensively, and to rectify it.

3. The operation of checking-in should be simple to the point of being practically mechanical.

4. A delicate or complicated mechanism is not desirable.

when a man goes to his shop at one end of the yard to check in and returns to his job on a ship at the other end. (At a plant like the Philadelphia navy yard, for instance, where the entrance is three-quarters of a mile from any of the shops or ships along the waterfront, this difficulty can be corrected best by locating the checking stations both in the shops and along the waterfront near or actually on board the principal vessels under repair or building.)

7. A minimum of ground space should be required, but efficiency demands a certain liberality in this respect, especially in connection with checking out.

8. The checking station should be well lighted, so that the numbers may be easily discerned.

9. Whatever apparatus and symbols are used should be constructed so as to be easily distinguishable. The size, shape, color and general arrangement of the checks or figures should be such as to assist clear vision.

10. It is desirable to have the checking performed on entering the plant (see 6) and a few minutes before starting work.

11. In most plants of this kind no useful purpose is served by recording the exact time an employee enters

the plant. It is merely desired to know that an employee has reported for work *before* a certain time. Whether he reports at 7:15, 7:45 or 7:55 is not material, provided he be at work by 8 o'clock. Time clocks therefore do not seem either necessary or desirable.

12. A minimum of time should be required for the operation of checking in or out, but not so little as to sacrifice accuracy for speed.

13. The type of board and check must be such as to facilitate a speedy muster being taken immediately after the board is closed and, if possible, by one man.

14. When the operation of checking in or out has once been performed, it should not be possible for the workmen to tamper with the check board at that muster.

15. Checking out on leaving the plant is another link in the chain of evidence and is proof (partial, not conclusive) that the employee has spent the day at the works.

A system that fulfills practically all the foregoing requirements and that has been in actual use for four years with entirely satisfactory results will now be described. It will be seen at the outset how the double record of attendance and cost, together with assigning a man his job, is all performed by a single instrument—a time card.

This time ticket (Fig. 1 for an individual workman or Fig. 2 for a gang) is furnished by the accounting or time office to the shops each morning, in triplicate for each workman. It has entered on it, by means of an addressograph, the workman's name, check number, trade and pay. The shop clerk arranges these tickets in piles according to leadingmen, or gang bosses. To each set of tickets is attached the triplicate ticket from the previous day. (The purpose of this is for convenience of the leadingman in assigning work for the next day.)

If the triplicate card indicates the job upon which the workman will be employed at the next 8 a.m. muster, the leadingman merely attaches it to the new cards for the shop clerk to use in writing up the cards on the typewriter. If, however, the triplicates indicate a job that has been completed and upon which the workman will *not* be employed at the next 8 a.m. muster, the leadingman destroys the old triplicate and proceeds to write in long hand the job for the next day, passing this along with the others to the shop clerk to be written up by the typewriter.

When the cards have been written up, they are distributed to their respective checking stations. The originals, arranged in numerical sequence, are placed in the "IN" time-card rack ready for the 8 o'clock muster the next day. The "IN" and "OUT" racks are identical (see Fig. 3) and consist of suitably numbered sheet-metal pockets in a wooden frame fitted with hasp and lock.

To describe the operation of the system it is best to begin with the men at work in the shop just before quitting time at night. When the whistle blows, the men proceed to a card rack marked "OUT," opened and watched by the timekeeper, and each man deposits his time ticket in a pocket labeled with his check number. This is exactly the same operation as the customary one of dropping a brass check into a tin box. When all the employees have left, the vacant pockets indicate the absentees. The muster report is promptly made up, the box locked, and the clerk may leave the plant. Just before the quitting hour the timekeeper, knowing at that time what each man will be engaged on the next morning, has prepared the men's time tickets for the next morning and placed them in an exactly similar rack, marked "IN,"

placed at the muster point and locked. In the morning when the men come to work the "IN" rack is opened and watched by the timekeeper. Each man as he goes by takes his time ticket out of the rack and proceeds to his work. When the whistle blows, those time tickets left in the rack designate the employees absent from the muster, and the clerk can make up his muster report. He then proceeds to check up all time tickets for the preceding day and takes them with the muster report to the accounting office, or time office.

Suppose now that a mechanic and his helper finish a job at 11 a.m. The cards are at once O.K.'d by the gang boss, turned into the office and the time stamped thereon; and the cards for their next job are issued to them, time stamped. These cards have been previously prepared by the timekeeper or shop clerk from information furnished by the leadingman, who has in the meantime proceeded to provide material, sketches or blueprints, templets, special tools and special instruments needed to carry out the job. The men, therefore, proceed on their next job without loss of time.

The timekeeper at both the "IN" and the "OUT" muster stands by the time-card racks to see that the men lift only one card and drop only one card. After the 8 o'clock muster the timekeeper makes up a list of the "OUTS" for the messenger, who then informs the foreman and the different leadingmen of the men not working that day. When a man is not working or on leave, a suitable card is sent up to the time office (see Figs. 4 and 5).

Among the additional advantages of such a system there may be mentioned the following:

1. All advantages that accrue through the use of a written instrument apply in the use of a written instrument in assigning a man to a job.

2. The system forces the supervisors to make out in advance the man's next job, which greatly facilitates the preparation of material, tools, etc., to enable the mechanic to start work immediately.

3. The charges returned are correct, because the job-order numbers are put on the time tickets in the foreman's office, where the job order itself is filed and available for ready reference. There is no question of memory involved. The tickets are typewritten in most cases and are therefore very plain to read.

4. The job is assigned by the leadingman or gang boss, a responsible and immediate supervisor, and should be O.K.'d by him on completion, thus further insuring correctness of the charge.

5. Productive employees are not required to do clerical or nonproductive work. The loss incident to this frequently encountered error can best be indicated by quoting from a comment of C. G. Morrison in the *American Machinist*, Vol. 43, p. 780. He says:

... Even under the best conditions, a mechanic's method of making an entry on a record is about as follows: Stop work, clean hands, get time card, get pencil, consult clock, make entries on card, put away pencil, resume work.

These operations consume considerable time, but under less favorable conditions the time taken is much greater. The method of making a time record has frequently been observed to be about as follows: Stop work, clean hands, get time card, hunt for pencil, borrow pencil, consult clock, make entry on card, break point of pencil, hunt for knife, borrow knife, sharpen pencil, consult clock, make entries on card, put away card, return pencil, return knife, resume work.

There are many variations of the foregoing, all of which consume time and many of which interrupt the work of other employees. All of this lost time should be productive.

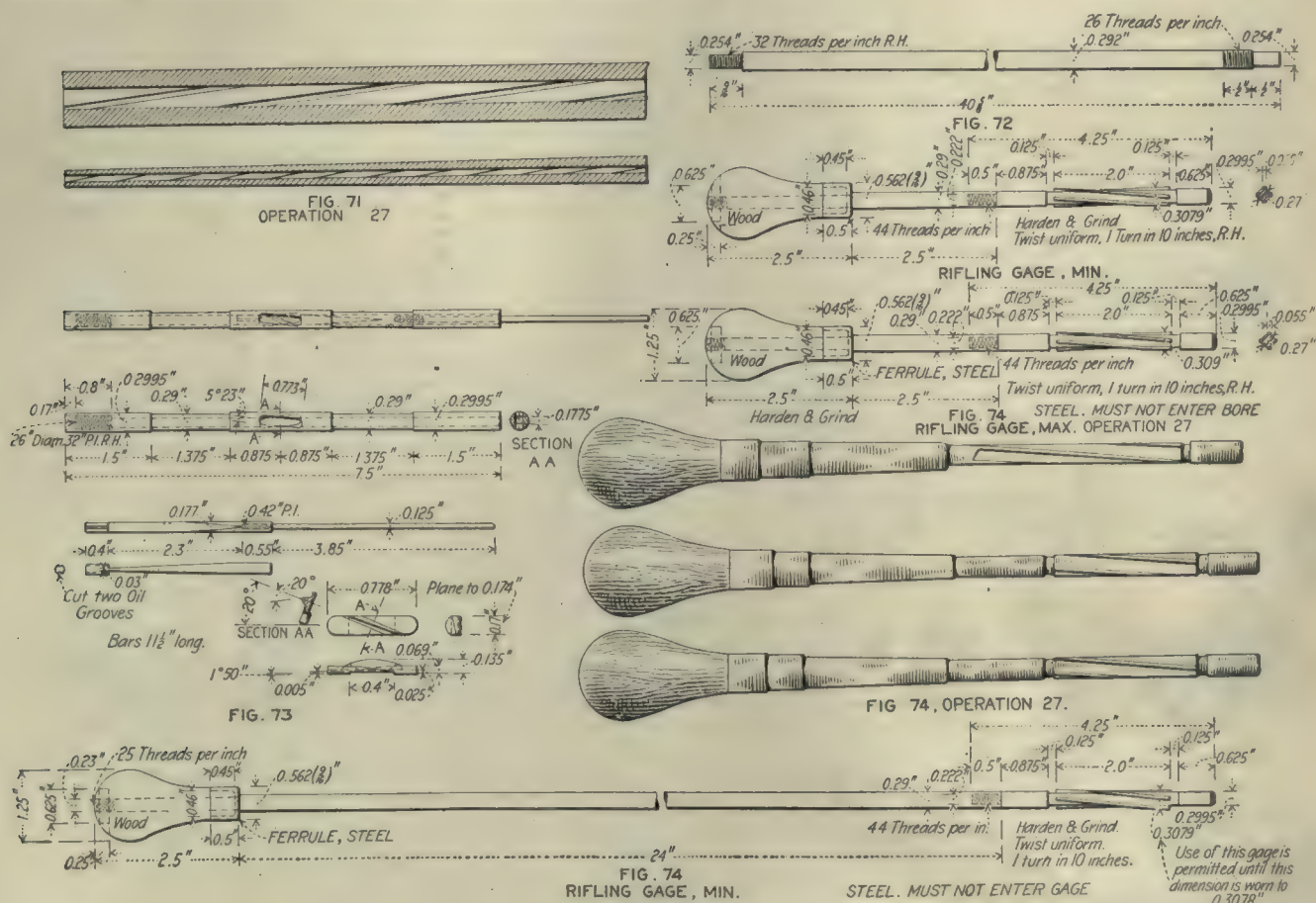
United States Munitions

The Springfield Model 1903 Service Rifle

Operations on the Barrel and the Fixed Stud

SYNOPSIS—This article continues the description of manufacturing operations on the Springfield Model 1903 rifle barrel, taking up also the operations on the fixed stud, which becomes a part of the barrel at this point.

After the rolls have been turned to their proper dimension, they are grooved by a special device, shown in Fig. 98. This consists principally of a base that is clamped on a lathe carriage in place of the usual cross-slide, the attachments being so located that the turning tool held in the tool post *F* will be in its proper position in regard to the roll to be cut. The shaft *A*, Fig. 98, is driven through a universal joint by an auxiliary shaft that runs in bearings attached to each end of the lathe headstock.



OPERATION 27. RIFLING THE BORE

Transformation—Fig. 71. Machine Used—Pratt & Whitney "grasshopper type," Fig. 104. Number of Machines per Operator—Six. Working-Holding Devices—Work is held by collet, which clamps barrel on curved part of butt end; muzzle end is supported by bushing fitted to steadyrest on machine. Tool-Holding Devices—Tools are held in rifling rod, Fig. 72; taper pin inside of box feeds cutters out at end of each stroke. Cutting Tools—Two scraping cutters, Fig. 73. Cut Data—Machine makes eight strokes per minute; this gives about 37.4 ft. per minute cutting speed. Coolant—Triumph cutting oil, two ¼-in. streams at each end of barrel. Average Life of Tool Between Stonings—6 to 8 barrels. Gages—Fig. 74. Production Time—46 min. for each machine, averaging about 6 min. per barrel per operator.

Making the rolls for shaping the rifle barrels the required size and shape involves an interesting process. The rolls blanks themselves, Fig. 97, are 18 in. in diameter when the rolls are new. They are, however, turned down as they wear, and the grooves are cut, so that the rolls can be utilized until they are about 15 in. in diameter, a total reduction of 3 in. in diameter.

The latter is turned by means of a chain from the feed cone on the back of the lathe spindle, by a suitable sprocket that clamps around the feed cone. The shaft *A* carries on its inner end a beveled pinion *B* that meshes into and drives a beveled gear fastened to the lower side of the spur gear *C*. The beveled pinion *B* can be thrown out of mesh by raising the handle *J* and can be locked in position by swinging the latch *K* so that the handle *J*

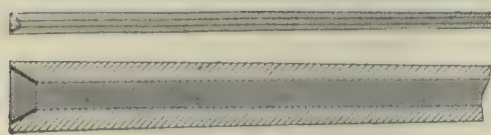


FIG. 75

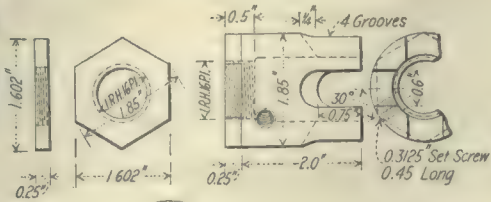


FIG. 76

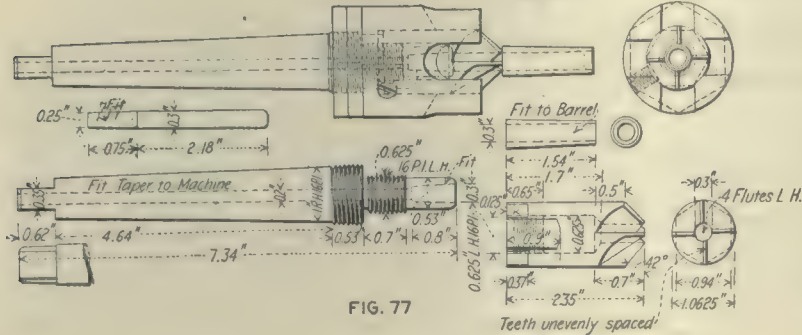


FIG. 77

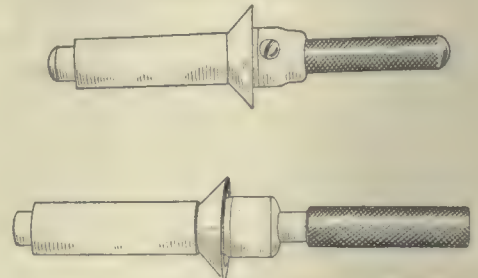


FIG. 78

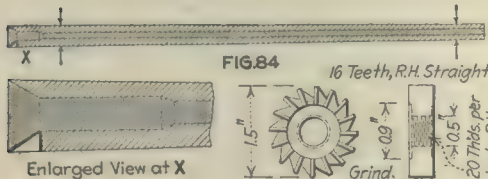


FIG. 84

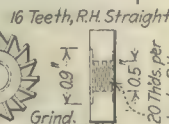


FIG. 86

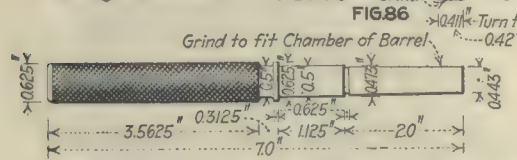


FIG. 87-A

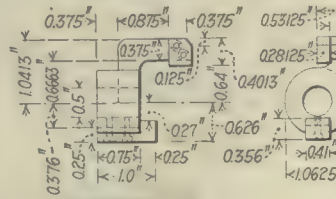


FIG. 87-B

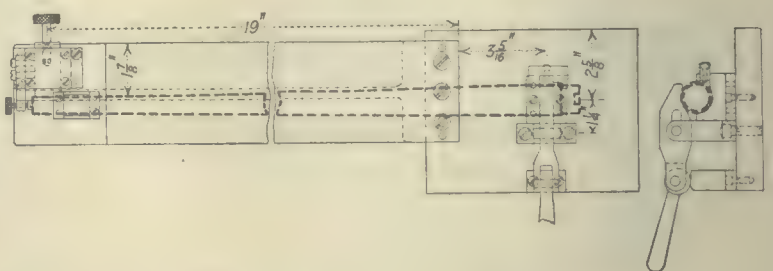
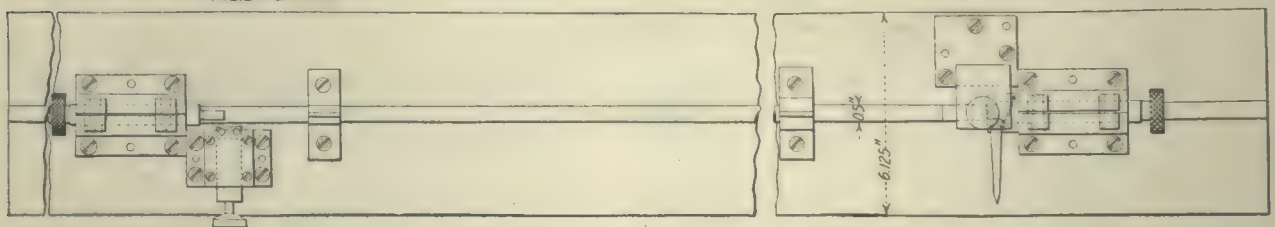


FIG. 85



CAST IRON

FIG. 87-C

OPERATION 37

OPERATION 28. BURRING THREAD AND SHOULDER

Number of Operators—One. Description of Operation—Removing burrs with hollow mill held in the hand. Apparatus and Equipment Used—Hollow mill, Fig. 59-A. Gages—None. Production—100 per hr. Note—This is a portion of operation 34, the burr being removed by hand with the tool shown at B in Fig. 59-A.

OPERATION 35. CUTTING CHAMBER RAMP

Transformation—Fig. 75. Machine Used—Garvin 16-in. lathe. Number of Operators per Machine—One. Work-Holding Devices—Work held by double-ended threaded dog which screws over butt thread as shown in Fig. 76; the straps front and back prevent its revolving while it is centered by a pilot on the facing cutter. Tool-Holding Devices—Special arbor with

pilot, Fig. 77. Cutting Tools—See Fig. 77. Number of Cuts—One. Cut Data—Cutter runs 70 r.p.m., hand-feed. Coolant—Triumph cutting oil. Average Life of Tool between Grindings—100 barrels. Gages—Plug gages, Fig. 78. Production—50 per hr.

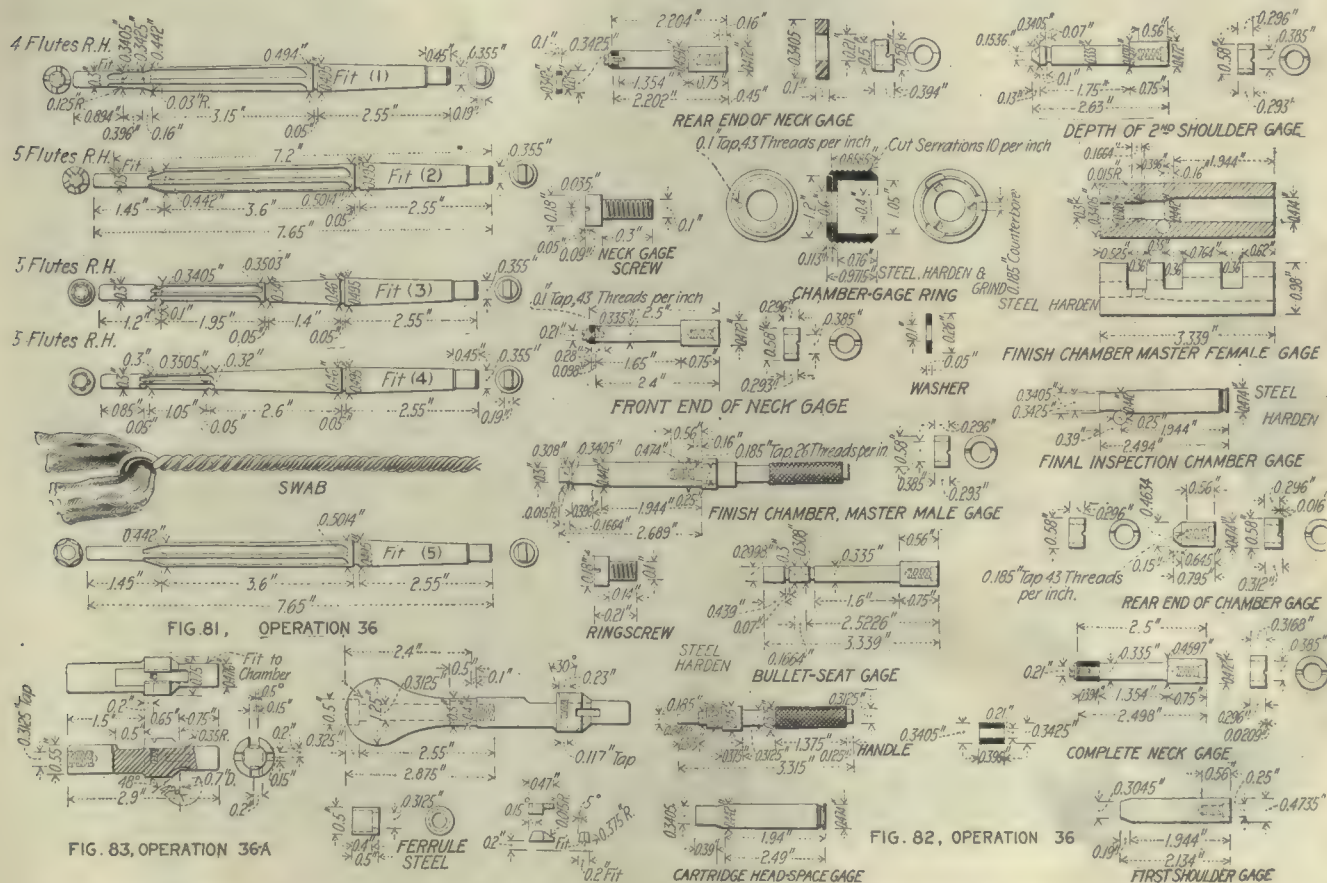
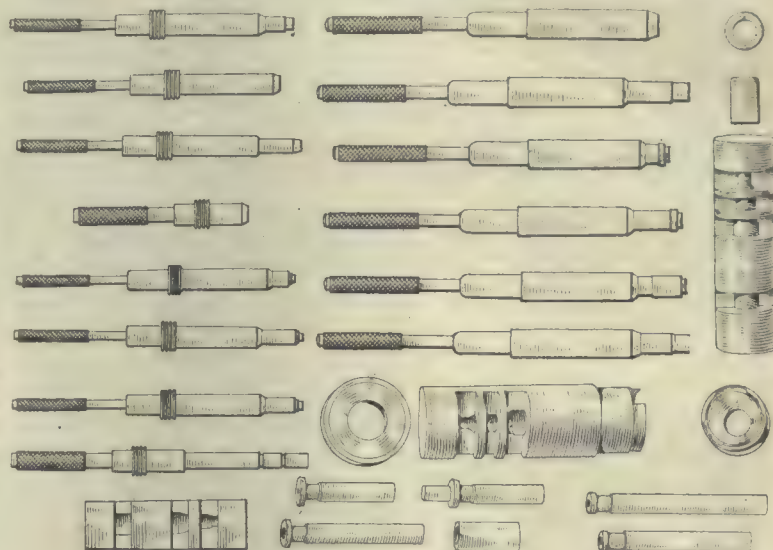
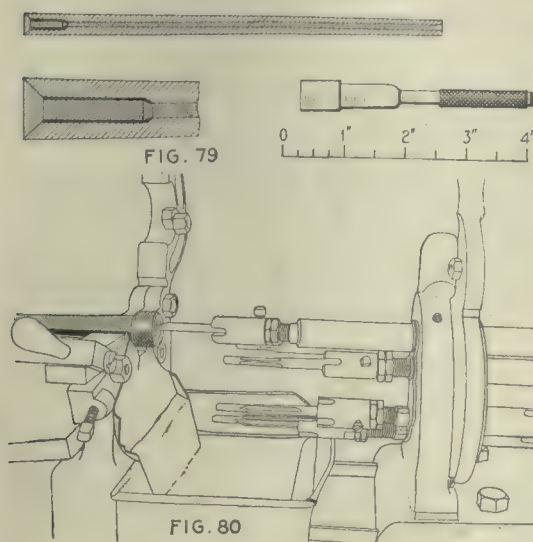
OPERATION 36-A. BURRING CHAMBER

Number of Operators—One. Description of Operation—Using hand mill to burr inside of chamber and outside of chamber so gages will fit. Apparatus and Equipment Used—Hand mill, with inserted cutter, Fig. 83. Gages—None. Production—125 per hr.

chamber gages shown below are slipped through the cup and the chamber depth gaged from the outer surface. Production—20 per hr. Note—The swab shown in the machining diagram is run into the chamber before the final reaming, to clear out all chips; this is done in a number of operations to prevent the possibility of chips getting on the "scrape" reamer and scratching the surface.

OPERATION—37. HAND-MILLING EXTRACTOR CUT

Transformation—Fig. 84. Machine Used—Garvin hand miller. Number of Operators per Machine—One. Work-Holding Devices—Held in special fixture, Fig. 85; locates it by



OPERATION 36. CHAMBERING TO FINISH

Transformation—Fig. 79. Machine Used—Pratt & Whitney hand screw machine, Fig. 80. Number of Operators per Machine—One. Work-Holding Devices—Draw-in chuck and steadyrest at butt end; thread protected by nut, as shown in Fig. 80. Tool-Holding Devices—Regular taper spindle. Cutting Tools—One counterbore and the four reamers shown in Fig. 81. Number of Cuts—Five. Cut Data—Speed, 90 and 100 r.p.m.; hand feed; first three cuts are made at 100 r.p.m., last two at 90 r.p.m. Coolant—Triumph cutting oil, $\frac{1}{4}$ -in. stream. Average Life of Tool Between Grindings—50 barrels. Gages—Fig. 82: chamber depth is gaged from the shoulder of the butt; the cup gage A slips over the thread until the three raised points bear against the shoulder, then the various

front spline. Tool-Holding Devices—Arbor and taper collet. Cutting Tools—Milling cutter $1\frac{1}{2}$ in. in diameter, $\frac{3}{8}$ in. wide, made from Victor high-speed steel, Fig. 86. Number of Cuts—One. Cut Data—125 r.p.m., hand feed. Coolant—Triumph cutting oil. Average Life of Tool Between Grindings—500 to 600 barrels. Gages—Fig. 87. Production—75 per hr. Note—Gage 87-B not only gages the width of the extractor cut, but also locates it with reference to the draw line; this is further tested by the stand gage, Fig. 87-C.

OPERATION 37-A. BURRING EXTRACTOR CUT

Number of Operators—One. Description of Operation—
Hand burring with file. Apparatus and Equipment Used—
File. Production—125 per hr.

is prevented from rising. The gear *C* drives the gear *D*, which carries the cam *E* attached to its upper surface.

The tool post *F* can slide across the block *G* under control of the cam cut on the inside of *E*. The block *G* is fastened to the wormwheel *H* and turns with it when the worm *I* is revolved by means of the miter gears *L* and the spur gear *M*, which are driven from the shaft *A*.

The cutting of these grooves may be likened to the backing off of milling cutter teeth, as the tool must start at the small end of the barrel and gradually increase the depth of the groove until the butt end is reached. It

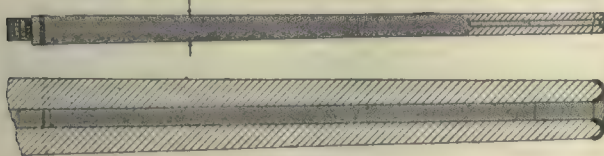


FIG. 88

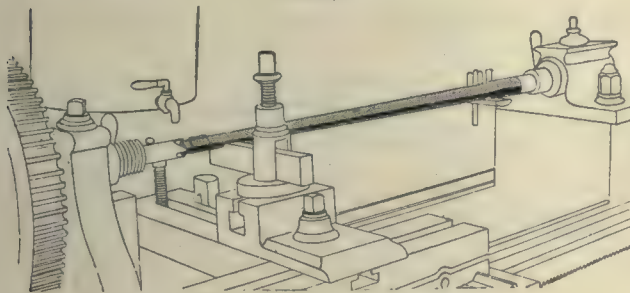


FIG. 89

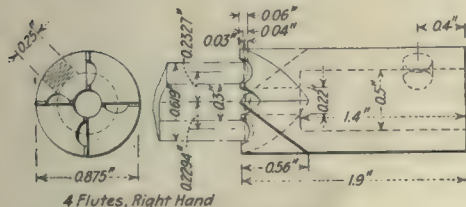


FIG. 90

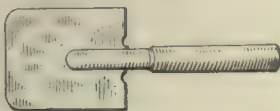
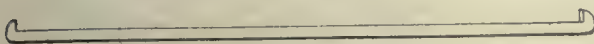


FIG. 91

OPERATION 38

must then snap back to begin cutting the small end of the groove during the next revolution of the roll. This means that the in and out action of the cutting tool must be positively timed to the revolutions of the roll, which is accomplished by the gearings shown.

The follower on one end of the tool block is held in contact with the cam by a heavy spring like that in the backing-off attachment. The gears *B*, *C* and *D* operate the cam *E* so that the tool is gradually moved near the center of the lathe as the roll revolves. On completing its revolution the cam *E* allows the tool block to snap back out of the deep cut and again begins on the small end of the barrel. At the same time the tool in the post *F* is being gradually turned around the axis of the block *G* by the wormwheel *H* so that it is automatically fed from one side of the groove to the other. The layout of the cams for the various grooves is shown in Fig. 99, all necessary diameters being given. These diameters

begin at 1.34 in. for the large end of the barrel and reduce 0.01 in. for each groove until the tenth groove, which is 1.25 in. This and the eleventh groove are of like radius.

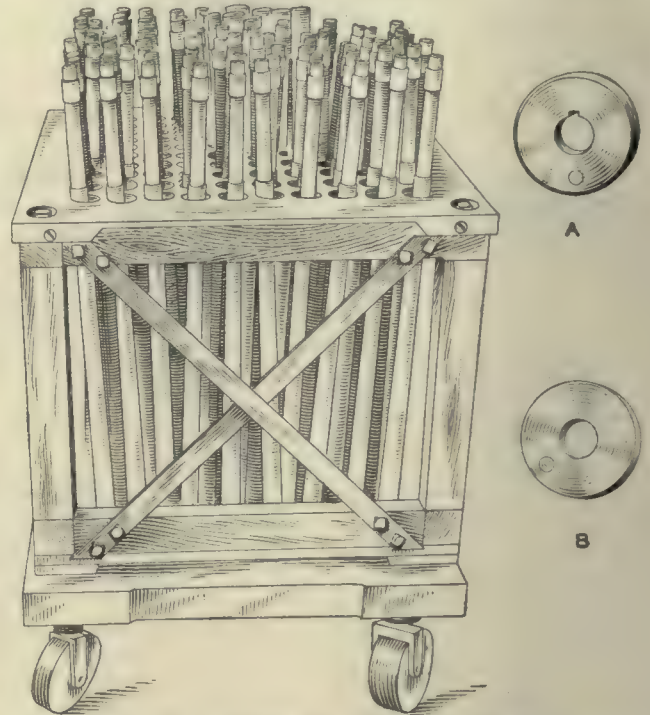


FIG. 96. TRUCKS FOR RIFLE BARRELS

From the time the barrels are turned they are handled in special trucks, as shown in Fig. 96, holding 100 barrels each. These trucks are easily rolled from one machine to another and prevent damage to the barrels. After the thread is milled on the butt end for the receiver, the muzzle end is always placed down, so as to protect the thread.

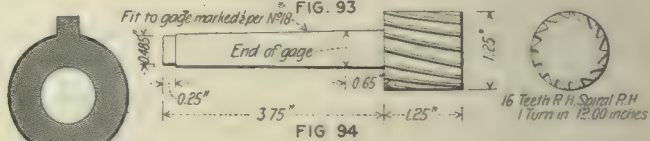
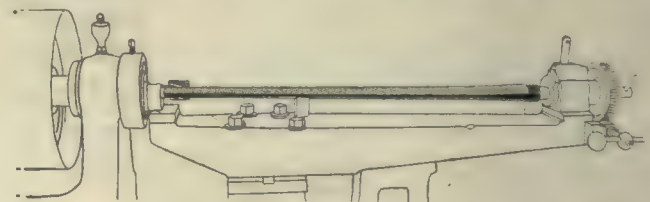


FIG. 92

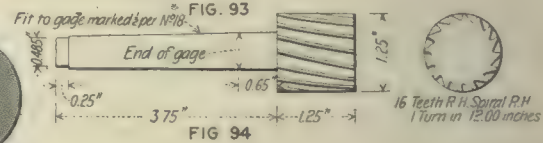


FIG. 93



FIG. 94

OPERATION 38 1/2

OPERATION 38. ROUNDING LIPS OF MUZZLE

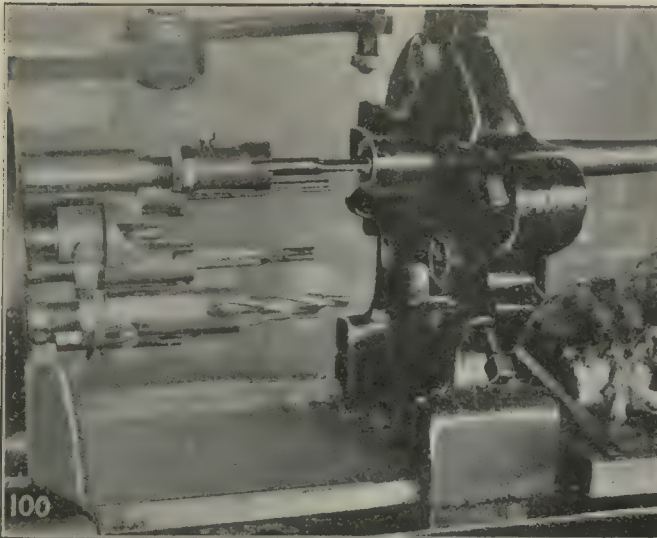
Transformation—Fig. 88. Machine Used—Regular 16-in. engine lathe. Number of Operators per Machine—One. Work-Holding Devices—Barrel is held on center at butt end; muzzle end is supported as shown in Fig. 89. Tool-Holding Devices—Milling tool held on arbor in lathe spindle. Cutting Tools—Special facing cutter with pilot, Fig. 90. Number of Cuts—One. Cut Data—Speed of lathe, 70 r.p.m. Coolant—Triumph cutting oil, 1/4-in. stream. Average Life of Tool Between Grindings—150 barrels. Gages—Contour of lips and length gage, Fig. 91. Production—100 per hr.

OPERATION 38 1/2. HAND-MILLING SEAT FOR FIXED STUD

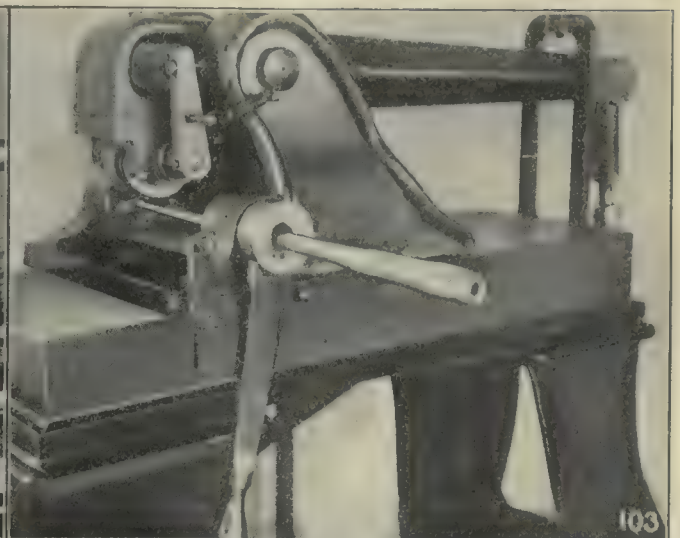
Transformation—Fig. 92. Machine Used—Whitney hand miller. Number of Operators per Machine—One. Work-Holding Devices—Special fixture, Fig. 93. Cutting Tools—Special milling cutter, Fig. 94. Number of Cuts—One. Cut Data—Speed of milling cutter, 125 r.p.m.; barrel, 30 r.p.m. Coolant—None. Average Life of Tool Between Grindings—150 barrels. Gages—Plug and snap, Fig. 95. Production—60 per hr.

OPERATION 39. FILING MUZZLE

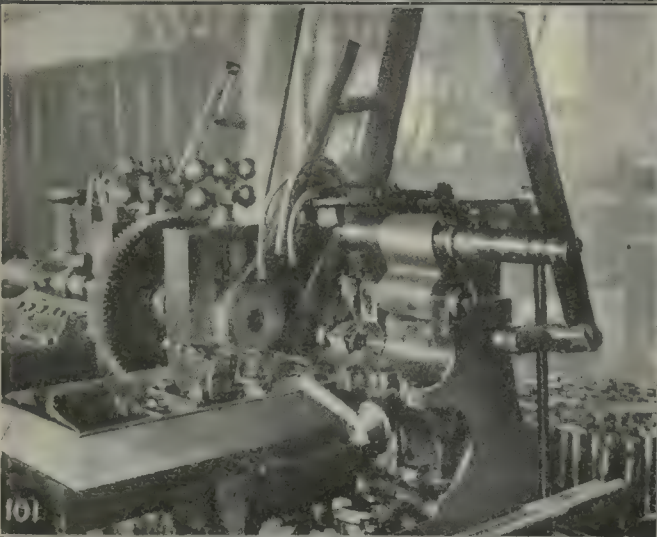
Gages—Ring gages for diameter, as shown in Fig. 95.



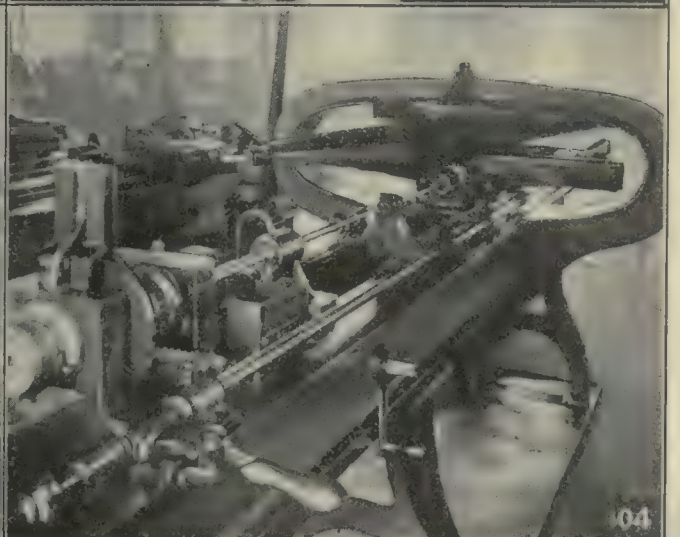
100



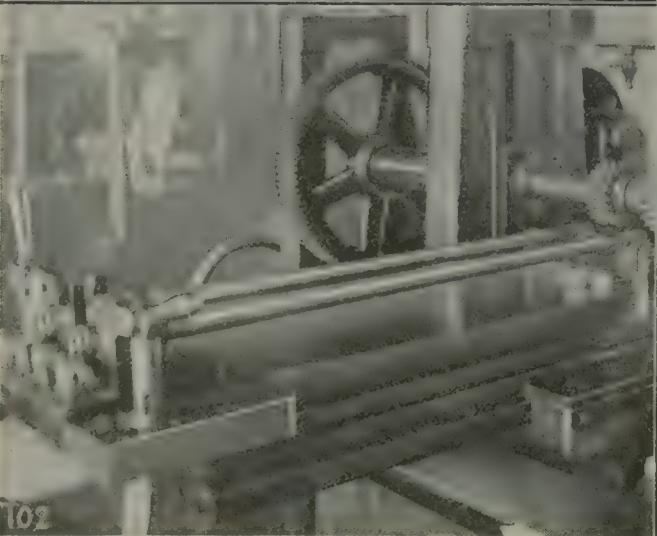
103



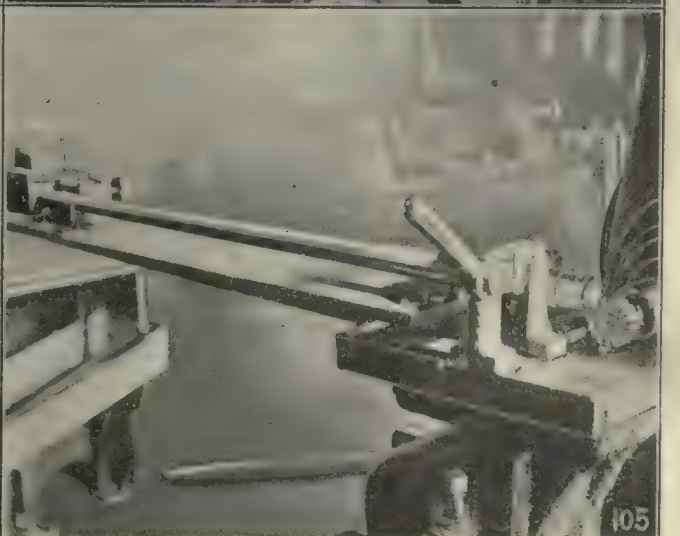
101



104



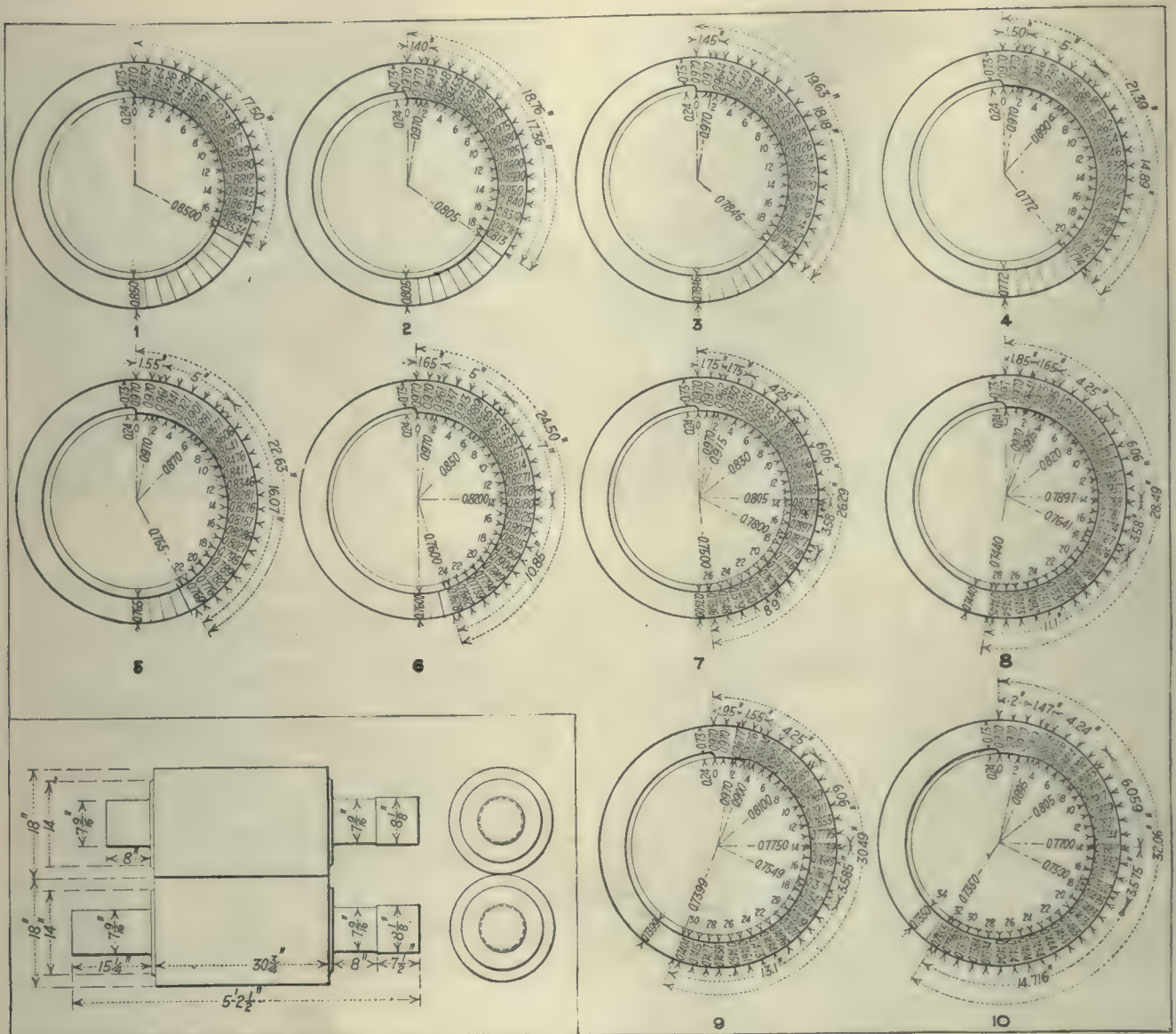
102



105

AS THE MANUFACTURE OF THE RIFLE BARREL PROCEEDS, THE OPERATIONS BECOME OF INCREASING INTEREST

Fig. 100—Chambering. Fig. 101—Skiving. Fig. 102—Spline milling. Fig. 103—Stamping. Fig. 104—Rifling.
Fig. 105—Milling extractor cut



FIGS. 97 AND 99. BLANKS FOR BARREL ROLLS, AND CAMS USED IN GROOVING THEM

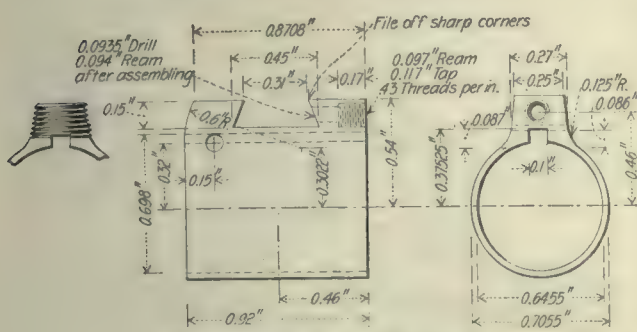


FIG. 106. THE FIXED STUD

The fixed stud, as shown in detail in Fig. 106, is forced over the muzzle end of the barrel and forms the base for the front sight. The fixed stud is made from a drop

- | | |
|--|---|
| A. Forging from bar | 10. Milling serrations on rear end of lug |
| C. Annealing | 9. Splining |
| C-1. Pickling | 7. Drilling screw holes |
| B. Trimming | 8. Tapping screw holes |
| 1. Straddle-milling both ends | 12 1/2. Filing and cornering operations 8, 9 and 10 |
| 2. Drilling bore for barrel | 12. Profiling dovetail cut and top of lug to finish |
| 5. Form-milling outside lengthwise | 13. Burring screw hole and filing to finish |
| 6. Milling top and stud crosswise, cutting apart | 14. Polishing |
| 3. Reaming bore for barrel | |
| 4. Squaring ends to finish length | |

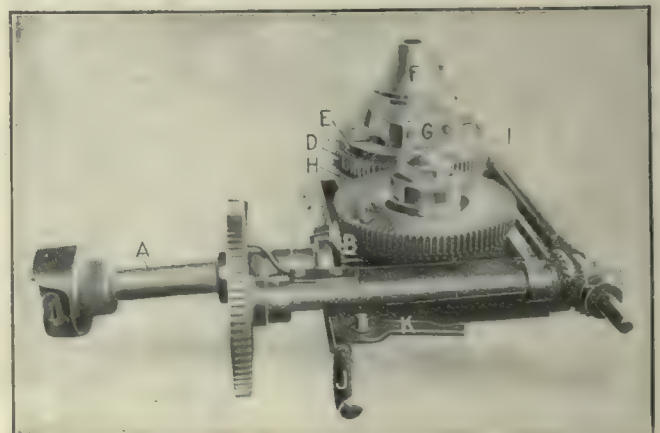


FIG. 98. RELIEVING ATTACHMENT FOR ROLL GROOVING

forging that is long enough to make six studs. These are sawed apart after the hole is drilled and reamed and the outside form-milled in operations 1, 2 and 5. When finished, the stud is a thin shell, the outside diameter being 0.7055 and the bore 0.6455 in. It is made from Class D steel, 0.80 in. square. The sequence of operations is presented in the accompanying table.

The operations on the fixed stud are to a large extent performed on milling machines, although there are a number in which the lathes have been arranged with special attachments and a few in which special machines altogether are used. The fixed stud also introduces the use of Pratt & Whitney profiling machines, examples of which

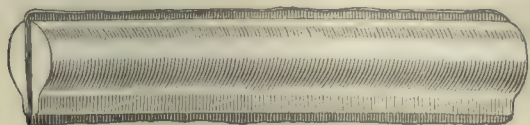


FIG. 107

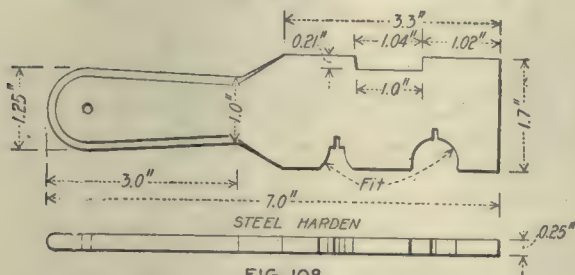
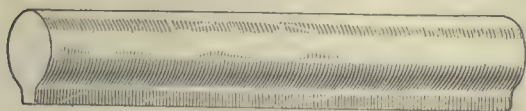
FIG. 108
OPERATION A

FIG. 109. OPERATION B

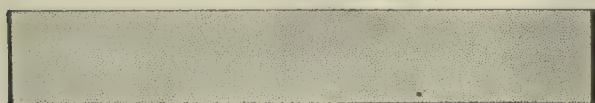


FIG. 110

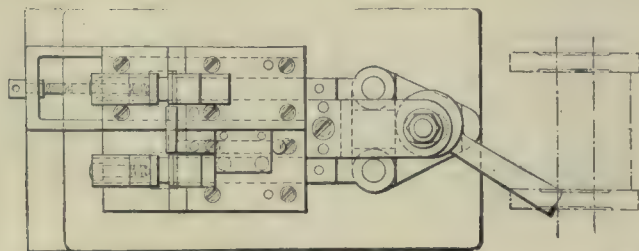
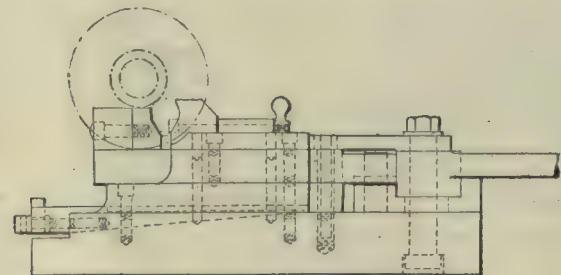


FIG. 112



sent by a small star. The templet is shown in connection with the profile finger and is represented as approximately having the same outline as that required in the piece. An example of this will be found in operation

OPERATION A. FORGING FROM BAR, SIX IN A STRIP

Transformation—Fig. 107. Number of Operators—One. Description of Operation—Drop forging. Apparatus and Equipment Used—Billings & Spencer 1,000-lb. drop hammer. Gages—Fig. 108. Production—440 studs per hr.

OPERATION C. ANNEALING

Number of Operators—One. Description of Operation—Heat to 350 deg. C. (1,562 deg. F) and allow it to cool down with the furnace over night. Apparatus and Equipment Used—Cast-iron annealing boxes or pots filled with charcoal and heated in a Brown & Sharpe furnace. Gages—Pyrometer.

OPERATION C-1. PICKLING

Number of Operators—One. Description of Operation—Pickled in 1 part sulphuric acid to 9 parts water; afterward washed in water and then lime. Apparatus and Equipment Used—Wooden pickling tank.

OPERATION B. COLD TRIMMING

Transformation—Fig. 109. Machine Used—Perkins back-gear press. Number of Operators per Machine—One. Punches and Punch Holders—Single punch and cast-iron holder. Dies and Die Holders—Single trimming die and cast-iron holder. Average Life of Punches and Dies—20,000 pieces between grindings. Production—450 blanks of 6 studs each per hr. Note—Blank is pushed down through die.

OPERATION 1. STRADDLE-MILLING BOTH ENDS OF STRIPS

Transformation—Fig. 110. Machine Used—Pratt & Whitney Lincoln type miller, belt drive. Number of Operators per Machine—One. Work-Holding Devices—Work held in vise with formed jaws, Figs. 111 and 112. Tool-Holding Devices—Cutters held on standard arbor, Cutting Tools—Two 4-in. side-cutting mills, Fig. 113. Number of Cuts—Two. Cut Data—Speed, 60 r.p.m.; feed, $\frac{1}{8}$ in. Coolant—Cutting oil put on by hand brush. Average Life of Tool Between Grindings—110 to 150 pieces. Gages—Length, Fig. 114. Production—25 per hr. per machine. Note—One man can run several machines; these pieces are handled in boxes holding 40 strips of 6 studs each.

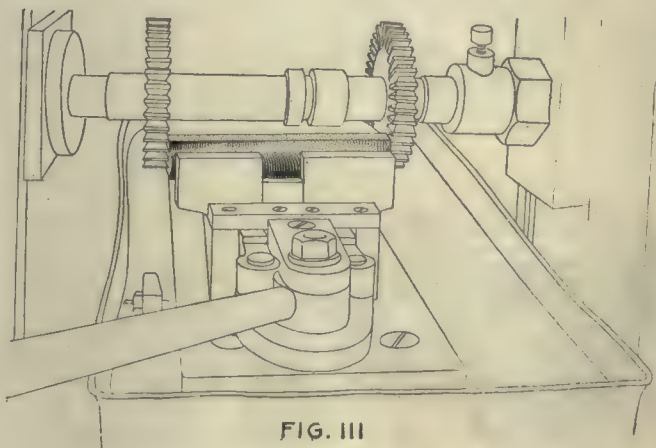


FIG. 111

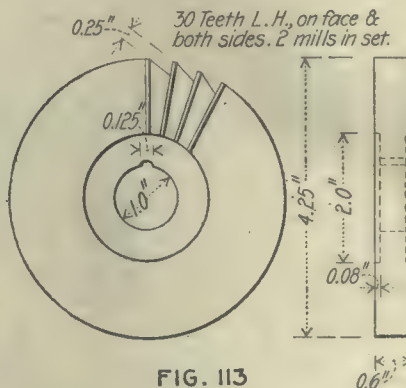


FIG. 113

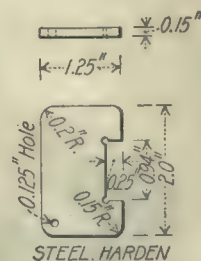


FIG. 114

will occur frequently in succeeding operations on various rifle parts.

In order to make clear the actual work performed in a profile milling operation, the operation is accompanied by a diagram which shows the relation between the profiling finger and the profiling cutter. The former is shown by means of a solid black circle while the cutter is repre-

sented by a small star. The templet is shown in connection with the profile finger and is represented as approximately having the same outline as that required in the piece. An example of this will be found in operation

Many interesting and valuable methods are to be noted in the practice at Springfield. Some of these are well adapted to use in shops working on other lines than the production of munitions. An example of this is shown in Fig. 126, in which a small brush is arranged at the

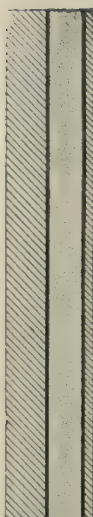


FIG. 115

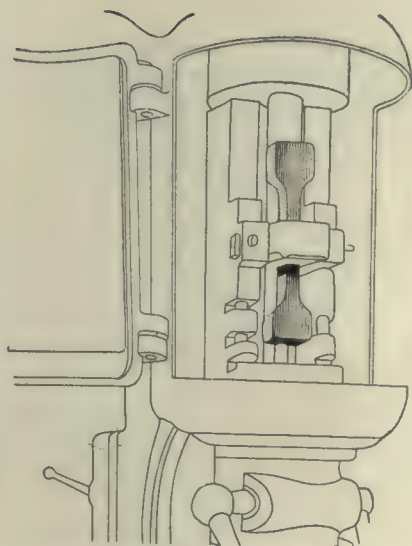


FIG. 116

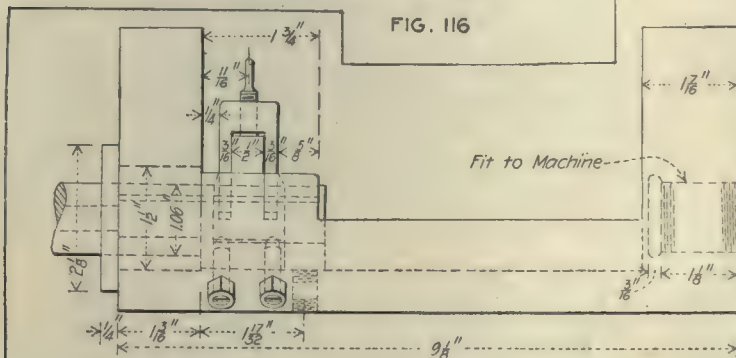


FIG. 117

OPERATION 2

OPERATION 2. DRILLING BORE OF FIXED STUD FOR BARREL

Transformation—Fig. 115. Machine Used—Pratt & Whitney automatic upright drill. Number of Machines per Operator—12. Work-Holding Devices—Work held in fixture by strap and clamp, Figs. 116 and 117. Tool-Holding Devices—Tool held in carriage of drill by setscrew. Cutting Tools—Special 0.643-in. drill, high-speed steel, Fig. 118. Number of Cuts—One. Cut Data—Speed, 600 r.p.m.; feed, $\frac{1}{16}$ in. Coolant—Cutting oil. Average Life of Tool Between Grindings—15 to 20 pieces. Gages—Fig. 119. Production—3 pieces per hr. per machine.

OPERATION 5. FORM-MILLING OUTSIDE OF FIXED STUD LENGTHWISE

Transformation—Fig. 120. Machine Used—Pratt & Whitney Lincoln type miller, belt driven. Number of Operators per Machine—One. Work-Holding Devices—Work held on pin that lines cut with bore clamped on ends, Figs. 121 and 122. Tool-Holding Devices—Cutters held on standard arbor. Cutting Tools—Two form cutters, Fig. 123. Number of Cuts—Two. Cut Data—Speed, 60 r.p.m.; feed, $\frac{1}{16}$ in. Coolant—Compound; $\frac{1}{4}$ -in. stream. Average Life of Tool Between Grindings—200 pieces. Gages—Snap, Fig. 124. Production—15 per hr.

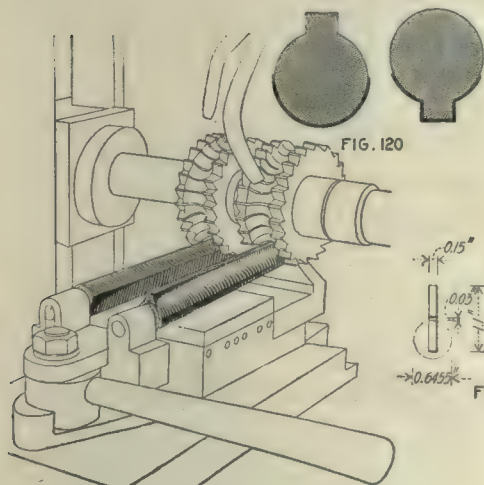


FIG. 121

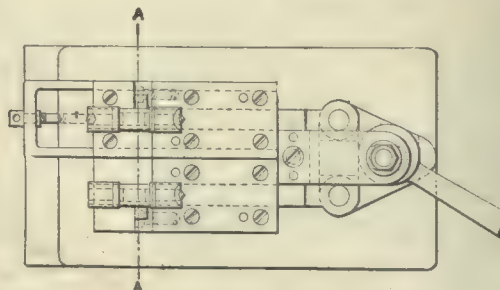


FIG. 122

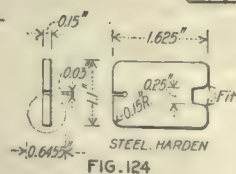


FIG. 124



SECTION A-A

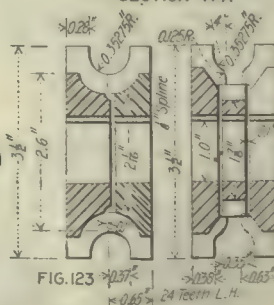


FIG. 123

OPERATION 5

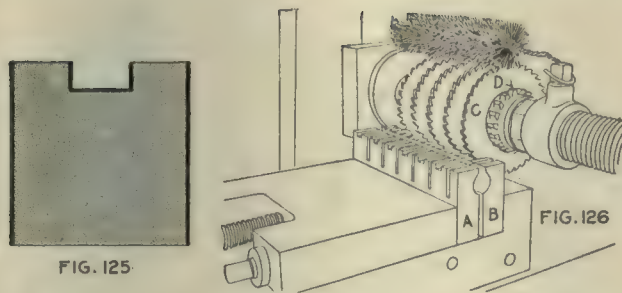
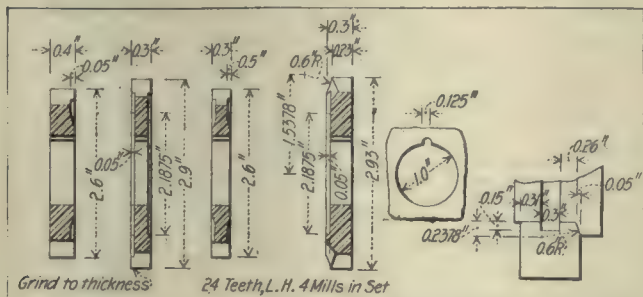


FIG. 125

FIG. 126



Grind to thickness

24 Teeth L.H. 4 Mills in Set

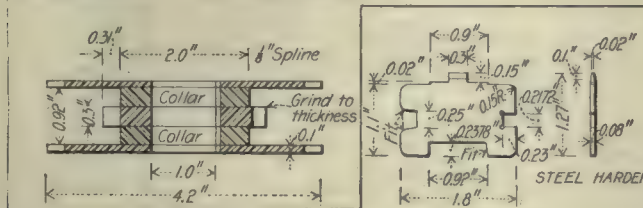


FIG. 127

FIG. 128

OPERATION 6

OPERATION 6. MILLING TOP AND SIDE CROSSWISE

Transformation—Fig. 125. Machine Used—Pratt & Whitney Lincoln type miller, belt drive. Number of Operators per Machine—One. Work-Holding Devices—Work held in vise form jaws, Fig. 126. Tool-Holding Devices—Tools held in standard arbor, Fig. 126. Cutting Tools—Four $\frac{1}{4} \times 4$ -in. saws, Fig. 127; four $2\frac{1}{2} \times \frac{1}{8}$ -in. slotting mills. Cut Data—Speed, 60 r.p.m.; $\frac{1}{2}$ -in. feed. Coolant—Cutting oil. Average Life of Tool Between Grindings—100 pieces. Special Fixtures—Standard vise, special jaws. Gages—Length and form, Fig. 128. Production—180 per hr.

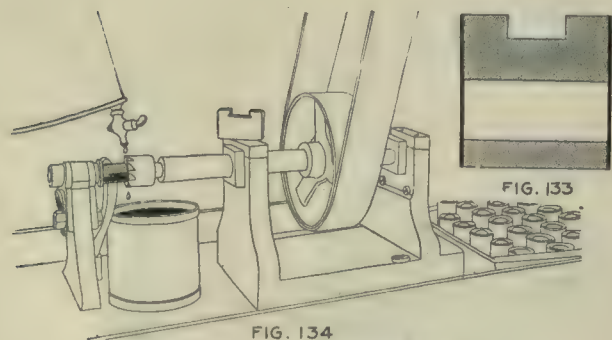


FIG. 134

FIG. 133

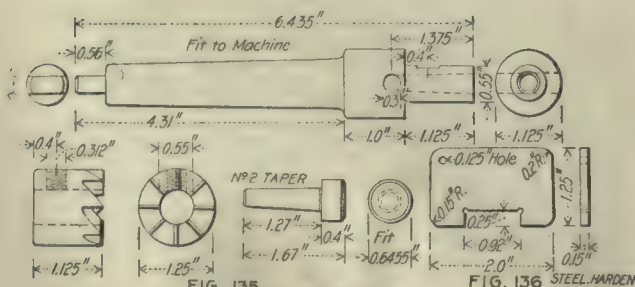


FIG. 135

FIG. 136

OPERATION 4

top of a gang of slitting saws for the purpose of removing chips from saw-teeth.

Another simple but time-saving arrangement is shown in Fig. 130, in which the fixed studs are reamed under drilling machines. Considerable time is saved by holding the reamer stationary as far as up-and-down movements are concerned and feeding the piece by hand with the crossbar arrangement shown.

A simple hand tapping machine which will be found of considerable use in many shops is shown in Fig. 150.

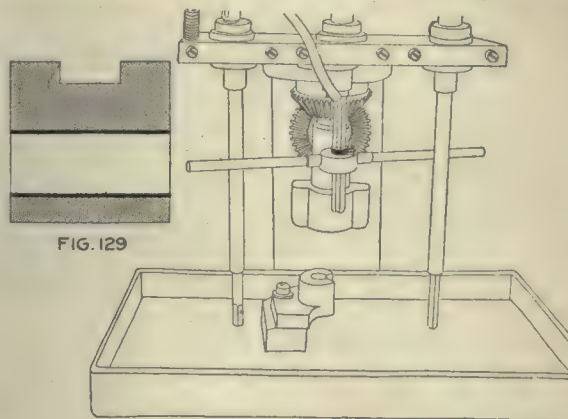


FIG. 129

FIG. 130

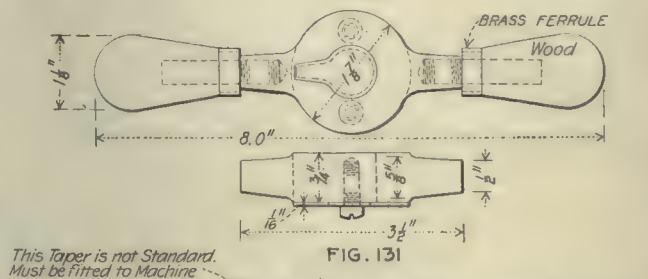


FIG. 131

FIG. 132

OPERATION 3

OPERATION 3. REAMING BORE FOR BARREL

Transformation—Fig. 129. Machine Used—Ames Manufacturing Co. upright drilling machine. Number of Operators per Machine—One. Work-Holding Devices—Work held in holder, Fig. 131; holder held by hand. Tool-Holding Devices—Reamer held by taper held in spindle, Fig. 130. Cutting Tools—Reamer, Fig. 132. Number of Cuts—One. Cut Data—Speed, 70 r.p.m.; hand feed. Coolant—Cutting oil; $\frac{1}{8}$ -in. stream. Average Life of Tool Between Grindings—2,000 cuts. Gages—Plug. Production—370 per hr.

OPERATION 4. SQUARING ENDS TO FINISH LENGTH

Transformation—Fig. 133. Machine Used—Special machine built in shops, Fig. 134. Number of Operators per Machine—One. Work-Holding Devices—Work held on pin in tailstock of machine. Tool-Holding Devices—End mill held by taper shank. Cutting Tools— $\frac{1}{4}$ -in. mill with pilot, Fig. 135. Number of Cuts—Two. Cut Data—Speed, 70 r.p.m.; hand feed. Coolant—Cutting oil; $\frac{1}{8}$ -in. stream. Average Life of Tool Between Grindings—1,000 cuts. Gages—Snap, Fig. 136. Production—120 per hr.

This can be placed in a bench vise, fastened to floor, post or bench itself or held in a variety of other ways. Its range as far as variety of work is concerned will be considerably increased by means of an adjustable vise, in place of the fixture at the left-hand end, which is used for holding the stud. A close study of operations on the rifle, many of which are the result of years of evolution, will reveal a number of such useful methods worthy of adoption as time savers.

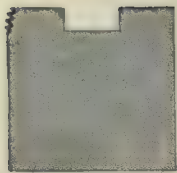


FIG. 137

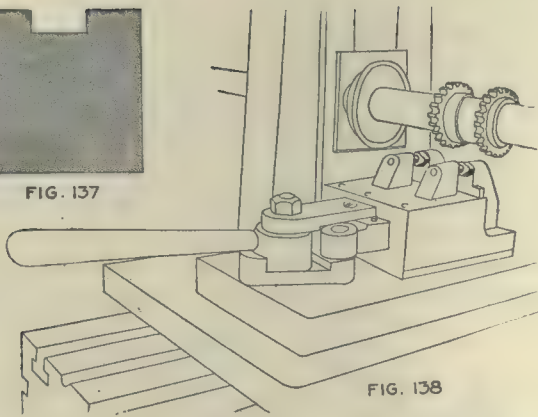
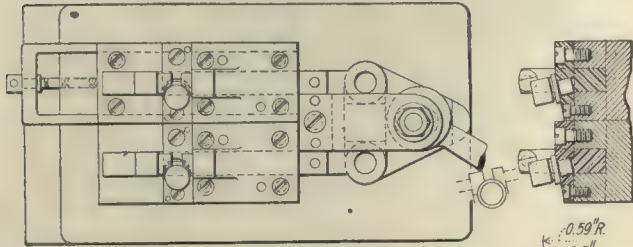


FIG. 138



0" 1" 2" 3" 4" 5"

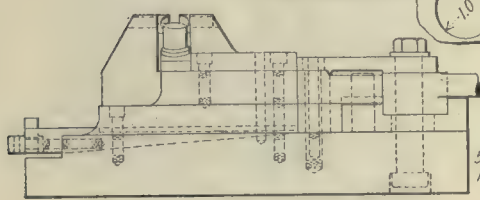
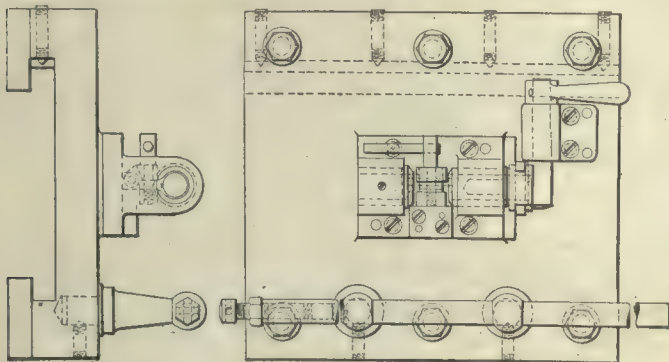
20 Teeth L. H. Formed
Mill 1 Mill in Set.

FIG. 139

OPERATION 10

OPERATION 10. MILLING SERRATIONS ON REAR END OF LUG

Transformation—Fig. 137. Machine Used—Pratt & Whitney Lincoln type miller, belt drive. Number of Operators per Machine—One. Work-Holding Devices—Work held on studs set at angle with vise jaws that bind on stud, Fig. 139. Tool-Holding Devices—Cutters held on standard arbor, Fig. 138. Cutting Tools—Two $2\frac{1}{2} \times \frac{3}{8}$ -in. serration cutters, Fig. 140. Number of Cuts—Two. Cut Data—Speed, 60 r.p.m.; $\frac{1}{2}$ -in. feed. Coolant—Cutting oil put on by hand brush. Average Life of Tool Between Grindings—500 pieces. Gages—None. Production—50 per hr.



0" 1" 2" 3" 4" 5"

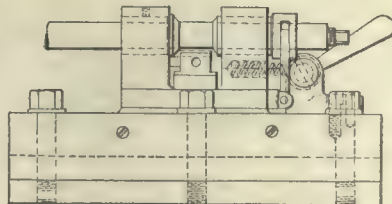


FIG. 143

OPERATION 9

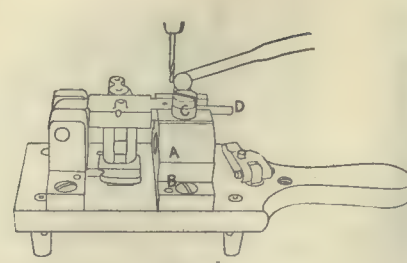


FIG. 147



FIG. 148A, OPERATION 7A

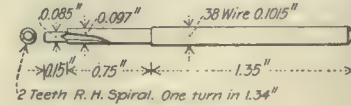


FIG. 148

OPERATION 7

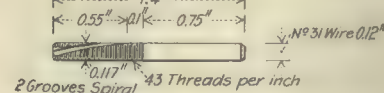
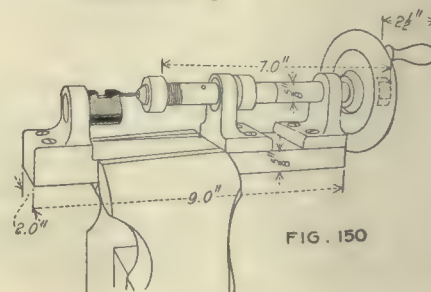
FIG. 151
OPERATION 8

FIG. 150

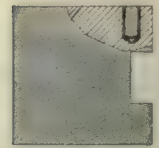


FIG. 146

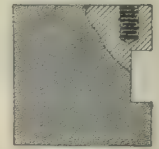


FIG. 149



FIG. 151A

The clamping devices used at the Springfield arsenal are also worthy of note. Many of them are similar in principle and are also the result of evolution and of discarding what is in use for something better, going back occasionally, however, to the original scheme.

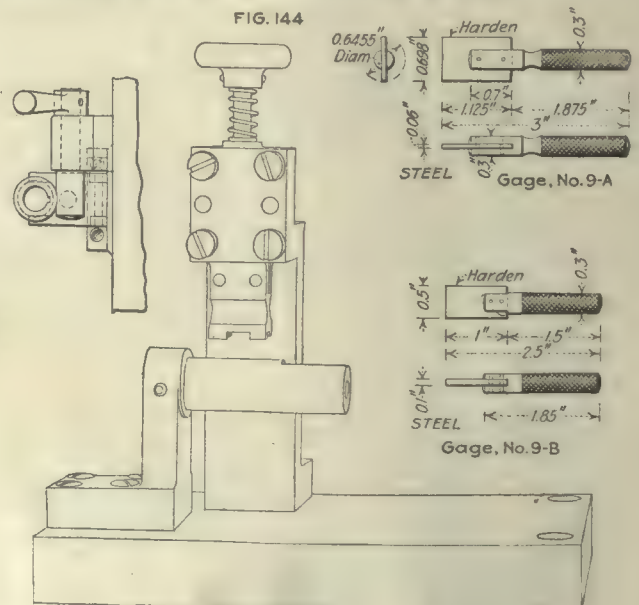
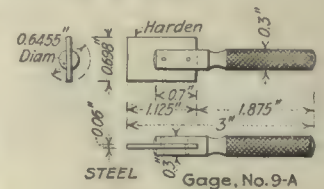
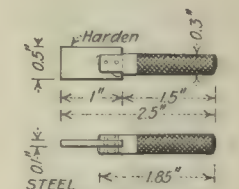


FIG. 144



Gage, No. 9-A



Gage, No. 9-B

FIG. 145

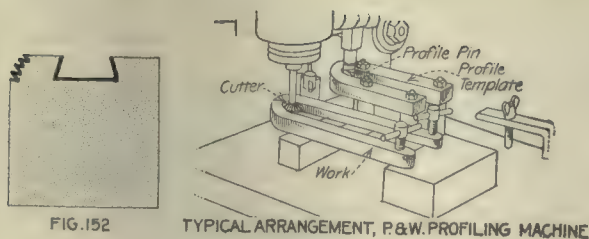


FIG.152

TYPICAL ARRANGEMENT, P.&W. PROFILING MACHINE

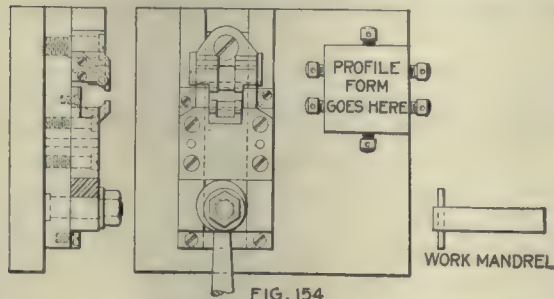


FIG. 154

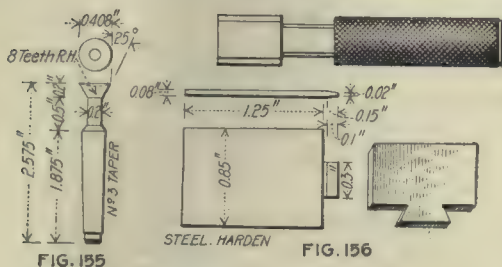


FIG. 155

FIG. 156

OPERATION 12

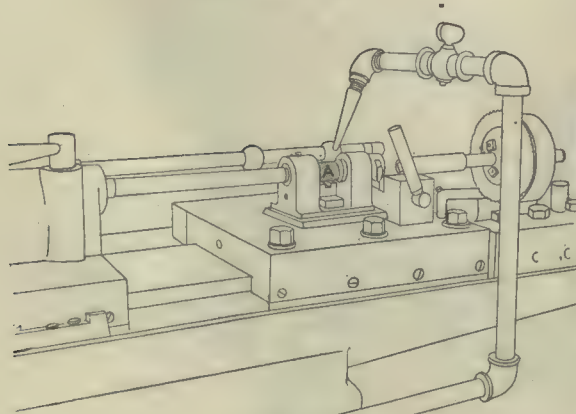


FIG. 142

OPERATION 9. SPLINING

Transformation—Fig. 141. Machine Used—Spliner made at Hill shops. Number of Operators per Machine—One. Work-Holding Devices—Work held in fixture clamped at ends, Fig. 143. Tool-Holding Devices—Cutter at each end of machine. Cutting Tools—Using studs or gulder barrel tool, Fig. 144. Number of Cuts—One. Cut Data—40 strokes per minute. Coolant—Cutting oil; $\frac{1}{8}$ -in. stream. Average Life of Tool Between Grindings—200 pieces. Gages—Fig. 145. Production—85 per hr. Note—One end of splining machine shown in Fig. 142.

OPERATION 7. DRILLING SCREW HOLES

Transformation—Fig. 146. Machine Used—Pratt & Whitney three-spindle 16-in. drilling machine. Number of Operators—One. Work-Holding Devices—Work held in drill jigs, Fig. 147. Tool-Holding Devices—Tools, drill and reamer, held in Almond chuck. Cutting Tools—.92-in. drill and .97-in. reamer, Fig. 148. Number of Cuts—Two. Cut Data—Speed, 150 r.p.m.; hand feed. Coolant—Cutting oil; $\frac{1}{4}$ -in. stream. Average Life of Tool Between Grindings—50 pieces. Gages—Locating, Fig. 148-A, No. 7. Production—62 per hr.

OPERATION 8. TAPPING SCREW HOLES

Transformation—Fig. 149. Machine Used—Hand-operated tapping machine—Fig. 150. Number of Operators per Machine—One. Tool-Holding Devices—Work held on stud pin for stop; stop held in little pivot chuck. Tool-Holding Devices—Tapping fixture held in vise at bench. Cutting Tools—0.117-in. tap, 43 threads per inch, Fig. 151. Number of Cuts—One. Coolant—Cutting oil put on with brush. Gages—Fig. 151-A. Production—150 per hr.

OPERATION 12½. FILING AND CORNERING OPERATIONS

8, 9 AND 10

Number of Operators—One. Description of Operation—Filing burrs off and touching up. Apparatus and Equipment Used—File and scraper. Production—150 per hr.

OPERATION 12. PROFILING DOVETAIL CUT AND TOP OF LUG TO FINISH

Transformation—Fig. 152. Machine Used—Pratt & Whitney belt-drive profiler. Number of Operators per Machine—One. Work-Holding Devices—Work held in vise fixture with special jaws, Fig. 154. Tool-Holding Devices—Tool or cutters driven by taper shank in spindle of machine. Cutting Tools—Angle cutter, Fig. 155. Number of Cuts—One, Fig. 153. Cut Data—Speed, 270 r.p.m.; hand feed. Coolant—Cutting oil. Average Life of Tool Between Grindings—400 pieces. Gages—Plug, Fig. 156. Production—40 per hr.

OPERATION 13. BURNING SCREW HOLE AND FILING
TO FINISH

Number of Operators—One. Description of Operation—Burring the burr on screw hole. Apparatus and Equipment Used—File and scraper. Production—90 per hr.

OPERATION 14. POLISHING

Number of Operators—One. Description of Operation—Rounding corners and brushing up; finishing all over. Apparatus and Equipment Used—Small-diameter polishing drill; cloth wheel. Production—35 per hr.

Quenching Mediums

Water, heavy oil, a mixture of oil and water and many special brands of quenching oils are advocated and used as quenching mediums. Water has the advantage of conferring excellent physical properties by reason of the rapid cooling, but for the same reason will produce dangerous shrinkage strains unless the cooling is very carefully timed. Heavy oil, such as cylinder oil, greatly reduces the danger from cracking, but quenches more slowly and therefore does not produce such good physical properties in the steel. With a view to reducing the danger of damage by water and at the same time to securing better

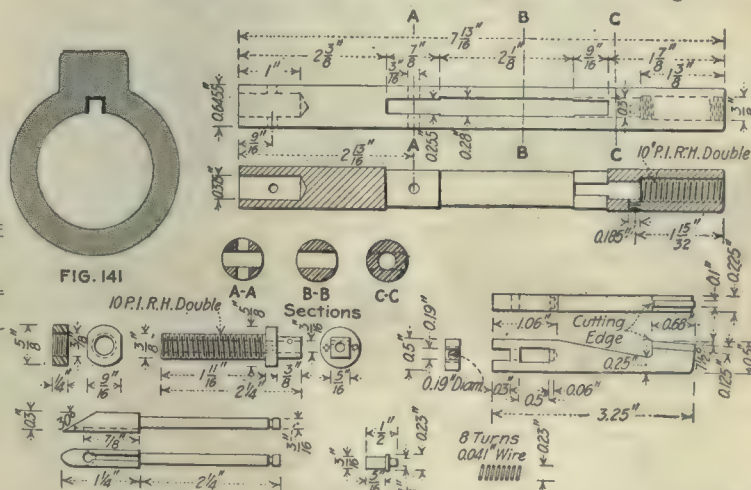


FIG. 141

results than can be obtained with heavy oil, various other quenching fluids are used. Some manufacturers use a mixture of oil and water similar to a drilling compound, while others use light oils of different grades.

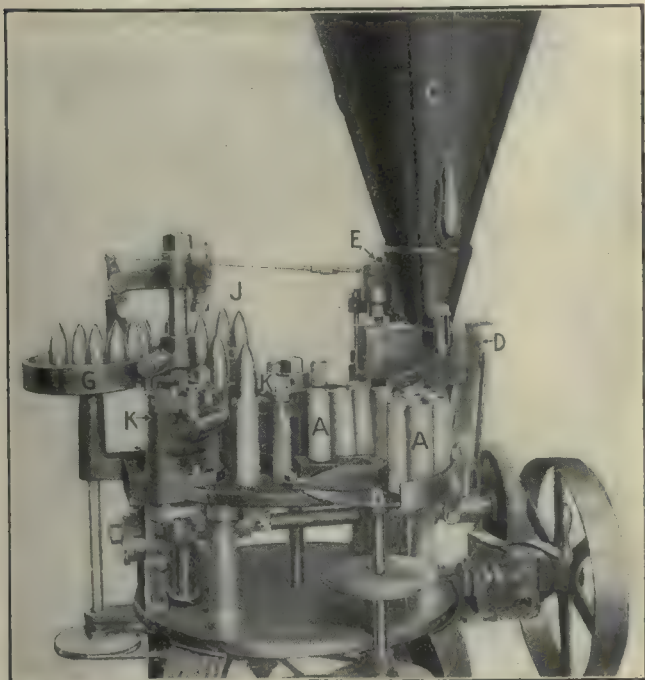
The writer advocates the use of an inexpensive light mineral oil with a fire point of about 390 deg. F., a flash point of about 350 deg. F. and gravity about 29 deg. Be. There should be separate quenching and storage tanks, the latter to have ample capacity and to be provided with cooling coils. The oil should be pumped from the storage into the quenching tank and delivered into the latter in such a way as to produce a vigorous and positive circulation about the object to be quenched. A system of this kind has many advantages, one of the most important being that since the circulation of the oil is controlled by the pump, the rate of circulation can be varied, and the rate of cooling thus adapted to suit the needs of almost any case.—L. H. Fry in *Railway Mechanical Engineer*.

Loading Machine for United States 1-Lb. Ammunition

By JOHN S. MONTAINE

With the growing use of 1-lb. ammunition in anti-aircraft, machine and subcaliber guns, the economical assembling of this size ammunition is of timely interest.

The machine shown in the accompanying illustration was designed and built at the Frankford Arsenal and has been in use there for the past three years. When operated by two men it will turn out from 1,000 to 1,100



LOADING MACHINE FOR U.S. 1-LB. AMMUNITION

rounds per hour, equal to the combined output of approximately twelve men, loading and assembling by hand.

A cartridge case *A*, which has already been primed, is taken from the disk *B* and carried around to the right, under the powder hopper *C* where it receives the propelling charge from a volumetric measure in the slide *D*.

In the manufacture of powder it is almost impossible to get two lots to burn exactly the same, so it is necessary to make corrections in the volume, or weight, of the charge, by an adjusting screw that extends into the cylindrical cavity of the measure, which remains fixed until the particular lot of powder is consumed.

After the charge is inserted, the case moves under a tamping stem *E*, on which are weights which compress the charge to uniform density. The case then moves under a test stem *F*, which is connected by a rod and lever to a plate cam *G*.

In actual practice it has been found that in a charge of approximately 1,000 grains this method of loading does not vary from normal more than three grains, although five grains are allowed; but to insure only normal charges going through, the test stem must bring the lever on the cam plate to a vertical position where the engagement of a pin allows a shell to be taken from the disk and carried around to meet the case under the ram stem *J*.

If a light charge is detected, no shell is picked up, and the operator takes the case out through a gate.

An inspector stands by and examines one or two out of each hundred rounds, and has the charge weighed as a check on the machine.

The spring seen on the ram stem is to insure just enough pressure on the projectile to force it home, but not enough to swell the case if it happens to be a little long.

The assembled round is next placed where it is crimped by one fixed and two movable jaws *K*; then striking a cam it is forced out, to be carried away, painted and packed.

✱

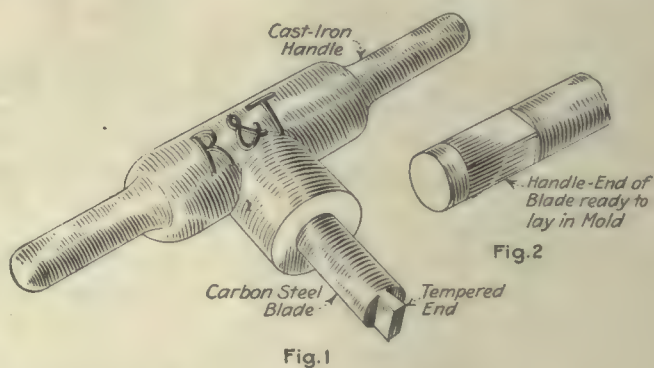
Obscuring Surface Defects on Castings

By DONALD A. HAMPSON

Several thousand of the special T-screw drivers shown in Fig. 1 were made. The carbon steel blades were machined to shape and "cast in" the handle and then tempered on the end. A gate of brass patterns was used, each pattern having a print the size of the projecting stem of the finished screw driver.

This construction was cheap and durable and ideal for the purpose—with two exceptions. At the center of the T on the cope side of the casting, scabs and holes appeared in fully half of the piece, and usually a third of the stems were loose in the handle. This latter, though not a serious fault, was undesirable. All attempts to overcome these foundry defects met with indifferent success and though the utility of the tools was not affected, it was certain that the sale was retarded thereby.

Hoping to obscure the scabbiness and holes so they would not be so noticeable, the writer tried the experiment of casting letters on the side of the handle. Poor



THE SPECIAL SCREW DRIVER

letters would be unimportant and raised letters of any kind would break up what should otherwise be a smooth surface, therefore by casting, if the same uneven spots developed in and on the letters, they would be less prominent than before. An additional point was the advertising value of the firm's initials, as well known in that particular field as are B & S in the machine-tool building field.

The scheme worked out better than was expected. The letters come out commercially good, and the looks of the tool are greatly improved. Rejections average one-half of one per cent. and the castings in general are nearer perfect. Another pleasing feature of the change in subsequent lots was that the stems were tighter though no reason could be given for that.

Letters from Practical Men

Pressed Brass Coupling Dies

The pressed brass coupling illustrated herewith is drawn in two operations. The first operation *A* (Fig. 1) is blanked and drawn from a $4\frac{3}{4}$ -in. blank in dies shown in Fig. 2. This die and punch is set up in a single-action press, and the shell must be drawn to a developed depth in order to correspond properly with the next operation die and punch to get the desired results.

In setting up this die, care must be exercised in adjusting the rubber buffer *N*. Too much stress on the pres-

sure pad *F* would strain, stretch and possibly break the brass, while not enough stress on the pressure pad would permit the metal to wrinkle and cause breakage and poor work on the succeeding operation. The lower punch *E* in the die has a small vent to facilitate the removal of the work from the punch and prevent distortion.

The blanking punch *A* has a positive knock-out that comes in contact with the stationary knock-out bar attached to the press while in operation. Should the shell stay in the punch, it is easily released on the upward stroke. The compound blanking and cupping punch *A* is made of machinery steel with a tool-steel bushing *B* pressed into place and secured by screws *C*. The bushing *B*, which does the actual work of blanking and cupping, can be shrunk several times when it wears too large and is easily replaced with a new one when this becomes necessary. A punch of this type, when its diameter exceeds 4 in., is cheaper and has longer life than a solid

tool-steel punch, because the bushings can be shrunk to size so often.

The blanking punch *D*, the forming punch *E* and the pressure pad *F* are made of tool steel, hardened and ground to size. The forming punch *E* is held in position by the bolt *H*, which has a vent similar to that in the punch *E*. The outlet is at *X*. The blanking die has $\frac{1}{8}$ -in. shear and is held in position by machine-steel strippers *I*, in turn held in place by capscrews *J* and dowel pins *K* seated and screwed to the cast-iron die plate *L*. The latter is secured to the bolster plate by capscrews *O*. The pressure-pad pins *M* are made of hardened and ground tool steel and transmit the pressure to the pad *F* from the rubber buffer *N*, which is adjusted by the lock-nuts *P*. The second operation *B* (Fig. 1) is performed on the drawing and perforating dies shown in Fig. 3. These dies draw the tapered shell *B* with a flange concentric with the walls of the shell, perforate four rivet holes in the flange and punch out the bottom simultaneously. Thus the coupling is finished in two operations. By using a die of this type, trimming is unnecessary, so that it is possible to use a smaller blank, thereby saving valuable stock and completing the article in the briefest possible manner. The drawing punch *A*, of tool steel, hardened, has double stripper bushings *BC*, made of tool steel, hardened and ground. The bushing *C*, connected to the bushing *B* by springs and screws *G*, is screwed and pinned to the machine-steel stripper bar *D*, which is held in place on the punch by the bolts *E*, screwed to the ram of the press. When these bolts are properly adjusted, they give the correct sliding motion on the punch

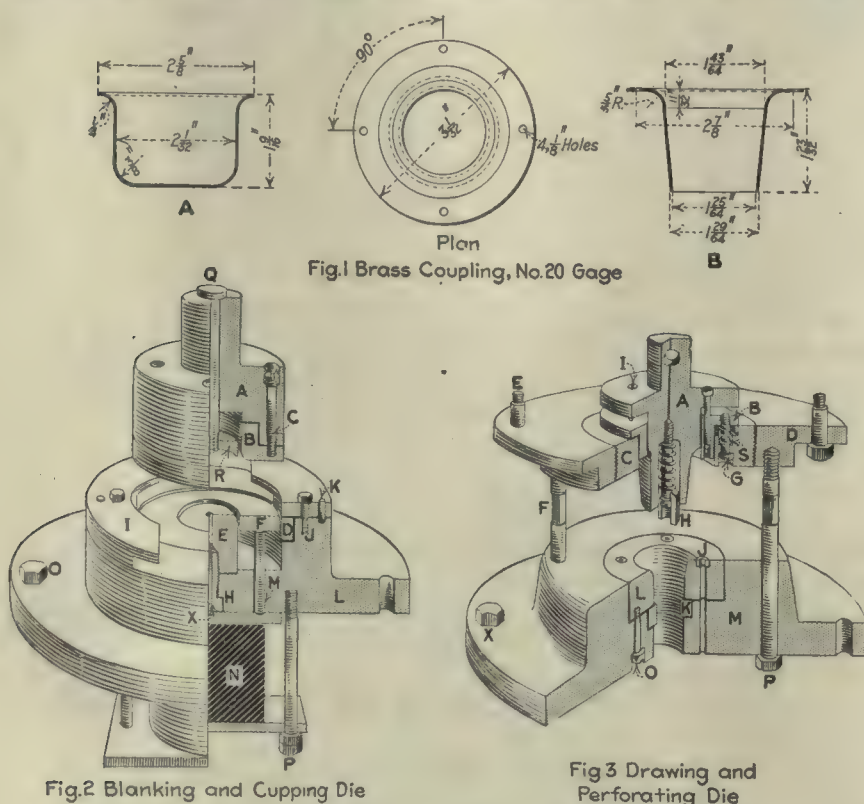


Fig. 1 Brass Coupling, No. 20 Gage

Fig. 2 Blanking and Cupping Die

Fig. 3 Drawing and Perforating Die

DIES FOR A PRESSED BRASS COUPLING

sure pad *F* would strain, stretch and possibly break the brass, while not enough stress on the pressure pad would permit the metal to wrinkle and cause breakage and poor work on the succeeding operation. The lower punch *E* in the die has a small vent to facilitate the removal of the work from the punch and prevent distortion.

The blanking punch *A* has a positive knock-out that comes in contact with the stationary knock-out bar attached to the press while in operation. Should the shell stay in the punch, it is easily released on the upward stroke. The compound blanking and cupping punch *A* is made of machinery steel with a tool-steel bushing *B* pressed into place and secured by screws *C*. The bushing *B*, which does the actual work of blanking and cupping, can be shrunk several times when it wears too large and is easily replaced with a new one when this becomes necessary. A punch of this type, when its diameter exceeds 4 in., is cheaper and has longer life than a solid

to release the stamping during the last $\frac{1}{4}$ in. of the upward travel of the press ram.

It is obvious that when the punch descends and enters the shell *X* the plug *H* (of tool steel, hardened and ground), having the proper spring tension, will straighten the shell in the bushing *C*. This tension from the spring *S* causes the bushing *C* to close on the die on the last $\frac{1}{4}$ in. of travel of the punch, which is necessary in order that the surplus flange stock may be properly forced into the die and down along the sides of the draw punch, assisting the drawing and perforating the flange holes.

The punch *A* is straight for $\frac{1}{2}$ in. above the curve on the lower end, to allow for the necessary over-travel to upset the end of the coupling slightly and prevent its having a feather edge. The perforating punches *I* are made of tool steel, hardened, ground, and screwed into place by having their heads threaded and slotted. The perforating bushings *J* are made of tool steel, hard-

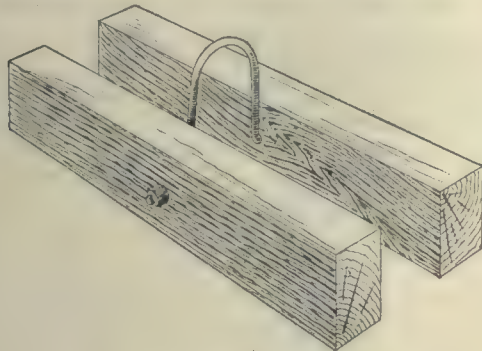
ened, ground, and pressed into place. The bushing *K* is likewise of tool steel, hardened and ground. It is held by the drawing die *L*, which is seated in the cast-iron die plate *M* and secured by the screws *O*. The die plate is fastened to the press bed by cap screws *X*.

Highland Park, Mich.

ERNEST A. WALTERS.

Packing Driver for Locomotives

In packing a locomotive piston time is frequently lost in the search for two pieces of wood the same length by



PACKING DRIVER

means of which the packing is forced into place with the crosshead.

In the sketch two pieces of wood the same length are fastened to a hook large enough to slip over the biggest piston rod.

Renovo, Penn.

B. A. DONLEY.

Time-Study Results; Making Automatic Bolts

Extensive articles have been written about the methods of time-study work, the principles on which to proceed and the forms to be used in recording the observations, but comparatively little has been written regarding the figures obtained under certain specified conditions for a specific product and with a certain machine tool.

The accompanying table shows some results secured in the manufacture of the bolts used in the assembly of automobiles, especially in the turning, forming and cutting off. The figures given, together with the formula, cover work on the Acme automatic screw machine and the Gridley multiple-spindle automatic, these machines being run in groups of three under the care of one operator. When the bolt is longer than 4½ in., the formula for the Gridley automatic is used, which is as follows:

$$P = \frac{11.56 \times \left(4 + \frac{L}{2}\right)}{60}$$

in which

L = Length of bolt, in inches;

P = Piece rate per 100, in cents.

For the screw-machine work the base rate adopted is 35c. per hr., and for the remainder of the operations the base rate is 28c. per hr. The material on which the studies were made is in accordance with the S.A.E. specifications, and the extra prices cover material which is more difficult to machine than that laid down in these specifications.

For bolts where the material is extra hard and the work is done on the Acme screw machine the following rates will be used:

Up to ¾ in. in diameter and up to 1½ in. long...	\$0.40 per 100
Up to ¾ in. in diameter and from 1½ to 4½ in. long	.50 per 100
From ¾ to 1 in. in diameter and up to 1½ in. long	.50 per 100
From ¾ to 1 in. in diameter and up to 4½ in. long	.60 per 100

For bolts of extra-hard material the following are the piece rates for drilling the pin hole:

Up to ¾ in. in diameter inclusive.....	\$0.15 per 100
From ¾ to 1 in. in diameter inclusive.....	.18 per 100

It is hoped that the publication of this material will lead to further contributions of a similar nature, as the information given cannot but be of considerable value

TIME-STUDY RESULTS IN BOLT MANUFACTURE

Bolt Size, ¼ In.				
Length, In.	Price, 3 Acme Machines	Drill Pin Hole	Burr Thread	Burr Head
Up to 1½	\$0.165	....	....	\$0.06
1½ to 2¼	.18	....	....	.06
2¼ to 3	.20	....	....	.06
3 to 3¾	.22	....	....	.06
3¾ to 4½	.24	....	....	.06
Bolt Size, ⅝ In.				
Up to 1½	.20	\$0.10	\$0.07	.06
1½ to 2¼	.22	.10	.07	.06
2¼ to 3	.24	.10	.07	.06
3 to 3¾	.26	.10	.07	.06
3¾ to 4½	.28	.10	.07	.06
Bolt Size, ¾ In.				
Up to 1½	.20	.10	.08	.07
1½ to 2¼	.22	.10	.08	.07
2¼ to 3	.24	.10	.08	.07
3 to 3¾	.26	.10	.08	.07
3¾ to 4½	.28	.10	.08	.07
Bolt Size, 7⁄8 In.				
Up to 2	.20	.12	.10	.07
2 to 2½	.22	.12	.10	.07
2½ to 3¼	.24	.12	.10	.07
3¼ to 4	.26	.12	.10	.07
4 to 4½	.28	.12	.10	.07
Bolt Size, 1½ to 2 In. Inclusive				
Up to 1½	.24	.12	.10	.07
1½ to 2	.26	.12	.10	.07
2 to 2¾	.28	.12	.10	.07
2¾ to 3½	.30	.12	.10	.07
3½ to 4	.32	.12	.10	.07
4 to 4½	.34	.12	.10	.07

to those who have to estimate on the production capacity of machines and the cost of producing certain work on the machines.

CHARLES F. SCRIBNER.

Springfield, Mass.

Questions of Lathe Design

Why is the handwheel for traversing the carriage on the bed placed on the left-hand side of the apron in most American lathes? Why are so many American lathe builders using left-hand lead screws? I recently saw an American lathe with a left-hand lead screw; and the only change on the lathe if it had a right-hand lead screw would have been the use of the tumbler gearing in the reverse direction.

One often hears the remark passed that such differences between English and American lathes is only a matter of trying to be different on the part of the manufacturers in the United States. The American lathes are on the whole more convenient to operate.

Wembley, England.

J. H. DAVIS.

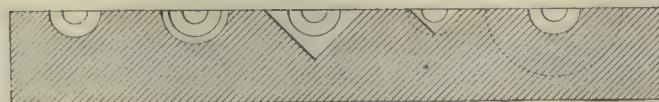
Manufacturing Enterprises Have Developed in the United States so rapidly in two years that 1914 figures are almost obsolete, yet they indicate the growth in the preceding five years. Thus, the capital employed, almost 23 billion dollars, represents an increase of nearly one-fourth. The amount of capital per establishment was \$83,000 in 1914, an increase of 35 per cent. The value of products, 25,200 million dollars, was 18 per cent. over the value in 1909. In 1914 the number of wage-earners employed ranged from 6,640,000 to 7,242,000 as against corresponding figures of 6,210,000 and 7,006,000 in 1909.

Discussion of Previous Question

Core-Box Reamers

Mr. Holaday's idea, page 385, of equipping the pattern shop with a set of reamers covering a certain range is good. It occurs to me that we may get along with a set of straight expansion reamers and one or two conical reamers that could take care of the tapered end. It could be done by dividing the cores into their elements and providing "elemental" core boxes, which are then glued or doweled together.

How about carrying the process of standardization a little farther? Let us differentiate and classify the elements according to the principles of "substitutability."



HYPOTHETICAL CORE BOXES

Then the same tapered ends could serve for different cylindrical lengths. In fact, it is not necessary that we make our elements just for the purpose of combining them with plain cylindrical ones. We may just as well use these ends for various other types of cores. The illustration schematically shows a series of cores subdivided by horizontal dash-dotted lines into their elements.

New York City.

R. HANAU.

✽

A Query on Cross-Knurling

Replying to Mr. Ware's query on page 388, next time he sees a knurled piece that has the appearance of a screw thread when revolved, if he will count the number of nicks made by each knurling wheel, he will probably find they are not equal.

On a hand-operated drill chuck in my possession there are three knurled bands, apparently made by two separate knurling wheels, one right-hand and the other left-hand. The central band and also the band nearest the lathe spindle, have the appearance, when revolved, of a fine pitch single-thread right-hand screw. On counting the number of nicks, there were found to be 181 having the same hand spiral as a right-hand thread and 180 left-hand. The knurled band nearest the chuck jaws had the appearance of a triple-thread right-hand screw, and the nicks, when counted, proved to be 181 right-hand and 178 left-hand.

Without going into any abstruse mathematical calculations, it would seem as though the hand of the apparent

thread was the same as the hand of the nicks that were in the majority, and if there is a difference of one between the number of right and left nicks, the apparent thread is single; while if this difference is two the thread is double; if three the thread is triple, and so on.

As to why these knurling tools sometimes make the right and left nicks equal in number and sometimes unequal, and at other times unequal by a different amount, is too much for me. If someone else can suggest a reason, no doubt Mr. Ware as well as other readers would be pleased to know what it is.

Brooklyn, N. Y.

WALTER GRIBBEN.

✽

American Machine Shops Abroad After the War

Recently having extended hospitality to an engineering student (a *candidat-ingenieur*) of the University of Ghent, who had the luck to escape Belgium, and constantly corresponding with prominent people in northern France and Holland, I have received information that seconds in full the statements of Mr. Bagenrieux, on page 477, as to future engineering opportunities in Belgium. In fact, as far back as a year ago a shrewd business man, a Fleming, urged me to return and to be ready to try on an unpretentious scale the setting up of a general construction shop in Belgium or near Belgium's unmolested frontier.

As Americans have done enough for Belgium to have earned undying fame, it is only fair to the interested readers of the *American Machinist* to discuss the proposition from an entirely business point of view.

Belgium not only for the present, but also for a long time after the *grand déménagement* (the great moving), will be practically closed to direct American enterprise. Besides Antwerp, Belgium does not boast any really important harbor. If machinery were landed somewhere along the North Sea coast, there would be no rolling stock to transport it. This assertion is in keeping with the information of Mr. Bagenrieux. To land the machinery in France for use in Belgium will be impossible for similar reasons and others equally important. The only place really desirable to land is Antwerp, just as indicated by Mr. Bagenrieux, and Antwerp is closed and its key in Holland. Antwerp can be reached only by way of the River Scheldt, which runs into the sea through Dutch territory.

The Scheldt has been closed for reasons of neutrality and military necessity, and since the fall of Antwerp there has been much speculation as to which of the contestants is going to drag Holland into the war by forcing the Scheldt. The participants, recognizing that half a million trained and well-equipped men added to one side might be sufficient to deal a vital blow to the opponent, did not and therefore will not molest Holland. The River Scheldt is closed and remains closed till the Dutch authorities see their way clear to open it without breaking any international laws. The opening of the

Scheldt, however, means the opening of the entire Belgian-Dutch frontier, and the enterprising Americans who are then ready to gain their point via Antwerp will find out that they have arrived rather late in the day.

Besides the hundred thousands of destitute Belgians who poured into Holland, hundreds of well-to-do Belgians also escaped and settled in the best hotels of Amsterdam, the Hague and other desirable places. These patriots have not done too much for their unfortunate fellow exiles, their defense against some attacks being that their money was needed for the reconstruction of their country. I have given them the benefit of the doubt, more so because I know that even now private parties and some large Dutch-Belgian engineering concerns are here, frantically trying to secure machinery for the purpose under discussion. Therefore the enterprising American will not be alone and besides will have to reckon with the Dutch machinery builders, who have extended their business considerably. (The *American Machinist* warned against this on page 505, Vol. 44.) Another factor to be considered is that Holland is rolling in gold at present and is anxious to compete.

From the above one may conclude that to share in the great Belgian opportunities one should erect his machine shop on the Belgian-Dutch frontier before the morrow of "the moving." Ground in Dutch Brabant and Limburg is exceedingly cheap, and light machinery halls will require but slight foundation. These localities are well connected by railroads and important waterways with the port of Rotterdam and also with all parts of Belgium. A location near the Belgian frontier on the South Willems Canal, which leads directly into Belgium and is near a railway junction, seems to me one of the ideal spots for such an undertaking. However, Maastricht in Limburg, Bergen op Zoom near Antwerp and even Sas van Gent in Dutch Flanders might prove to be just as advantageous. The distances from the frontier into Belgium are negligible, and the tariff, if there is any during the restoration, has never been of a forbidding nature. Further advantages are that many of the Belgian mechanics now in Holland would gladly consider a position in such a shop, and the force might also be recruited from among the manufacturing population of these parts, who speak practically the same tongue as their Belgian neighbors, the Flemings.

In the opinion of everyone able to judge the Belgian situation intelligently, "lots of money" is waiting for the man who takes the risk and arrives at the right time.

Brooklyn, N. Y.

JAN SPAANDER.



Aeroplane-Propeller Problems

The author of the article, "Aeroplane-Propeller Problems," *American Machinist*, page 125, gives a clear idea of the stresses to which an aeroplane propeller is subjected when a strong motor is used and the propeller has a large diameter. My experiences in this respect persuade me to call attention to the most frequent cause of propeller failure—faulty construction.

Propellers are subjected to bending strains, torsion and, through centrifugal force, to pulling strains. These forces are all functions of the diameter, the number of revolutions and the horsepower of the engine.

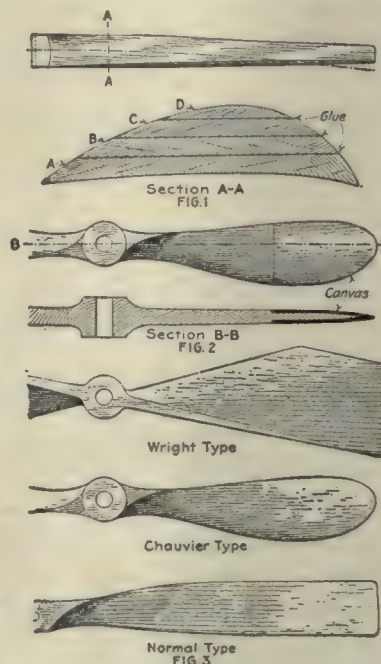
Since the propeller is made of many layers which are held together by glue, it is evident that this glue is also

subjected to stress, and it will be interesting to consider how the adhesive is affected.

The propellers bend in the direction of the motion of the aeroplane. One sees plainly in section AA that the layers, owing to manufacturing operations on the propeller, have greatly decreased in strength. The layer D has become much weaker than the others, and when the bending moment is acting we get different stresses in the different layers, since their cross-sections vary.

Layer A will therefore resist the bending stresses better than the others. The result is that the layers have a tendency to separate. For instance, the glue between layers C and D is subjected to more strain than that between B and C or A and B.

In view of the fact that the stresses act more unfavorably at the ends of the propeller, where adhesive conditions are the worst, it is not surprising that propeller fail-



DETAILS OF AEROPLANE-PROPELLER CONSTRUCTION

ures start at the ends by the parting of the various layers. This is true in regard to conditions resulting from torsion and centrifugal forces. The pulling stress is especially unfavorable to the adhesive material in propellers of large diameter. Those stresses which cause the layers to part, resulting in the failure of the propeller, can be counteracted by properly constructing the blades. A strong and lasting propeller can be obtained by eliminating these faults in construction. The propeller should be made from layers cut from the same piece of wood. The result will be a propeller with layers of uniform quality. If the layers are made from different kinds of wood, the possibilities are that one layer will not be so dry as another, affecting not only the glue but causing the layers to warp during construction.

In making the propeller care should be taken to make the adhesive surfaces as large as possible, thereby increasing the effect of the glue. In this respect the Wright or Chauvier type of propeller, where the ends are kept at the maximum width, are to be preferred to the normal type. The Chauvier type has another great advantage in that the front edge is bent backward more than the back is bent forward. This results in a perfect compensation of the

reaction stresses, since they are so divided over the surface of the propeller that the point of action of the forces working on the propeller is situated on the axis of inertia. The torsion and unfavorable vibrations are by this means eliminated.

Because the separation of the layers starts at the ends of the blades it is advisable to cover them with some material, preferably canvas. This is done in the following manner: The completely finished propeller, which is as yet unpolished, is cut down far enough at the tips of the blades to allow the space to be filled in with carefully glued canvas. After it is thoroughly dry and hard the propeller is polished. The canvas will hardly be noticeable and almost as smooth as the uncovered parts of the propeller.

In some types of hydro-aëroplane propellers, where the tips of the blades are likely to touch the water, copper plate can be used. These protecting copper shoes are fastened to the blades with rivets. This process has disadvantages, as it makes the balancing of the blades a difficult matter and also considerably weakens the propeller.

Hoboken, N. J.

B. Z. REITER.

✽

Young Men of Today--A Criticism

I have read Mr. Brophy's article, "Young Men of Today," with interest, and I want to ask him if he is sure that he has not somewhat lost his perspective of the "years gone by."

I must confess that I do not really know, but I am inclined to think that the wages paid, both to apprentices and office boys, have not advanced as much as for other work.

Isn't it true that older men, both those who have the power to set the wages and the men in the shop, are apt to think of what they got when they served their time and feel that that is about right? They forget that they are getting just about twice as much now as the men did in corresponding positions when they were boys.

Isn't it true that "in years gone by" apprentices and office boys were paid about as much as boys of the same age could get at any other work? I hardly think that it is true now. Piece work and the constant drive for production have tended to push up the earning power of the boys in the factory. They can hardly be blamed for going where they can make the most. I feel quite sure that boys of my generation, and Mr. Brophy's, did pretty much the same.

In other words I believe that it is conditions that have changed rather than the boys.

Conditions have changed in other respects also. It isn't only the boys who spend more time amusing themselves. Old people, on the whole, have more sources of amusement now than they had twenty-five or thirty years ago. Life is getting easier—that is, in the way of more conveniences and what used to be called luxuries.

As I look back—more years than I care to say—I cannot see that I and my friends were any less fond of amusements, or any more concerned with the future, than are the boys whom I have had working for me for the past ten years.

As for the office boy job, I have a strong notion that Mr. Brophy has in mind one or more shining lights of today who were office boys in their time. But really now, aren't you overlooking entirely the thousand and one

boys who have passed through the office and disappeared—many of them to be forgotten as promptly as possible? If you hunted round now wouldn't you find a whole lot of them are old, underpaid bookkeepers and clerks—several thousand to one who is president?

I believe that it makes mighty little difference where the bright ambitious boy starts—he will not stay there. I cannot see that the road to the president's office is any easier via apprenticeship and trade than through the production department. The boy on the last press may work up to be room foreman, and so on to the top. The boy driving a grocer's delivery wagon has the best opportunity in the world to learn the first steps in salesmanship—and good salesmen are better paid than good mechanics—and the sales department is just as good a road to the inner office as the shop.

I'll admit that the man of low, or average, ability and push is better off with a trade. The middle-aged man in the shop is paid better than the same man on the wagon. I do not think that that applies at all to the office boy, however, and you can hardly expect the boy of eighteen to look at it in just that light.

Of course the old style system of having apprentices bound by their parents is gone. I hardly think that Mr. Brophy would advocate its return—even though it did have its good points.

To get right down to brass tacks, why shouldn't the boys be paid as much in the shop as in the factory, or on the wagon? There is a popular assumption that they are being taught something and are really not worth their salt. But let the boss get out his cost-sheets and see if he can look himself in the eye and say that it is so. Personally I have found that the boys considerably more than "earned their salt," unless there were too many.

I will repeat what I said at first, that I am not sure about comparative wages now and years ago. I should like to know the facts on that point.

Plymouth, Mich.

W. B. GREENLEAF.

After reading Mr. Brophy's condolatory criticism on page 269, I think he is looking at the apprentice question from his own side of the fence. I'll take the young man's side.

The fundamental principle of the apprentice system was that it gave a monopoly of the trade to those who served their time; in other words, it restrained competition by the unskilled. Nowadays, anybody may claim having served an apprenticeship, and there is no way of disproving the statement where the goods are delivered. An apprentice, therefore, should be given other advantages and privileges in order to compensate him in some measure for the loss of his original one.

Let us take the question of earnings into consideration. Because of the low rate of wages paid to them, apprentices are in many cases dependent on their parents for food, lodging, clothing, etc.; and for this reason parents are often unwilling, or unable, to support a young man who earns only 70 to 80c. per ten-hour day, when he should be earning at the very least \$1.50 per day. This latter sum would enable him to pay for his board and clothing and allow him something for pocket money.

In the case of parents who *do* desire that their son learn a trade, a deterring reason is the matter of age. Fifteen or twenty years ago, if a boy was at all sturdily built, he could be taken into a shop when he was fourteen

years old, and because of his age he was held subject to his parents' wishes. Today, a young man must be eighteen years of age before many of the factories will take him, and at that time in life he can, and often does, set aside his parents' suggestions.

The inducements that will bring the best young men to your shops must be liberal. I will try to cite the principal ones: First, enough money to live on, at the very least \$22 a month for the first year; second, three years in some shops is too short a time for apprentices to serve, and four years seems too long. Why not split the difference, unless the young man can be afforded six months of drafting-room training? Twenty-eight hundred hours a year is all that an apprentice should be required to serve, whether he is paid by the hour or by the month. Remember that February has only twenty-eight days, that there are quite a few national or state holidays, and that an apprentice should work fifty-five hours a week.

No rule should prohibit an apprentice from leaving his machine or work place unless absolutely necessary.

He should be changed from one department to another every three months and be put on jobs that will be to his advantage.

Where possible, the apprentice should be allowed six months of training in the drafting room, and he should not be kept at filing prints for more than one week. That should be a long enough time for him to learn the location and method of finding any print he would have occasion to use. The chief draftsman should encourage the apprentice by giving him more important work as his ability increases. If it can be done, the apprentice should be allowed to spend a month each in the pattern shop, smith shop and foundry.

The apprentice should also be given some clerical work, as this experience would make him acquainted with the office end of the business. He should be given special work in preference to any one else, as work of this nature tends to develop his individuality.

The time that an apprentice may serve should count on any length-of-service record that may carry with it special privileges.

B. A. DONLEY.

Renovo, Penn.

How Would You Produce This Casting?

In replying to the question of how to make the casting illustrated on page 318, I submit the following two solutions.

First method: The pattern could be made with the parting line at AA, Fig. 1. It would then be an easy matter for the molder to take one-half of the pattern and place it on his molding board and ram up one-half of this flask. He would then turn it over and place the other half of his pattern and ram up the other half of his mold.

The molder would then remove one-half of his flask with the pattern, which would stay in the flask, owing to its construction. As the pattern is in the shape of an arc, he could readily draw each half of the pattern.

Second method: The simplest way to make the casting would be to split the pattern in the middle on the solid end, as shown in Fig. 2, and also make a support of 1/2-in. rod between the bosses fastened to each side (top and bottom) of the pattern.

The molder would use a two-part flask and would mold this with a cheek between the top and bottom of the pattern, as shown in the sketch.

In removing the pattern from the sand he would lift off his cope and remove one side of the pattern, replace

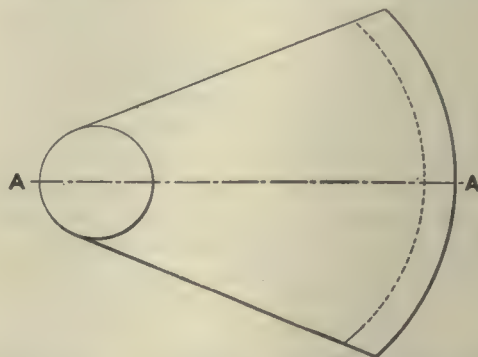


FIG. 1. PATTERN FOR FIRST PROPOSED METHOD

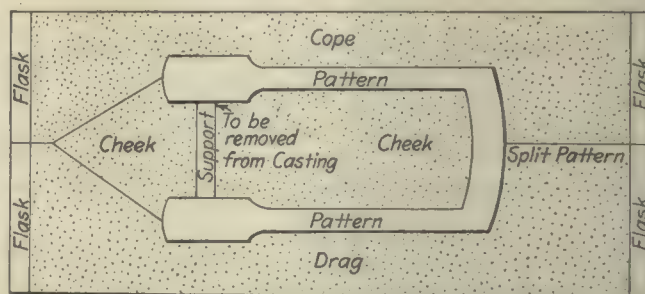


FIG. 2. ANOTHER SIMPLE PROPOSED METHOD USING A FORM OF SPLIT PATTERN

the cope and turn his flask over, and remove the other side of the flask and pattern the same as he did the cope.

After the casting is made, the small support between the bosses can be removed readily by a slight tap with a hammer.

A. E. HOLADAY.

Naugatuck, Conn.

Cutting Speeds and Feeds-- Erratum

In my article "Cutting Speeds and Feeds," pages 405-6, equation

$$V_a = V_b \sqrt{\left(\frac{F_a}{F_b}\right)^2}$$

should read

$$V_b = V_a \sqrt{\left(\frac{F_a}{F_b}\right)^2}$$

and

$$V_a = 240 \sqrt{\left(\frac{0.01}{0.006}\right)^2} = 336$$

should be

$$V_b = 240 \sqrt{\left(\frac{0.01}{0.006}\right)^2} = 336$$

Columbus, Ohio.

W. A. KNIGHT.

Editorials

Industrial Equivalent of War

The United States is receiving gold and securities from Europe in return for an enormous volume of raw materials, foodstuffs and manufactured articles that are being sent to the belligerent nations. Many of our industries are busy contributing to this stream of exports. But manufacturing conditions have not undergone any important change. Aside from some accumulation of skill in the manufacture of a few kinds of munitions it is doubtful if our industries possess anything today that they did not have on Aug. 1, 1914.

By contrast the machinery-building plants of Europe have learned much. They now understand thoroughly the principles and advantages of mass production; they know the results that flow from intense application in industry; they have had the stimulus that comes from a spirit of sacrifice; mechanical skill has been spread broadcast through classes of society that previously knew nothing about it—as among the women; they have utilized automatic machinery as never before; they have developed and applied special-purpose machinery in a way hitherto unknown; and they have learned the advantages in production in using highly developed small tools. Many of these things American shops have known and utilized for years. But “the new broom sweeps clean,” and it is possible—some say probable—that methods and machinery heretofore considered strictly American are now employed with greater effectiveness in the industries of Europe than has ever been the case in the shops of the United States.

When we contrast these two sets of conditions, we realize that European industry is gaining tremendously through the stress of war—and, on the other hand, that the United States has no equivalent for this war stimulus.

So far as can be seen, nothing from without will bring a new energizing of our forces here in America. If it cannot come from without, it must come from within. Are American manufacturers and workmen far-sighted enough and possessed of sufficient determination to advance our industries still further, so that the United States can hold her proper place among the nations of the world?

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Wasteful Economies in Large Corporations

Consolidations and mergers are considered more efficient than individual enterprises, and there is no question as to the economies that they should effect. But in too many cases the theorist and the systematizer have difficulty in showing the real saving by money actually in the bank. The careful observer does not have to seek far for some of the reasons.

Probably the weakest link in the whole chain—and this becomes weaker as the size of the corporation increases—is the lack of personal contact between the real executives

and those responsible for performance in detail. Or shall we say that authority is not given to executives as far down the line as necessary in order to secure best results? Here is a case in point.

The repair shop of one of the largest mills of a corporation, with a capitalization of more millions than one can readily count, is so miserably equipped with tools and appliances as to increase largely the cost of repairs every day of the year. The officials in charge of the mechanical departments have repeatedly asked for different equipment, but with no result. Nothing could be appropriated for shop equipment because it was desired to pile up a big surplus, cut a melon, or at least give the dear public the idea that a nice juicy one was in the icebox. So these excessive repair costs have been going on for several years. Having piled up the surplus, the shop was granted a small appropriation and immediately proceeded to buy such needed equipment as small chucks, etc.

Here is where the small shop with its personal contact between the owner or manager and all these details saves money over the large corporation. Until the systematizers work out some way in which the needs of the smaller departments can be supplied without waiting for the stock-selling end of the business the large corporation will not make the showing it ought in real economy over the smaller business. The case mentioned is unfortunately not an isolated one and seems to be a part of the present system of running big businesses, especially those in which the stock selling is considered as important as actual operation.

The trouble lies in not having executives with authority to make necessary expenditures right on the job at all points. There is too much reading of reports and not enough actual contact with conditions as they exist in the shops.

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Well Worthy of Imitation

From this day on, the name of the prime mover in an automobile using oil as fuel is “engine.” Popular usage has been applying the name “motor.” (To be consistent we should probably now say “engine car” instead of “motor car” and “motor vehicle.”) The recommendation for this use of the term engine is in a bulletin devoted to automobile nomenclature, just issued by the Society of Automobile Engineers. This pamphlet gives a list of over 600 separate names of the more important parts of automobiles. The work is not completed, for there are several groups still under consideration that will be reported upon at a later date.

The advantages of uniform names of automobile parts hardly need comment. Users will be better able to indicate articles needed for repairs and replacements. Manufacturers will benefit for the same reason. The entire industry will welcome anything that will put an end to the present chaotic condition, for seemingly each maker uses a different terminology.

A few of the recommendations are worth pointing out. "Bushing" instead of "bearing" is used for removable and renewable linings in a plain bearing. This bit of naming might well be applied in all kinds of machines. We should all be grateful for this classification of clutches: Plate clutch—one plate clamped between two others; disk clutch—more than three disks; dry disk clutch; lubricated disk clutch; cone clutch—leather faced, asbestos faced; expanding clutch. There follows a series of names for the individual parts of each type of clutch.

Another section that at once attracts attention is division 18, devoted to types of bodies. Sixteen are listed. Once these are adopted, a body-type name will have meaning. Today a person must be intimately acquainted with the product and designs of the various manufacturers in order to be conversant with the terminology peculiar to individual firms.

The *American Machinist* is heartily in favor of all these earnest attempts to bring about uniformity in the designation of machine parts. The suggestion has frequently appeared in these columns that machine tools might very properly be studied, first, to establish uniformity in type names, and second, to standardize construction and parts names. The youngest machine-building industry in the United States has shown what it can do with this particular problem. Cannot the machine-tool building industry follow? The example set is well worthy of imitation.



Council of National Defense Advisory Commission

On Oct. 11, President Wilson made public the names of the distinguished Americans who had been appointed members of the Advisory Commission of the Council of National Defense. Two engineers are among the number. In their selection nonpartisan engineering has again been honored and the door opened for still wider service in governmental affairs. One of the engineering appointees is Howard E. Coffin, of Detroit, Mich., whose earnest work for preparedness is so well known through his chairmanship of one of the committees of the United States Naval Consulting Board. He is still a member of that board and thus becomes the one who will connect the work already done in organizing our industries with further work that will be under the direction of the Council of National Defense.

The second engineer on the commission is Dr. Hollis Godfrey, of Philadelphia, Penn. Dr. Godfrey is a consulting engineer and since 1913 has been president of the Drexel Institute.

The medical member of the commission is Dr. Franklin H. Martin, of Chicago, Ill., who is a distinguished surgeon and was recommended by the Affiliated Medical Societies of the country. The banking member is Bernard Baruch, of New York City. The president of the Baltimore & Ohio R.R., Daniel Willard, of Baltimore, represents transportation interests. The labor member is Samuel Gompers, of Washington, president of the American Federation of Labor. The seventh and last member of the commission is Julius Rosenwald, of Chicago, president of Sears, Roebuck & Co. Mr. Rosenwald is widely known for his business interests and his widespread philanthropies.

In announcing the appointments the President outlined the chief functions of the council as follows:

1. The coordination of all forms of transportation and the development of means of transportation to meet the military, industrial and commercial needs of the nation.

2. The extension of the industrial mobilization work of the Committee on Industrial Preparedness of the Naval Consulting Board. Complete information as to our present manufacturing and producing facilities adaptable to many-sided uses of modern warfare will be procured, analyzed and made use of.

One of the objects of the council will be to inform American manufacturers as to the part they can and must play in national emergency. It is empowered to establish at once and maintain through subordinate bodies of specially qualified persons an auxiliary organization composed of men of the best creative and administrative capacity, capable of mobilizing to the utmost the resources of the country.

The personnel of the council's advisory members, appointed without regard to party, marks the entrance of the nonpartisan engineer and professional man into American governmental affairs on a wider scale than ever before. It is responsive to the increased demand for and need of business organization in public matters and for the presence there of the best specialists in their respective fields. In the present instance, the time of some of the members of the Advisory Board could not be purchased. They serve the Government without remuneration, efficiency being their sole object and Americanism their only motive.



Value of Actual Experience Often Overlooked

The making of the military rifle is an excellent example of a somewhat intangible factor in manufacturing which is too often overlooked, that of actual experience in handling the work and the machines on which it is performed. This is perhaps the most intangible thing in mechanical production, and yet it counts for more than we are apt to realize in securing accurate and rapid work.

That something more than drawings, specifications, machinery and men are needed has been clearly shown by the troubles experienced by the firms that have rifle contracts. No expense was spared to secure the best equipment and the best men available. But that something was lacking is evident from the difficulties encountered in actually turning out acceptable rifles after efforts extending over considerable periods.

Contrast this with the work of experienced men in shops with inferior equipment, and the value of experience at once becomes apparent. And it also makes it clear that there are things about an intricate machine that it is not possible to reduce to black and white on a card index; that the best of men must secure actual experience in the work before good results can be secured.

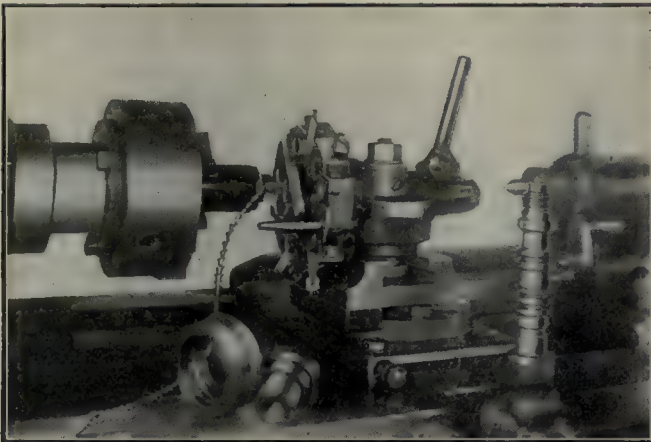
The experience of those who have attempted to build rifles in large quantities has shown the vast amount of time and money that must be spent in laying a foundation for the actual work itself. In too many cases this foundation has had to be rebuilt a number of times before it was satisfactory. Too often the element of experience has been overlooked, and theorizers on the way a shop should be run, men who were not familiar with the intricacies of the problem, placed in charge.

Shop Equipment News

Tool-Post Turret

The illustration shows a tool-post turret recently developed by the Universal Machine Works, 311 West 59th St., New York City.

This turret has six stations for turning, or external, tools and six stations for boring, or internal, tools. In-



TOOL-POST TURRET

dexing is by means of the lever shown in an elevated position at the rear. A 12-toothed ratchet with a pawl backed up by a heavy spring provides means for indexing the turret head and holds it against the forces set

up by the cut. The tool is carried in the tool slot, and a threaded sleeve provides vertical adjustment to accommodate it to lathes of various swing.

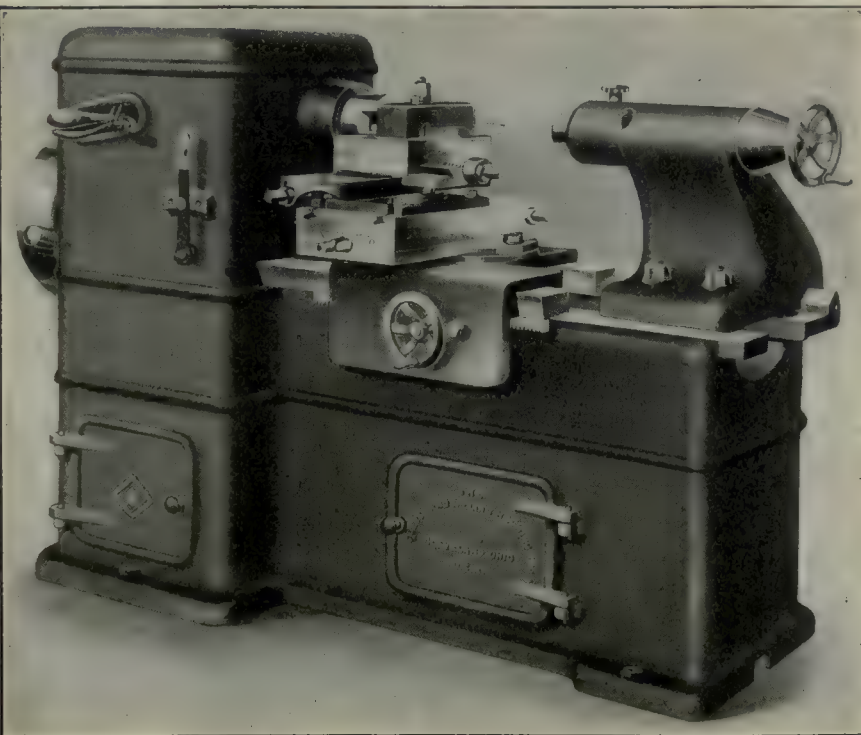
The turret is made of casehardened steel, and it is carried in a body of cast iron. The turning tools are carried in swiveling holders. A setscrew under the end of each turning tool provides vertical adjustment of the cutting edge for each individual tool. A special eccentric holder is also supplied to hold a cutting-off tool. On the piece of work shown to the right all of the tools in the turret were utilized.

✻

Cutter-Relieving Machine

The cutter-relieving machine shown, designed to give straight, side or end relief on all cutters that can be accommodated by the machine, is a recent product of the Cleveland Milling Machine Co., Cleveland, Ohio.

It will be observed that the box-type of construction has been generally applied. From the pulley the drive is through a set of reverse gears to a tumbler pinion, from which five selective spindle speeds are obtained, the drive being transmitted through a wormwheel of large diameter mounted directly upon the spindle. The machine can be started, stopped or reversed by manipulating a single hand-lever. The spindle is machined from a high carbon-steel forging and is $3\frac{1}{2}$ in. in diameter at the largest point. It runs in solid tapered phosphor-bronze bearings provided with means of compensation for wear. The taper hole in the spindle is No. 10 Brown & Sharpe, and the spindle is bored to accommodate a 1-in. draw bolt. Alignment of the tailstock is maintained through one 90-deg. V-way at the back of the bed. The tailstock may be locked in any desired position by two clamping bolts located in front of the tailstock. The carriage is gibbed longitudinally to the front bearing, and the apron is cast integral with the carriage. The longitudinal adjustment of the carriage is obtained by operating a hand-wheel, of which a single turn gives a longitudinal carriage movement of 1 in. A single-throw cam giving relief from zero to $\frac{3}{4}$ in. is carried by a cam-slide swivel plate that is adjustable to any degree desired. Tapered gibs are provided for taking up wear on all slides. The forming tool may quickly be positioned in the proper relation to the cutter by means of a double adjustable tool post graduated to 0.001 in. Provision is also made for bringing the cutter to be relieved in the proper relation to the form tool without loos-



CUTTER-RELIEVING MACHINE

Capacity, cutters up to $13\frac{1}{2}$ in. in diameter, any number of teeth from 1 to 28, any even number of teeth from 28 to 42; maximum tailstock adjustment, 7 in.; carriage longitudinal adjustment, maximum, 13 in.; pulley, 14 in. in diameter; belt, 3 in.; weight of machine, 7,000 lb.

ening the cutter on the arbor or loosening the change gears on the end of the machine. Corrugated adjustable wedges on top of the tool post provide for adjusting the amount of stock that is ground off the forming tool from $\frac{3}{4}$ to $\frac{1}{4}$ in.

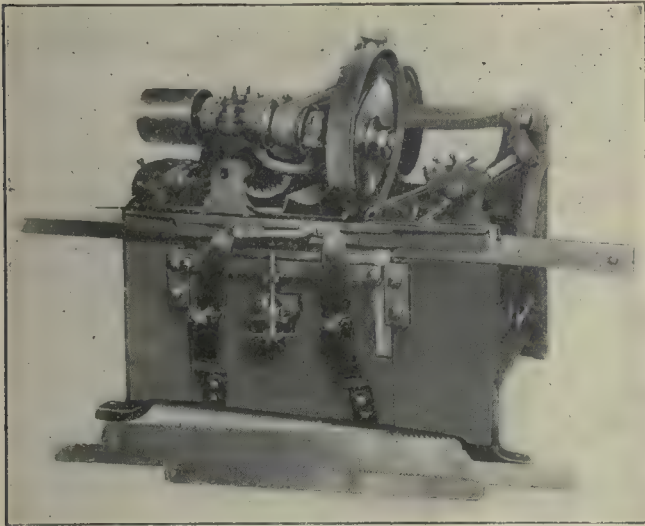
The machine may be motor-driven, in which case a 3-hp. constant-speed motor is employed, mounted on top of the headstock.

❧

Automatic Power Hacksaw Sharpening Machine

The machine shown was designed for reshaping power hacksaw blades and is of the fully automatic type, blades of the same width and number of teeth being fed through the machine without stoppage or the necessity of adjustments.

The iron frame is of one-piece construction, and all wearing parts are made of steel. The main-drive shaft



AUTOMATIC HACKSAW-BLADE SHARPENER

Capacity, blades 36 in. long with teeth up to 33 to the inch; floor space, 22x24 in.; weight, 260 lb.

runs in babbitted bearings, while the grinding-wheel bearings are bronze. The vise is of the spring type and has tension screws with locknuts.

From the main-drive shaft, which extends across the back of the machine, a belt transmits power to the shaft that drives the grinding wheel. This shaft is suspended at the end of an arm, the opposite end of which is supported between hardened-steel pivots on a segment. This allows the grinding-wheel head to be set at such an angle as to allow the edge or corner only of the grinding wheel to come in contact with the face of the tooth, and the opposite edge or corner on the back of the tooth, and by so doing the wheel through its action dresses itself by wear always to a knife-edge.

Two adjustments control the movements of this head: One governs the depth the grinding wheel is allowed to go into the gullet of the tooth; the other regulates the amount of cut to be taken from the back of the tooth. This last adjustment (the control of cut from the back of the tooth) is made by the adjustment screw coming in contact at the proper time with a roller that rides on a cam. This one cam controls all the different-shaped backs of teeth; where teeth are extremely shallow or deep, an adjustment permits raising or lowering the point of the cam.

Power is taken from the main-drive shaft, through a worm gear, to a shaft at the left-hand side of the machine, on the end of which shaft there is a slotted eccentric with a screw feed. This eccentric governs the movement or feed of the blade to the machine. There is a scale on the eccentric that is so marked that the proper feed adjustment can be quickly made.

The blade is positively fed through the machine by a double-pawl positive-feed movement. The pawl on the right draws the blade in and starts the grinding of the first tooth; that on the left draws the blade clear of the grinding wheel and discharges it. Where teeth are broken out, this double-pawl positive movement permits a continuous feed of the blade.

There is an adjustment on the front of the machine for raising the blade in the vise, thereby permitting a slightly heavier cut to be taken without changing the other adjustments.

The machine is a recent product of the Wardwell Manufacturing Co., Cleveland, Ohio.

❧

Compensated Recording and Indicating Pyrometers

The compensated recording pyrometer shown in Fig. 1 is automatic in action and may be arranged to give records from 1, 3, 6, 9 or 12 stations. The recording chart is 18 in. in diameter, and each record is individual and legible, as records of the various furnaces never cross or conflict.

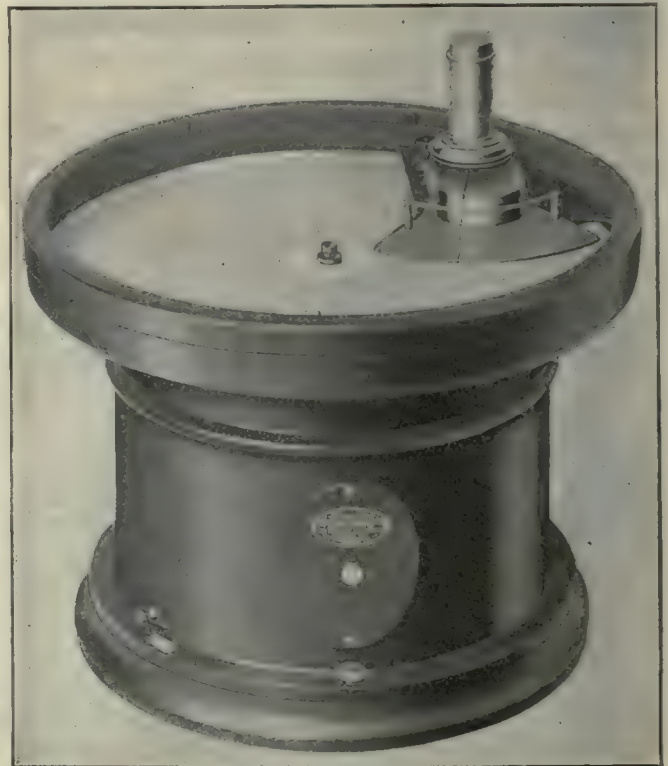


FIG. 1. COMPENSATED RECORDING PYROMETER

The method of suspension of the indicating needle is known as the "unipivot suspension." In this the moving element is suspended by a phosphor-bronze suspension supported by one sapphire jewel and steel pivot instead of the customary two pivots. Marking of the record is accomplished by means of a spark which occurs at the end of the galvanometer and which burns a small hole through the paper.

The resistance of the Beighlee pyrometer is 1,200 ohms, 1,144 of which is of manganin, which has no temperature coefficient, reducing the temperature-coefficient error to one-tenth of 1 per cent. for every 10 deg.

The cold-junction error is compensated by means of the wheatstone-bridge principle operated by a single dry-

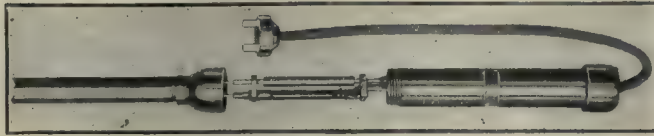


FIG. 2. COMPENSATOR OF THERMO COUPLE

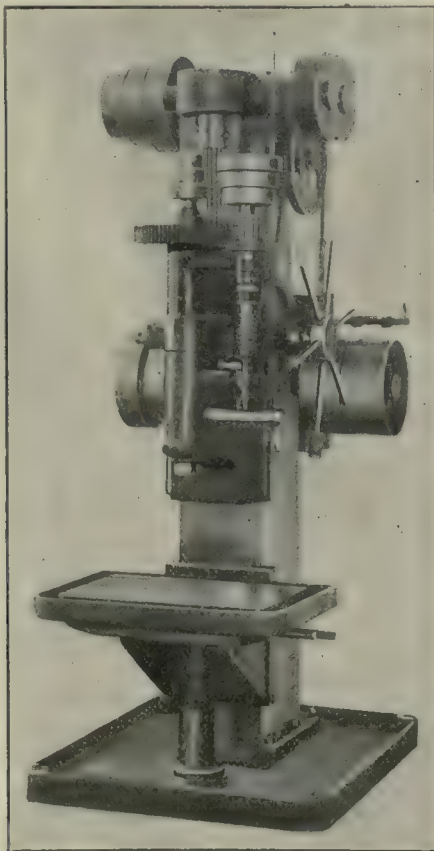
cell battery, the neutral point being 75 deg. F. The lead-resistance error is overcome by calibrating each lead, regardless of length, to a predetermined resistance.

This pyrometer is the product of the Beighlee Electric Co., Cleveland, Ohio.

Traversing-Head Drilling Machine

The heavy-duty single-spindle drilling machine shown is a recent addition to the line made by the Moline Tool Co., Moline, Ill.

The entire head is traversed by a double rack and pinion, the spindle running in bronze bushings, which are provided with adjustment for compensating for usual wear.



TRAVERSING-HEAD DRILLING MACHINE

Distance from center of spindle to face of column, 10 in.; maximum distance table to spindle, 34 in.; working face of table, 15x24 in.; vertical adjustment of table, about 15 in.; travel of head, about 18 in.; diameter of spindle in lower bearing, 2 1/8 in.; tight and loose pulleys, 12x5 in.

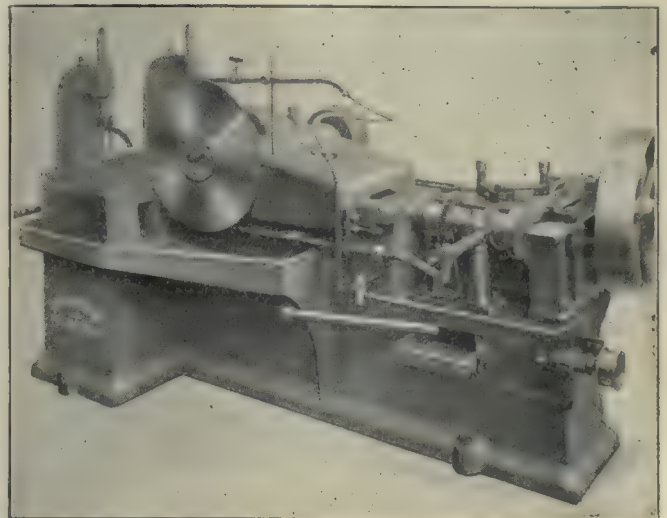
The spindle-drive gear is mounted directly on the spindle and is traversed along a wide-faced pinion, which is supported its entire length and runs in bronze bushings. The pinion is driven by steel and bronze spiral gearing.

Between the spiral pinion and the cone-pulley shaft there are change gears by which practically any range of speed can be obtained.

As shown, the machine is provided with belt feed, but a gear box can be supplied if desired.

Small Cold-Sawing Machine

The small cold-metal sawing machine shown is of the gear-feed type. The spindle revolves in capped bearings and is driven by spur gears through a worm and worm-wheel, the wormwheel being of solid bronze and the worm



COLD-METAL SAWING MACHINE

Capacity for solids up to 5 1/2 in. in diameter; blade, 20 in. in diameter

being fitted with roller thrust bearings. The feed screw is provided with a bearing to insure operation at a constant tension.

The saddle has solid cast underlocking gibs with vertical and horizontal adjustments secured by taper shoes. Fast power return for the saddle is provided in addition to a gear box that allows changes without the removal of gears. The saddle is fitted with trips to stop the feed at any predetermined point, and there are safety stops for each of the extreme positions of travel. The oil pans are cast solid with the base, the lubricant reservoir being located in the rear of the base. Pump, piping and attachments are supplied.

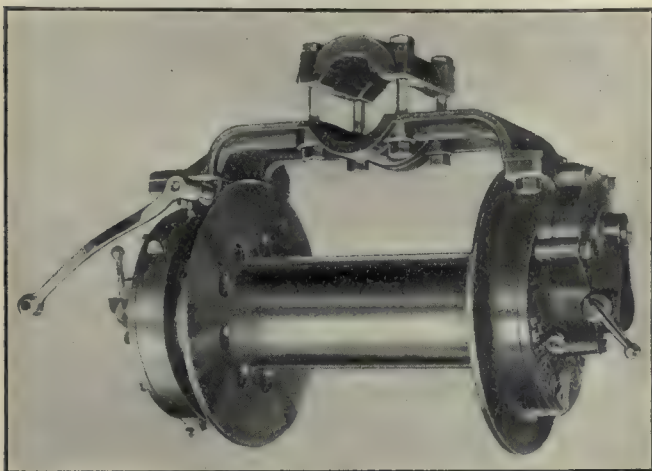
The machine is a recent addition to the line made by the Newton Machine Tool Works, Philadelphia, Penn.

Light Rope Hoist

For the use of those who prefer manila rope to wire rope for light hoisting and hauling, the Ingersoll-Rand Co., New York City, has brought out the model shown.

The square piston, reversible driving engine, automatic lubrication, inclosed gearing, drum-release clutch and worm-operated band brake are essentially the same as in the model that was described on page 477, Vol. 44. The main differences are in the diameter and the length of

the drum, the width of the flanges and, necessarily, the main frame and overall dimensions. The hoist is built for operation both by compressed air and steam. The



LIGHT ROPE HOIST

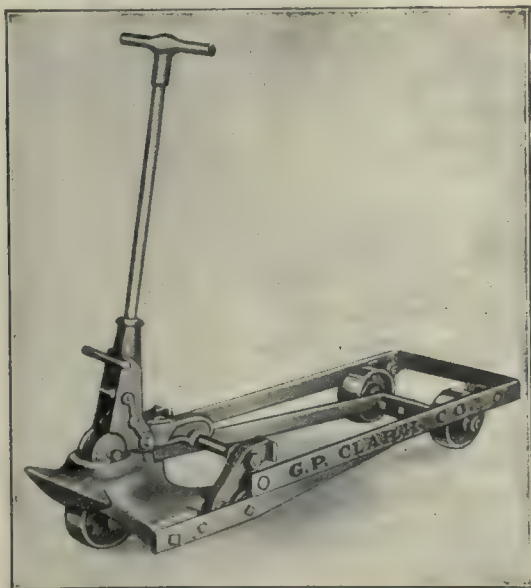
Hoisting drum, 7 in. in diameter, 17 in. long, 5-in. flanges; capacity, 300 ft. $\frac{3}{4}$ -in. manila rope; maximum capacity of hoist, 600 lb.; dimensions, 21 $\frac{1}{2}$ in. long, 31 $\frac{1}{4}$ in. wide, 23 in. high; weight, 358 lb.

standard clamp fits a column or pipe 4 $\frac{1}{2}$ in. in diameter, but by removing the clamp the hoist can readily be bolted directly to any convenient support, timber, flooring, etc.

Shop Transfer Truck

The shop truck shown is the latest addition to the line of such equipment made by the George P. Clark Co., Windsor Locks, Conn.

The truck is constructed entirely of metal. The frame, axles, rods and handle are of steel. The wheels are of



SHOP TRANSFER TRUCK

iron fitted with roller bearings. The handle is attached to the top of neap swivel, which is designed to permit sharp corners to be easily turned. A device, operated by the handle, raises and lowers the upper frame of the truck, while the same handle raises the load, is used to move the truck and lowers the load. This form of truck is made in a wide variety of sizes in capacities up to 2,500 lb.

A Tolerance System and Metric Conversion Tables

By M. S. WRIGHT

The work now being done on gun work in some sections has in many instances necessitated the translation of millimeters into inches. The tables given, which are more complete than any I have seen, have been compiled to make this operation easy through a large range.

While the metric system is simple in some ways, there is nothing to be gained by changing, especially if we use our "inch" and "foot" consistently and to the best

MILLIMETER EQUIVALENTS FOR INCHES

In.	0	1	2	3	4	5	6
0	0.00	25.40	50.80	76.20	101.60	127.00	152.40
1/64	0.40	25.80	51.20	76.60	102.00	127.39	152.79
1/32	0.79	26.19	51.59	76.99	102.39	127.79	153.19
3/64	1.19	26.59	51.99	77.39	102.79	128.19	153.59
1/16	1.59	26.99	52.39	77.79	103.19	128.59	153.98
5/64	1.98	27.38	52.78	78.18	103.58	128.98	154.38
3/32	2.38	27.78	53.18	78.58	103.98	129.38	154.78
7/64	2.78	28.18	53.58	78.98	104.38	129.78	155.18
1/8	3.17	28.57	53.97	79.37	104.77	130.17	155.57
9/64	3.57	28.97	54.37	79.77	105.17	130.57	155.97
5/32	3.97	29.37	54.77	80.17	105.57	130.97	156.37
11/64	4.37	29.77	55.16	80.56	105.96	131.36	156.76
3/16	4.76	30.16	55.56	80.96	106.36	131.76	157.16
13/64	5.16	30.56	55.96	81.36	106.76	132.16	157.56
7/32	5.56	30.96	56.36	81.75	107.15	132.55	157.95
15/64	5.95	31.35	56.75	82.15	107.55	132.95	158.35
1/4	6.35	31.75	57.15	82.55	107.95	133.35	158.75
17/64	6.75	32.15	57.55	82.95	108.34	133.74	159.14
9/32	7.14	32.54	57.94	83.34	108.74	134.14	159.54
19/64	7.54	32.94	58.34	83.74	109.14	134.54	159.94
5/16	7.94	33.34	58.74	84.14	109.54	134.94	160.33
21/64	8.33	33.73	59.13	84.53	109.93	135.33	160.73
11/32	8.73	34.13	59.53	84.93	110.33	135.73	161.13
23/64	9.13	34.53	59.93	85.33	110.73	136.13	161.53
3/8	9.52	34.92	60.32	85.72	111.12	136.52	161.92
25/64	9.92	35.32	60.72	86.12	111.52	136.92	162.32
13/32	10.32	35.72	61.12	86.52	111.92	137.32	162.72
27/64	10.72	36.11	61.51	86.91	112.31	137.71	163.11
1/2	11.11	36.51	61.91	87.31	112.71	138.11	163.51
29/64	11.51	36.91	62.31	87.71	113.11	138.51	163.91
15/32	11.91	37.31	62.71	88.10	113.50	138.90	164.30
31/64	12.30	37.70	63.10	88.50	113.90	139.30	164.70
1/2	12.70	38.10	63.50	88.90	114.30	139.70	165.10
33/64	13.10	38.50	63.90	89.30	114.69	140.09	165.49
17/32	13.49	38.89	64.29	89.69	115.09	140.49	165.89
35/64	13.89	39.29	64.69	90.10	115.49	140.89	166.29
9/16	14.29	39.69	65.09	90.49	115.89	141.28	166.68
37/64	14.68	40.08	65.48	90.88	116.28	141.68	167.08
19/32	15.08	40.48	65.88	91.28	116.68	142.08	167.48
39/64	15.48	40.88	66.28	91.68	117.08	142.48	167.88
5/8	15.87	41.27	66.67	92.07	117.47	142.87	168.27
41/64	16.27	41.67	67.07	92.47	117.87	143.27	168.67
21/32	16.67	42.07	67.47	92.87	118.27	143.67	169.07
43/64	17.07	42.46	67.86	93.26	118.66	144.06	169.46
1/2	17.46	42.86	68.26	93.66	119.06	144.46	169.86
45/64	17.86	43.26	68.66	94.06	119.46	144.86	170.26
23/32	18.26	43.66	69.05	94.45	119.85	145.25	170.65
47/64	18.65	44.05	69.45	94.85	120.25	145.65	171.05
3/4	19.05	44.45	69.85	95.25	120.65	146.05	171.45
49/64	19.45	44.85	70.25	95.65	121.04	146.44	171.84
25/32	19.84	45.24	70.64	96.04	121.44	146.84	172.24
51/64	20.24	45.64	71.04	96.44	121.84	147.24	172.64
13/16	20.64	46.04	71.44	96.84	122.24	147.63	173.03
53/64	21.03	46.43	71.83	97.23	122.63	148.03	173.43
27/32	21.43	46.83	72.23	97.63	123.03	148.43	173.83
55/64	21.83	47.23	72.63	98.03	123.43	148.83	174.22
7/8	22.22	47.62	73.02	98.42	123.82	149.22	174.62
57/64	22.62	48.02	73.42	98.82	124.22	149.62	175.02
29/32	23.02	48.42	73.82	99.22	124.62	150.02	175.42
59/64	23.42	48.81	74.21	99.61	125.01	150.41	175.81
15/16	23.81	49.21	74.61	100.01	125.41	150.81	176.21
61/64	24.21	49.61	75.01	100.41	125.81	151.21	176.61
31/32	24.61	50.01	75.41	100.80	126.20	151.60	177.00
63/64	25.00	50.40	75.80	101.20	126.60	152.00	177.40

advantage. It is not merely a question of translating measurements in the drafting room, but think what drive, force or running fits would be if expressed in millimeters. It would be Greek to the average mechanic for years to come.

The real difficulty of our system of measurements lies not with the system itself but with its application. Why should we express one distance as $\frac{3}{4}$ in. and another as 0.751 in.? The answer is that when the machinist or tool maker sees $\frac{3}{4}$ in. he at once knows that it is a scale measurement, except in some large machinery building factories where nothing but fractions are used; while 0.751 in. means that the tool maker must use some other method of measuring than the use of a scale. Even when only fractions are given on drawings the tool maker has to use micrometers to make some parts of a fixture

DECIMAL EQUIVALENTS OF MILLIMETERS

From $\frac{1}{16}$ to 100 Mm. Advancing by $\frac{1}{16}$ Mm.

Mm.	In.	Mm.	In.	Mm.	In.	Mm.	In.	Mm.	In.	Mm.	In.	Mm.	In.	Mm.	In.
0.1	0.00394	11.3	0.44488	22.4	0.88188	33.5	1.31889	44.6	1.75590	55.7	2.19290	66.8	2.62991	77.9	3.06692
0.2	0.00787	11.4	0.44881	22.5	0.88582	33.6	1.32283	44.7	1.75983	55.8	2.19684	66.9	2.63385	78.0	3.07086
0.3	0.01181	11.5	0.45275	22.6	0.88976	33.7	1.32676	44.8	1.76377	55.9	2.20078	67.0	2.63779	78.1	3.07479
0.4	0.01575	11.6	0.45669	22.7	0.89369	33.8	1.33070	44.9	1.76771	56.0	2.20472	67.1	2.64172	78.2	3.07873
0.5	0.01968	11.7	0.46062	22.8	0.89763	33.9	1.33464	45.0	1.77165	56.1	2.20865	67.2	2.64566	78.3	3.08267
0.6	0.02362	11.8	0.46456	22.9	0.90157	34.0	1.33858	45.1	1.77558	56.2	2.21259	67.3	2.64960	78.4	3.08660
0.7	0.02756	11.9	0.46850	23.0	0.90551	34.1	1.34251	45.2	1.77952	56.3	2.21653	67.4	2.65353	78.5	3.09054
0.8	0.03149	12.0	0.47244	23.1	0.90944	34.2	1.34645	45.3	1.78346	56.4	2.22046	67.5	2.65747	78.6	3.09448
0.9	0.03543	12.1	0.47637	23.2	0.91338	34.3	1.35039	45.4	1.78739	56.5	2.22440	67.6	2.66141	78.7	3.09841
1.0	0.03937	12.2	0.48031	23.3	0.91732	34.4	1.35432	45.5	1.79133	56.6	2.22834	67.7	2.66534	78.8	3.10235
1.1	0.04330	12.3	0.48425	23.4	0.92125	34.5	1.35826	45.6	1.79527	56.7	2.23227	67.8	2.66928	78.9	3.10629
1.2	0.04724	12.4	0.48818	23.5	0.92519	34.6	1.36220	45.7	1.79920	56.8	2.23621	67.9	2.67322	79.0	3.11023
1.3	0.05118	12.5	0.49212	23.6	0.92913	34.7	1.36613	45.8	1.80314	56.9	2.24015	68.0	2.67716	79.1	3.11416
1.4	0.05512	12.6	0.49606	23.7	0.93306	34.8	1.37007	45.9	1.80708	57.0	2.24409	68.1	2.68109	79.2	3.11810
1.5	0.05905	12.7	0.49999	23.8	0.93700	34.9	1.37401	46.0	1.81102	57.1	2.24802	68.2	2.68503	79.3	3.12204
1.6	0.06299	12.8	0.50393	23.9	0.94094	35.0	1.37795	46.1	1.81495	57.2	2.25196	68.3	2.68897	79.4	3.12597
1.7	0.06692	12.9	0.50787	24.0	0.94488	35.1	1.38188	46.2	1.81889	57.3	2.25590	68.4	2.69290	79.5	3.12991
1.8	0.07086	13.0	0.51181	24.1	0.94881	35.2	1.38582	46.3	1.82283	57.4	2.25983	68.5	2.69684	79.6	3.13385
1.9	0.07480	13.1	0.51574	24.2	0.95275	35.3	1.38976	46.4	1.82677	57.5	2.26377	68.6	2.70078	79.7	3.13779
2.0	0.07874	13.2	0.51968	24.3	0.95669	35.4	1.39369	46.5	1.83070	57.6	2.26771	68.7	2.70471	79.8	3.14172
2.1	0.08267	13.3	0.52362	24.4	0.96062	35.5	1.39763	46.6	1.83464	57.7	2.27164	68.8	2.70865	79.9	3.14566
2.2	0.08661	13.4	0.52755	24.5	0.96456	35.6	1.40157	46.7	1.83857	57.8	2.27558	68.9	2.71259	80.0	3.14960
2.3	0.09055	13.5	0.53149	24.6	0.96850	35.7	1.40550	46.8	1.84251	57.9	2.27952	69.0	2.71653	80.1	3.15353
2.4	0.09448	13.6	0.53543	24.7	0.97243	35.8	1.40944	46.9	1.84645	58.0	2.28346	69.1	2.72046	80.2	3.15747
2.5	0.09842	13.7	0.53937	24.8	0.97637	35.9	1.41338	47.0	1.85039	58.1	2.28739	69.2	2.72440	80.3	3.16141
2.6	0.10236	13.8	0.54330	24.9	0.98031	36.0	1.41732	47.1	1.85432	58.2	2.29133	69.3	2.72834	80.4	3.16534
2.7	0.10629	13.9	0.54724	25.0	0.98425	36.1	1.42125	47.2	1.85826	58.3	2.29527	69.4	2.73227	80.5	3.16928
2.8	0.11023	14.0	0.55118	25.1	0.98818	36.2	1.42519	47.3	1.86220	58.4	2.29920	69.5	2.73621	80.6	3.17322
2.9	0.11417	14.1	0.55511	25.2	0.99212	36.3	1.42913	47.4	1.86613	58.5	2.30314	69.6	2.74015	80.7	3.17715
3.0	0.11811	14.2	0.55905	25.3	0.99606	36.4	1.43306	47.5	1.87007	58.6	2.30708	69.7	2.74408	80.8	3.18109
3.1	0.12204	14.3	0.56299	25.4	0.99999	36.5	1.43700	47.6	1.87401	58.7	2.31101	69.8	2.74802	80.9	3.18503
3.2	0.12598	14.4	0.56692	25.5	1.00393	36.6	1.44094	47.7	1.87794	58.8	2.31495	69.9	2.75196	81.0	3.18897
3.3	0.12992	14.5	0.57086	25.6	1.00787	36.7	1.44488	47.8	1.88188	58.9	2.31889	70.0	2.75590	81.1	3.19290
3.4	0.13385	14.6	0.57480	25.7	1.01181	36.8	1.44881	47.9	1.88582	59.0	2.32283	70.1	2.75983	81.2	3.19684
3.5	0.13779	14.7	0.57873	25.8	1.01574	36.9	1.45275	48.0	1.88976	59.1	2.32677	70.2	2.76377	81.3	3.20078
3.6	0.14173	14.8	0.58267	25.9	1.01968	37.0	1.45669	48.1	1.89369	59.2	2.33070	70.3	2.76771	81.4	3.20471
3.7	0.14566	14.9	0.58661	26.0	1.02362	37.1	1.46062	48.2	1.89763	59.3	2.33464	70.4	2.77164	81.5	3.20865
3.8	0.14960	15.0	0.59055	26.1	1.02755	37.2	1.46456	48.3	1.90157	59.4	2.33857	70.5	2.77558	81.6	3.21259
3.9	0.15354	15.1	0.59448	26.2	1.03149	37.3	1.46850	48.4	1.90550	59.5	2.34251	70.6	2.77952	81.7	3.21653
4.0	0.15748	15.2	0.40157	26.3	1.03543	37.4	1.47243	48.5	1.90944	59.6	2.34645	70.7	2.78346	81.8	3.22046
4.1	0.16141	15.3	0.60236	26.4	1.03936	37.5	1.47637	48.6	1.91338	59.7	2.35039	70.8	2.78739	81.9	3.22440
4.2	0.16535	15.4	0.60629	26.5	1.04330	37.6	1.48031	48.7	1.91732	59.8	2.35432	70.9	2.79133	82.0	3.22834
4.3	0.16929	15.5	0.61023	26.6	1.04724	37.7	1.48425	48.8	1.92125	59.9	2.35826	71.0	2.79527	82.1	3.23227
4.4	0.17322	15.6	0.61417	26.7	1.05118	37.8	1.48818	48.9	1.92519	60.0	2.36220	71.1	2.79920	82.2	3.23621
4.5	0.17716	15.7	0.61810	26.8	1.05511	37.9	1.49212	49.0	1.92913	60.1	2.36613	71.2	2.80314	82.3	3.24015
4.6	0.18110	15.8	0.62204	26.9	1.05905	38.0	1.49606	49.1	1.93306	60.2	2.37007	71.3	2.80708	82.4	3.24408
4.7	0.18503	15.9	0.62598	27.0	1.06299	38.1	1.49999	49.2	1.93700	60.3	2.37401	71.4	2.81101	82.5	3.24802
4.8	0.18897	16.0	0.62992	27.1	1.06692	38.2	1.50393	49.3	1.94094	60.4	2.37794	71.5	2.81495	82.6	3.25196
4.9	0.19291	16.1	0.63385	27.2	1.07086	38.3	1.50787	49.4	1.94488	60.5	2.38188	71.6	2.81889	82.7	3.25590
5.0	0.19685	16.2	0.63779	27.3	1.07480	38.4	1.51180	49.5	1.94881	60.6	2.38582	71.7	2.82283	82.8	3.25983
5.1	0.20078	16.3	0.64173	27.4	1.07873	38.5	1.51574	49.6	1.95275	60.7	2.38975	71.8	2.82677	82.9	3.26377
5.2	0.20472	16.4	0.64566	27.5	1.08267	38.6	1.51968	49.7	1.95669	60.8	2.39369	71.9	2.83070	83.0	3.26771
5.3	0.20866	16.5	0.64960	27.6	1.08661	38.7	1.52361	49.8	1.96062	60.9	2.39763	72.0	2.83464	83.1	3.27164
5.4	0.21259	16.6	0.65354	27.7	1.09054	38.8	1.52755	49.9	1.96456	61.0	2.40157	72.1	2.83857	83.2	3.27558
5.5	0.21653	16.7	0.65747	27.8	1.09448	38.9	1.53149	50.0	1.96850	61.1	2.40550	72.2	2.84251	83.3	3.27952
5.6	0.22047	16.8	0.66141	27.9	1.09842	39.0	1.53543	50.1	1.97243	61.2	2.40944	72.3	2.84645	83.4	3.28346
5.7	0.22440	16.9	0.66535	28.0	1.10236	39.1	1.53936	50.2	1.97637	61.3	2.41338	72.4	2.85039	83.5	3.28739
5.8	0.22834	17.0	0.66929	28.1	1.10629	39.2	1.54330	50.3	1.98031	61.4	2.41732	72.5	2.85432	83.6	3.29133
5.9	0.23228	17.1	0.67322	28.2	1.11023	39.3	1.54724	50.4	1.98425	61.5	2.42125	72.6	2.85826	83.7	3.29527
6.0	0.23622	17.2	0.67716	28.3	1.11417	39.4	1.55118	50.5	1.98818	61.6	2.42519	72.7	2.86219	83.8	3.29920
6.1	0.24015	17.3	0.68110	28.4	1.11810	39.5	1.55511	50.6	1.99212	61.7	2.42912	72.8	2.86613	83.9	3.30314
6.2	0.24409	17.4	0.68503	28.5	1.12204	39.6	1.55905	50.7	1.99606	61.8	2.43306	72.9	2.87007	84.0	3.30708
6.3	0.24803	17.5	0.68897	28.6	1.12598	39.7	1.56299	50.8	1.99999	61.9	2.43700	73.0	2.87401	84.1	3.31101
6.4	0.25196	17.6	0.69291	28.7	1.12991	39.8	1.56692	50.9	2.00393	62.0	2.44094	73.1	2.87794	84.2	3.31495
6.5	0.25590	17.7	0.69684	28.8	1.13385	39.9	1.57086	51.0	2.00787	62.1	2.44488	73.2	2.88188	84.3	3.31889
6.6	0.25984	17.8	0.70078	28.9	1.13779	40.0	1.57480	51.1	2.01180	62.2	2.44881	73.3	2.88582	84.4	3.32283
6.7	0.26377	17.9	0.70472	29.0	1.14173	40.1	1.57873	51.2	2.01574	62.3	2.45275	73.4	2.88976	84.5	3.32677
6.8	0.26771	18.0	0.70866	29.1	1.14566	40.2	1.58267	51.3	2.01968	62.4	2.45669	73.5	2.89369	84.6	3.33070
6.9	0.27165	18.1	0.71259	29.2	1.14960	40.3	1.58661	51.4	2.02361	62.5	2.46062	73.6	2.89763	84.7	3.33464
7.0	0.27559	18.2	0.71653	29.3	1.15354	40.4	1.59054	51.5	2.02755	62.6	2.46456	73.7	2.90156	84.8	3.33857
7.1															

or machine, and he has to transpose the fraction into a decimal first. For instance, when he tries to measure a $\frac{29}{64}$ stud with a pair of micrometers, this diameter is a farce.

Why, then, should we any longer mix things by the use of fractions and decimals, if the decimals have to be used for certain measurements? Why not follow that system all the time? One-half inch could just as well be expressed 0.5 in. or $\frac{3}{8}$ in., 0.37 in. Then there are some factories that follow the following practice: $\frac{3}{4}$ in.—0.001. This is often done on a shaft or a bearing.

Suppose we were to use decimals entirely, never using fractions. We could then express scale dimensions in one or two places, as 0.5 in. and 0.87 in.

The question of where to draw the line between three and four decimal places is much disputed. Why not establish a system of tolerances which would automatically take care of the number of places to carry a decimal? One which has worked out very satisfactorily is where any decimal is expressed in three places the tolerance is 0.001. Half of this tolerance may be each side of the nominal or basic figure. For example, 0.500 in. would indicate that the workman could make the dimension so indicated 0.4995 in. or 0.5005 in. Any decimal expressed in four places, as 0.3750 in., indicates that the tolerance of only 0.0001 is permissible, half of which may be each side of the basic figure, 0.37495 or 0.37505 in.

But should it be necessary to have the tolerance all in one direction, the decimal may be followed by a plus or a minus sign indicated thus: —0.3750+, meaning 0.3751 maximum and 0.3750 minimum. A $\pm$ sign would mean 0.3749 in. minimum or 0.3751 in. maximum, as usual.

Should it be desired to have the tolerance more than can be obtained automatically by the number of places

expressed in the decimal, then that figure may be followed by the desired tolerance in thousandths, indicated by the plus or minus sign. Thus, 0.8750 + 12 in. indicates that the piece may be 0.8750 or 0.8762 in.

Annual Meeting of Machine Tool Builders Association

The fifteenth annual convention of the National Machine Tool Builders Association will be held October 24 and 25 at the Hotel Astor, New York City.

The program for this annual convention does not contain any technical papers but will include reports of all standing committees and two addresses of general interest by Frank F. Dresser and James A. Emery.

Exports of Metal-Working Machinery

	July, 1916	August, 1916	July, 1916	August, 1916
France.....	1,922,740	1,950,786	Cuba.....	49,447
Germany.....			Haiti.....	12
Russia in Europe..	2,378,070	1,870,655	San Domingo.....	2,608
United Kingdom..	1,333,000	1,416,322	Argentina.....	12,043
Other Europe.....	939,236		Brazil.....	1,929
Canada.....	652,488	130	Chile.....	12,277
Australia.....	99,054	67,627	Colombia.....	1,944
Denmark.....		21,163	Ecuador.....	253
Finland.....		800	British Guiana.....	194
France.....		1,950,786	Peru.....	3,207
Italy.....		506,877	Uruguay.....	1,995
Netherlands.....		77,026	Venezuela.....	90
Norway.....		42,851	China.....	458
Portugal.....		2,645	British India.....	7,619
Spain.....		120,757	Dutch East India.....	1,079
Sweden.....		34,030	Japan.....	7,359
Bermuda.....		5	Persia.....	678
British Honduras..		20	Ru. Asia.....	2,03
Canada.....		130	Siam.....	15,252
Costa Rica.....		738	Australia.....	240
Guatemala.....		2,230	New Zealand.....	67,027
Nicaragua.....		8	Philippine Islands..	5,140
Panama.....		5,205	British South Afr.....	1,784
Salvador.....		1,761	Portuguese Africa.....	29,544
Mexico.....		3,287	Egypt.....	439
Newfoundland.....		84	Other Countries.....	10,681
Jamaica.....		279		
Trinidad.....		29		
Other British West Indies..		60	Total.....	7,814,691 6,292,850

Personals

Robert R. McKechnie, who has acted for many years as mechanical engineer and assistant to the general manager of the Variety Iron and Steel Works Co., Cleveland, Ohio, has resigned.

B. D. Gray, for several years manager of the Hess-Bright Manufacturing Co., Philadelphia, Penn., was elected president, succeeding F. E. Bright, who will continue to act as chairman of the board of directors.

Obituary

Leigh Stanley Bache, first vice-president and general manager of the Bound Brook Oil-Less Bearing Co., Bound Brook, N. J., died on Sept. 28, 1916.

Samuel Newbold Trump, president of the Trump Bros. Machine Co., Wilmington, Del., died in that city on Oct. 5, aged 81 years. Owing to advanced age Mr. Trump had been inactive for several years past.

James H. Anthony, connected with the Brown & Sharpe Manufacturing Co. during recent years, who in the early days was general superintendent of the Providence Tool Co. and its successor, the Household Sewing Machine Co., died at his home in Providence, R. I., on Oct. 7. Mr. Anthony was 76 years of age.

Business Items

Vulcan Steel Products Co., New York City, has been organized to specialize on foreign steel products business. Otto Kafka is general manager of the concern and has surrounded himself with a corps of associates trained in the steel industries.

The Doehler Die-Casting Co. announces the removal of its brass-back bearing department from

the Brooklyn to its Toledo plant. An entire new factory building, housing foundry and machine shop, fully equipped, is devoted to the exclusive manufacture of the "Doehler" babbit-lined brass-back bearings.

The New Departure Manufacturing Co., Bristol, Conn., held a barbecue and field day on Sept. 30, in which 2,700 employees of the company participated. The company furnished everything for the day, the arrangements for which were in the hands of a committee of the New Departure Mutual Relief Association, and the action of DeWitt Page, president of the company, in authorizing the festival, was signally appreciated.

The Inter-Continental Machinery Corporation has just been organized with headquarters in the City Investing Bldg., New York City, to act as machinery agents. The organization is headed by Charles N. Thorn, until recently vice-president of the Allied Machinery Co. of America. The other officers consist of Joseph S. Clark of E. W. Clark & Co., Philadelphia; R. E. Robinson, of R. E. Robinson & Co., bankers, New York, and C. B. Overbaugh, formerly manager of Thompson-Starrett Co., Washington, D. C., vice-presidents, and Arthur M. Watkins, secretary. Mr. Watkins is to take charge of the domestic business. It is planned to open offices in Russia, Paris, London, China and Japan.

Trade Catalogs

Taps, Dies, Reamers, Gages, Threading Machines, etc. Greenfield Tap and Die Corporation, Greenfield, Mass. Catalog No. 37, pp. 270, 5x7 in. This catalog includes the tools made by the Wells Bros. Co., the Wiley & Russell Manufacturing Co. and the A. J. Smart Manufacturing Co.

Swedish Gages. Swedish Gage Co., Inc., 22 West 61st St., New York. Catalog, pp. 44, 8½x11 in. In addition to a complete illustrated description of the Johansson gaging system, commonly known as Swedish gages, this catalog presents an abundance of information on the application of such gages to tool-room and other classes of precision work.

Forthcoming Meetings

National Machine Tool Builders' Association. Annual convention, Oct. 24-25, Hotel Astor, New York City. Charles E. Hildreth, general manager, Worcester, Mass.

American Society of Mechanical Engineers. Annual meeting, Dec. 5-8, Engineering Building, New York City. Calvin W. Rice, secretary, 29 West 39th St., New York City.

American Society of Mechanical Engineers. Monthly meeting, first Tuesday. Calvin W. Rice, secretary, 29 West 39th St., New York City.

Boston Branch National Metal Trades Association. Monthly meeting on first Wednesday of each month, Young's Hotel. W. W. Poole, secretary, 40 Central St., Boston, Mass.

Providence Association of Mechanical Engineers. Monthly meeting, fourth Wednesday of each month. J. A. Brooks, secretary, Brown University, Providence, R. I.

New England Foundrymen's Association. Regular meeting, second Wednesday of each month, Exchange Club, Boston, Mass. Fred F. Stockwell, 205 Broadway, Cambridgeport, Mass.

Engineers' Society of Western Pennsylvania. Monthly meeting, third Tuesday; section meeting, first Tuesday. Elmer K. Hiles, secretary, Oliver Building, Pittsburgh, Penn.

Rochester Society of Technical Draftsmen. Monthly meeting, last Thursday. O. L. Angevine, Jr., secretary, 857 Genesee St., Rochester, N. Y.

Superintendents' and Foremen's Club of Cleveland. Monthly meeting, third Saturday. Philip Frankel, secretary, 310 New England Building, Cleveland, Ohio.

Western Society of Engineers, Chicago, Ill. Regular meeting, first Wednesday evening of each month, excepting July and August. J. H. Warder, secretary, 1785 Monadnock Block, Chicago, Ill.

Philadelphia Foundrymen's Association. Meetings first Wednesday of each month. Manufacturers' Club, Philadelphia, Penn. Howard Evans, secretary, Pier 45 North, Philadelphia, Penn.

Technical League of America. Regular meeting, second Friday of each month. Oscar S. Teale, secretary, 35 Broadway, New York, N. Y.

Toolroom, Hardening Room and Laboratory for Dies*

By EDWARD DEAN†

SYNOPSIS—The machine-tool and bench equipment of the toolroom, a few tool-making methods, the furnace and pyrometer equipment of the die-hardening room and the complete equipment of the laboratory used for studying die steels. The latter includes a microscope mounted over a special, graduated table which is carried on cross-slides with vernier graduations, and apparatus for taking both full-size photographs and microphotographs.

A preceding article outlined the general results that have come from a long study of the conditions surrounding the making of high-duty dies. This article takes

maximum service. A consideration of this equipment naturally divides into three groups: That used in the tool-making room, that provided for hardening and tempering, and that necessary for laboratory study. These three groups will be taken up in the order named.

Turning to the illustrations, the first three, Figs. 1 to 3, show the tool-making department, and give an idea of the general arrangement of the room, the setting of the machine tools, the provisions for benchwork and the means for providing artificial illumination. One feature of the concrete building construction is the flat ceiling. To this, countershaft stringers are attached with a minimum drop, thus avoiding all deep pockets for shadows and dust such as are always present with a beam-and-girder

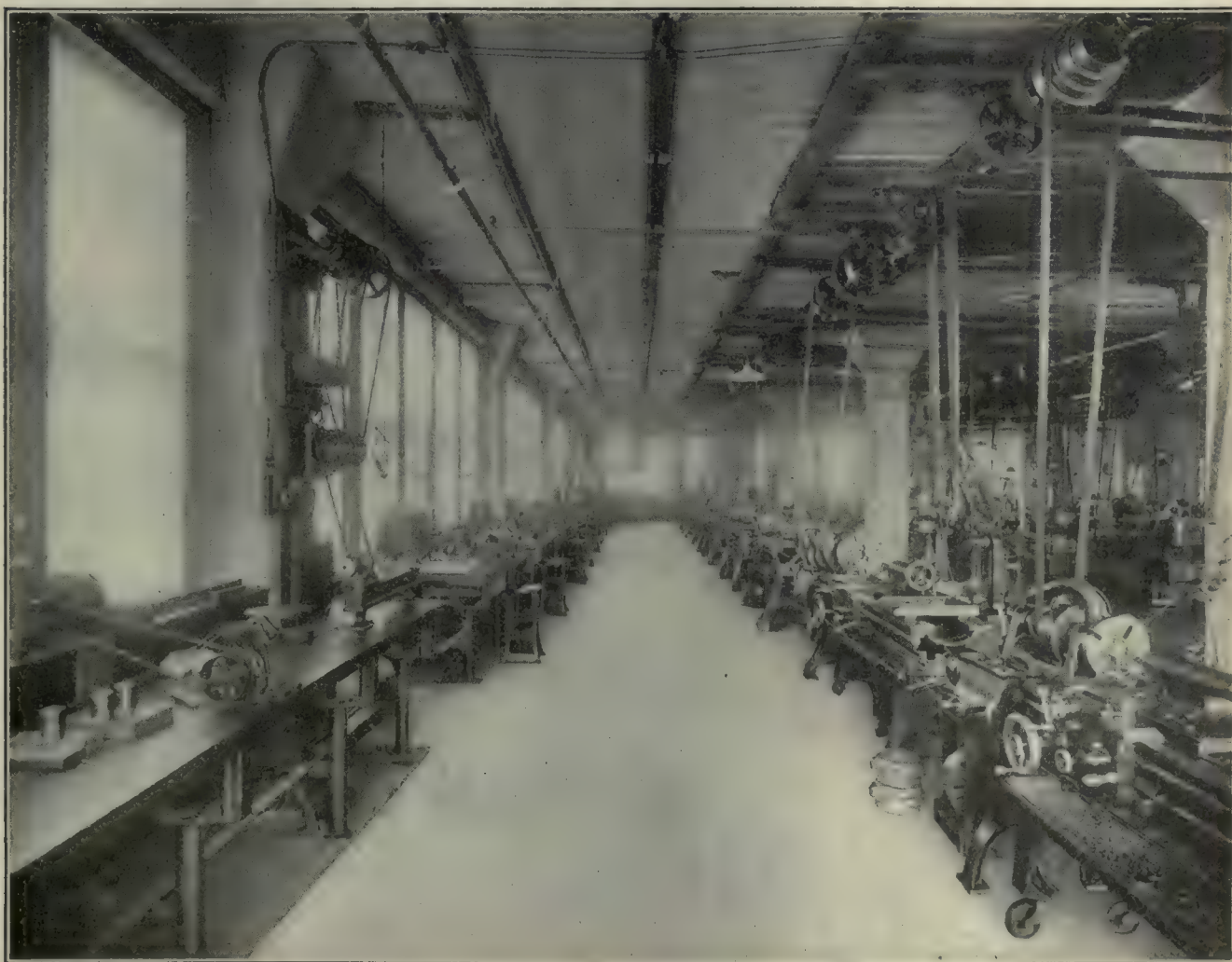


FIG. 1. LATHE AND BENCH AISLE OF TOOL- AND DIE-MAKING ROOM

up in detail the machine and laboratory equipment that is in daily use in the making of such dies, and in the study of die steels and the more hidden factors that make for either failure or success in producing press tools for

construction. This type of ceiling affords an excellent reflecting surface for both natural and artificial light, is easily illuminated, and is at all times pleasing in appearance. Figs. 1 and 3 give an excellent idea of its advantageous features. A study of these views will show the means employed to attach the various kinds of overhead fixtures, including the countershaft harness work,

*The first installment of the article on die making written by Mr. Dean was published on page 661.

†Superintendent, Century Electric Co.

the back-boards for electric wiring, the piping of various kinds, including that for the sprinkler system, and the line shafting. Iron tee slabs are embedded in the concrete ceiling on a spacing of 3 ft. centers crosswise of the building, and 4 ft. centers lengthwise. Similar tee slots are set in all four faces of the interior columns and in the inner faces of the exterior columns. Figs. 1, 2 and 3 also show the arrangement of machine tools, a striking feature of which is the broad aisles, wide spacing and ample working space around each machine. The bench construction can be seen in Figs. 1 and 3. The benches are of standard construction paralleling the windows and, in addition to carrying vises and bench plates, are also provided with smaller tools such as bench lathes and filing machines. One each of the two latter are shown at the left in Fig. 1. In my first article I mentioned the development of tool making methods which practically eliminate all filing, and whereby the accuracy of the dies comes from the machine work. Fig. 4 shows a set-up for milling the grooves in the periphery of a lamination die. The miller centers are set up on a base that gives them the right pitch for the clearance in the bottom of the slot. The first cut is made straight through with an ordinary milling cutter, and is for the purpose of removing the stock only. After this cut is completed the regular milling cutter is replaced by a specially formed cutter resembling a regular gear cutter. Three cuts are taken with this special cutter. The first is straight through and of the proper depth. The other two are on each side of the opening, with the centers and work shifted to give the required side clearance. This work can be done so that no filing is needed to give the required accuracy to the die openings. Smoothing the working surfaces and removing the burrs is all that is necessary. In a similar fashion all round holes are machine-finished. The smaller ones are taper-reamed from the back side of the die and the larger ones are finished by grinding after the die is hardened. Some of the advantages of the sectional construction are indicated by this brief description of some of the machining methods.

Turning now to the hardening room, it will be remembered that in my first article I commented upon the difficulty of obtaining suitable furnaces and accurate pyrometers. Fig. 5 shows four gas-fired furnaces used for hardening all of the carbon-steel tools and the high-speed steel tools that are not heated in a barium chloride bath. The furnace for this bath was installed after the photograph from which this view was made had been

taken. Its location is in the farther corner near the positive-pressure blower that supplies air to the furnaces.

All of these furnaces are connected to the indicating pyrometer that is on the small stand in the foreground. A switch at the near end of the stand permits any fur-

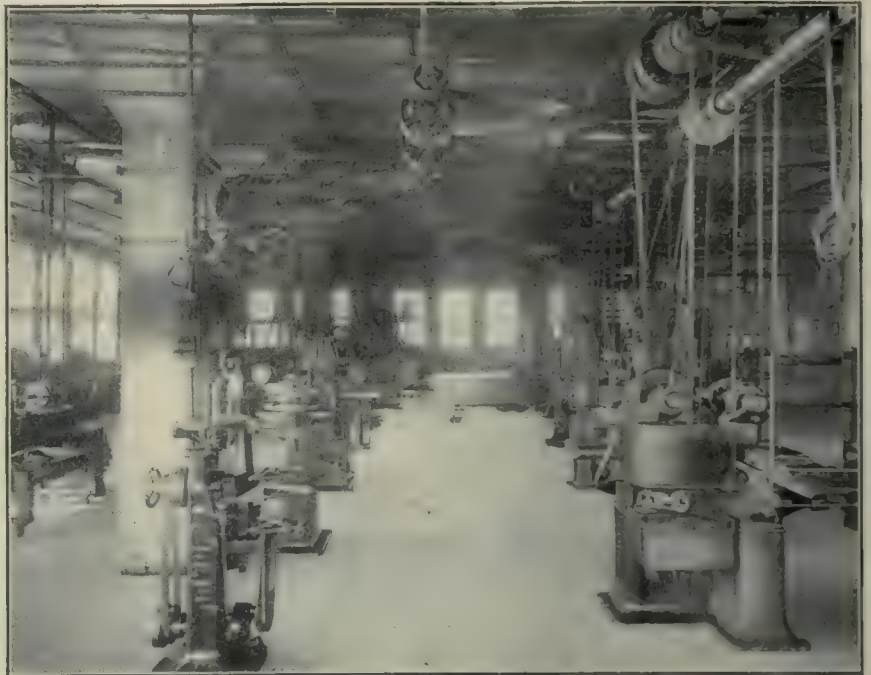


FIG. 2. GENERAL MACHINE AISLE OF TOOL- AND DIE-MAKING ROOM



FIG. 3. MILLER AND BENCH AISLE OF TOOL- AND DIE-MAKING ROOM

nance to be connected to the pyrometer at will. The cold junctions of the thermo-couples are surrounded by circulating water to keep them at a uniform temperature. These junctions are inclosed in the straight run of piping that can be seen above each furnace. Connected to this piping is a three-legged loop, each branch of which has a shut-off valve. By proper setting of these valves the water can be circulated around each cold junction, or it can be by-passed from all but one for special tests.

Above the pyrometer is a thermometer in the water-circulating system to give the actual temperature of the cold junctions. This pyrometer outfit, though very accurate and sensitive, is not used to determine the actual quenching heats of the dies and tools. It is used, however,

of the die is heating too rapidly, he can shut off his fuel supply, wait until the temperature has equalized throughout the tool, then turn on the fuel again, bring the furnace temperature to the determined point and watch until the piece is properly heated for quenching. By this

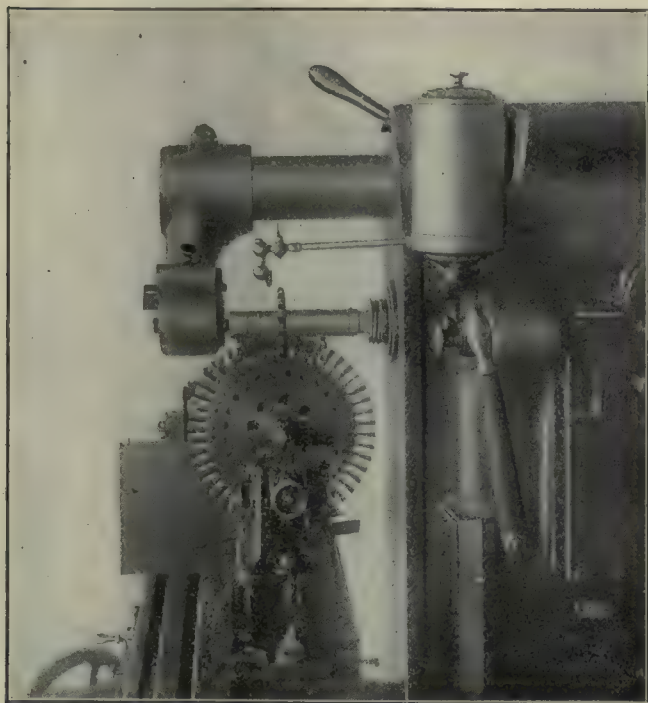


FIG. 4. MILLER SET-UP FOR CUTTING SLOTS IN A LAMINATION DIE



FIG. 6. OIL-DRAWING TANKS AND EXHAUST PIPING

method of hardening the heating of every piece is a matter of skill and judgment on the part of the hardener, and the conditions under which he observes his heats are fixed and uniform. He cannot overheat to do serious damage. No blind reliance is placed in the pyrometer or any other measuring instrument.

Fig. 6 shows the oil-drawing tanks covered by a hood from which the fumes are mechanically exhausted. Each

tank is provided with a high-reading thermometer. For handling sectional dies such as were illustrated in the previous installment on this subject a special dipping basket has been found necessary. This consists of two pieces of $\frac{1}{8} \times 1\frac{1}{4}$ -in. flat steel fastened together to form a right-angled cross. The upper edges of these pieces are beveled to an edge having a land of about $\frac{3}{16}$ in. The grooves are also cut through the upper edges to permit circulation of water and to prevent the possibility of covering any of the small holes in the die. The die to be hardened is placed on this framework with its lower face down, and wires are passed over it and hooked into holes in the ends of the $\frac{1}{8} \times 1\frac{1}{4}$ -in. strips. The hardener then picks up this basket by slipping a poker under the cross-wires, this affording an easy and sure means of handling the die while it is being heated and quenched. It is obvious that tongs could not be used on such a built-up die when it was

heated, because of the danger of misplacing some of the small parts. This special hardening basket is shown in Fig. 7.

Much more difficulty was met with in collecting the apparatus for the laboratory than in finding the machines and appliances for the toolroom and hardening department. Fig. 8 shows a general view of the laboratory

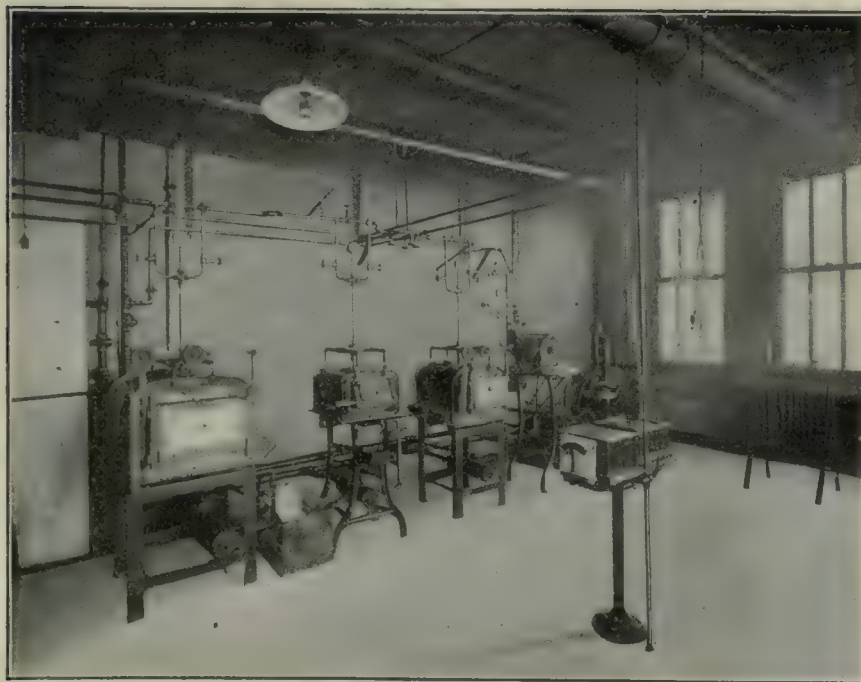


FIG. 5. TOOL-HARDENING ROOM, FURNACES AND PYROMETER

to maintain a uniform previously determined furnace temperature. The purpose of this is to standardize the light conditions inside of the furnaces so that the hardener will have constant conditions from which to gage the heating of his work. The actual heating of the work is gaged by the eye through the peep hole in the oven door of the furnace. Should the hardener notice that one part

with many of the instruments spread out on the table. This room has also undergone some change since the photograph used for Fig. 8 was taken. When the microscope began to be used for large magnifications it was found that the vibration in the shop due to external causes, such as the passing of street cars and trucks, was sufficient to make the use of the instrument unsatisfactory. The first step toward modifying this condition was to make a large cast-iron floorplate weighing about a ton. Upon this the table carrying the microscope was mounted. However, things were not much improved. The most recent step has been to mount a rigid platform from the cast-iron base and put the observer's chair upon it. Previous to this the chair had been standing on the floor. This last arrangement has proved satisfactory for observing magnifications up to 1,000 to 1,200 diameters.

A detailed view of the microscope and its mounting is shown in Fig. 9. A cast-iron base supports the microscope, a special table for holding specimens and a vertical bar that carries the camera. As shown in Fig. 9 a die conceals the table. However, this is round, having a diameter of 7 in. with its periphery graduated into

The complete table is mounted on cross-slides accurately set at right angles to each other. Each has a scale and

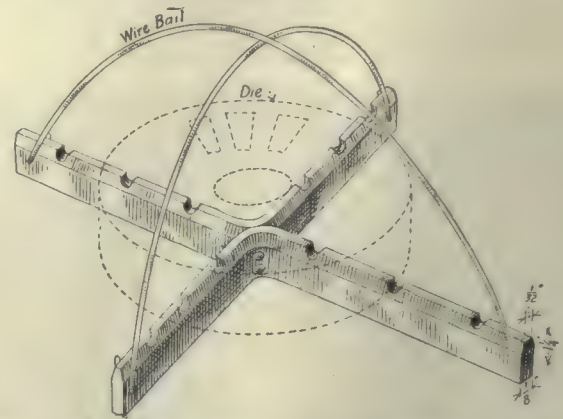


FIG. 7. DIPPING BASKET USED FOR SECTIONAL DIES

vernier permitting settings to be made to 0.001 in. A set of index centers to be used for measuring taps, plug gages and similar work is also part of the equipment.



FIG. 8. LABORATORY AND APPARATUS USED TO STUDY DIE STEELS

degrees, and is provided with a small worm and wheel actuated by the upper crank-handle shown in Fig. 9. The worm can be disengaged by a small lever, thus permitting the table to be revolved by hand. A vernier permits readings to be made to minutes of arc.

The microscope is provided with several eye-pieces that permit of a range of magnification from 16 diameters to 1,800 diameters. A micrometer eye-piece having a disk with 100 divisions is also part of the equipment. One revolution of this disk gives an actual displacement of

0.003 in. The accuracy and ease of both setting and measuring with this microscope may be judged from these adjustments.

Turning back to Fig. 9, at the extreme right is an arc lamp to illuminate the specimen; behind this and

picion that a lot of commercial taps are too brittle. The machine is also used on steel specimens, usually rounds or squares $\frac{1}{4}$ in. in diameter or smaller.

The shop and laboratory equipment that has just been described has been of assistance in working out some of



FIG. 9. MICROSCOPE, LAMPS, CAMERA AND SPECIAL MICROSCOPE BASE USED IN STUDYING DIE STEELS

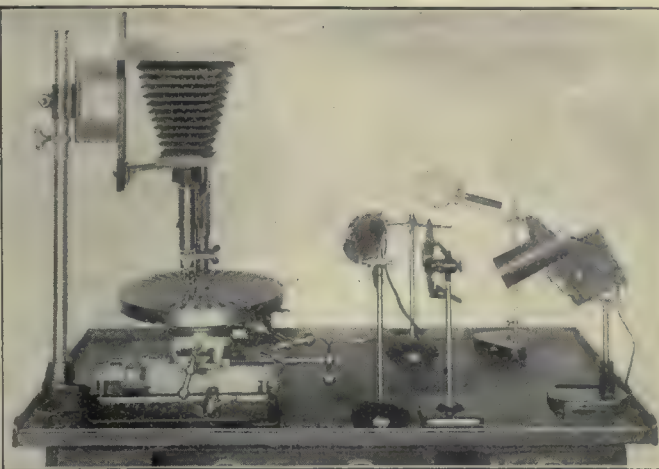


FIG. 10. CAMERA ARRANGED FOR TAKING A MICRO-PHOTOGRAPH OF DIE-STEEL SPECIMEN

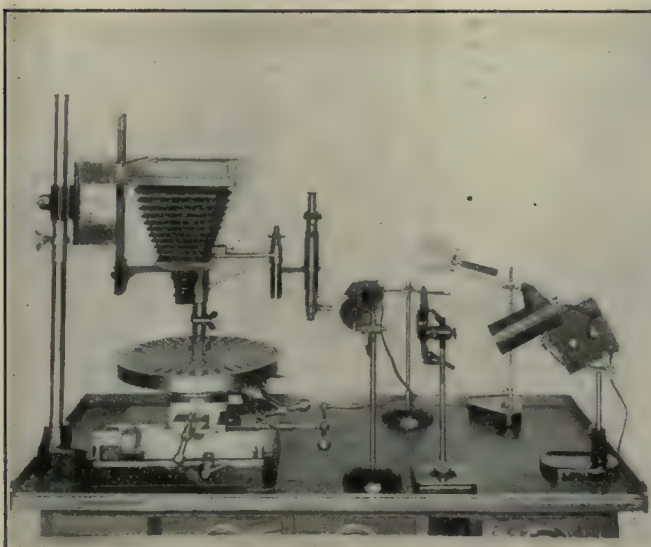


FIG. 11. MICROSCOPE AND CAMERA ARRANGED TO TAKE FULL-SIZE PHOTOGRAPHS

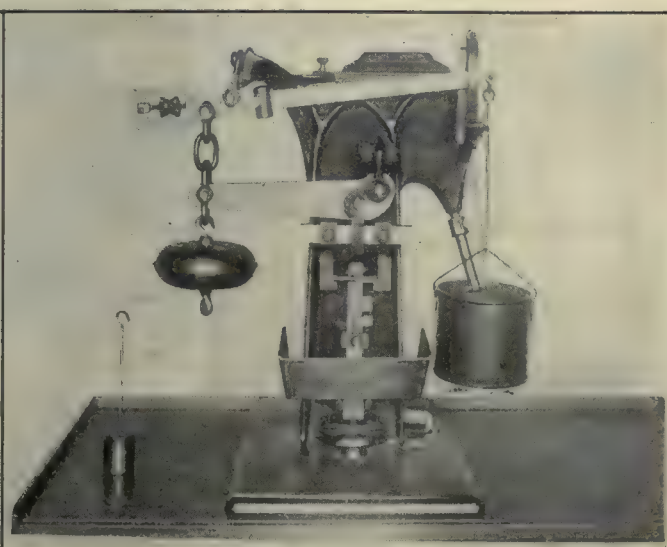


FIG. 12. MACHINE FOR TESTING BRITTLINESS—MADE FROM CEMENT-TESTING MACHINE

a little toward the left is a reading glass for setting the specimen; next toward the left is an illuminating stand carrying an iris diaphragm to regulate the light of the arc lamp, and next to that at the left is a bull's-eye lens. The small stand directly at the right of the microscope is an incandescent lamp used for setting.

Figs. 10 and 11 show this same equipment somewhat differently arranged. In Fig. 10 the microscope is shown focused on a spot on the die, and in position above it is the camera ready to take a microphotograph. The largest size of plate that can be used in this camera is a 5x7-in. Fig. 11 shows the microscope swung to one side and the camera in position to take a full-size photograph.

Another part of the laboratory equipment is shown in Fig. 12. This is a machine to study the brittleness of steel specimens and was made from a cement-testing machine. A tap is shown in position for cross-breaking. This test is occasionally employed where there is a sus-

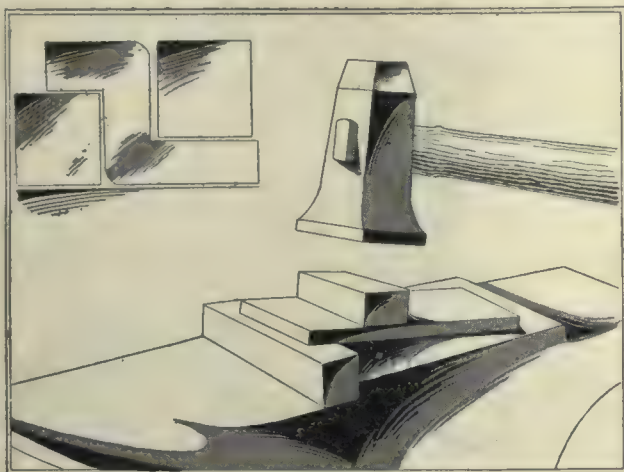
the principles of die design and die-steel treatment that must be observed if uniformly successful dies are to be produced. My next article will give these principles and show how they are applied in practice.

✻

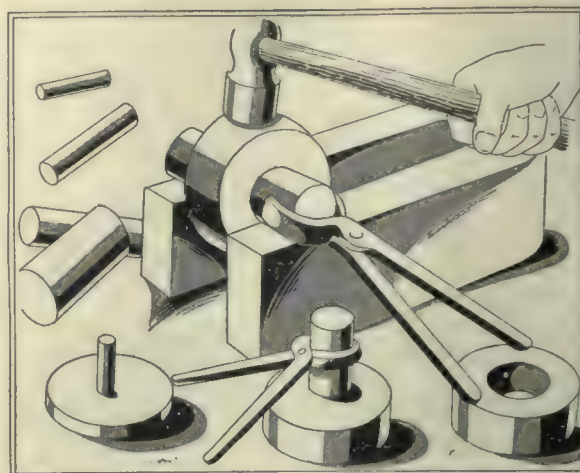
Example of Concentrated Thought—A superannuated master car builder, who was recuperating in our office one day, remarked: "Theories are very good in their place, but they do not teach a person how to drive a nail. Nothing but practice will do that, and even practice without the proper thought will fail to accomplish it. You must have both combined. When you drive a nail into a board, what do you do? Do you trust to luck that the swinging hammer above your head shall come down on the right spot? Do you concentrate your thoughts on the hammer circling in the air? No. You concentrate your thoughts and eyes square on the head of the nail you want to hit, and no matter where your hammer is or what course it describes in the air, if your intense thought is on the spot where the blow should fall, then there it will fall. If your thoughts wobble and are uncertain, you will miss the nail or drive it sidewise."—"Railway and Locomotive Engineering."

From a Small-Shop Notebook

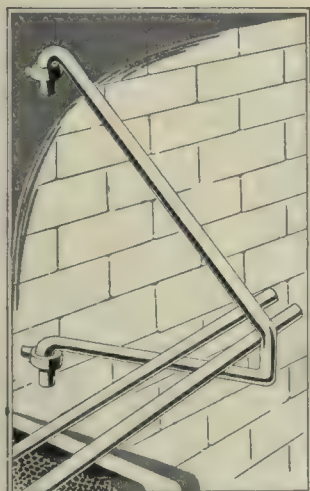
BY JOHN H. VAN DEVENTER



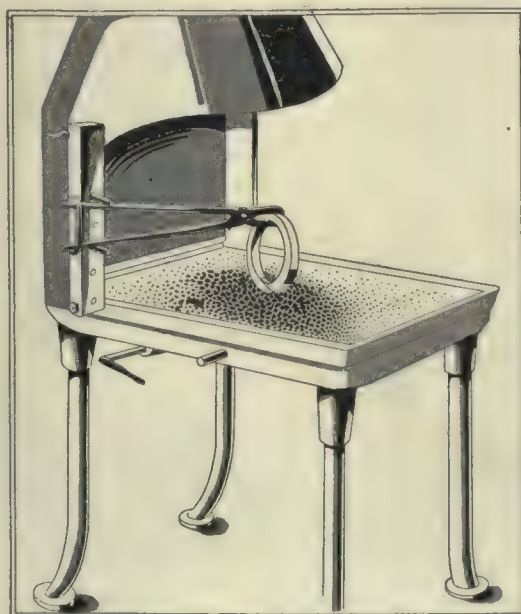
BENDING WITH FLATTER AND BLOCKS



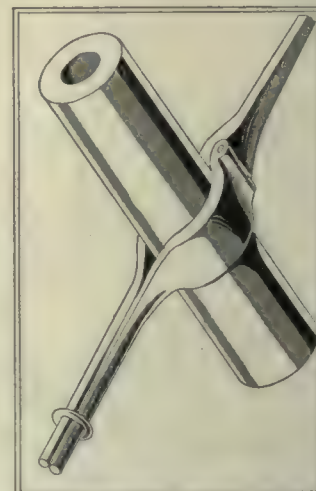
ONE METHOD OF MAKING RINGS



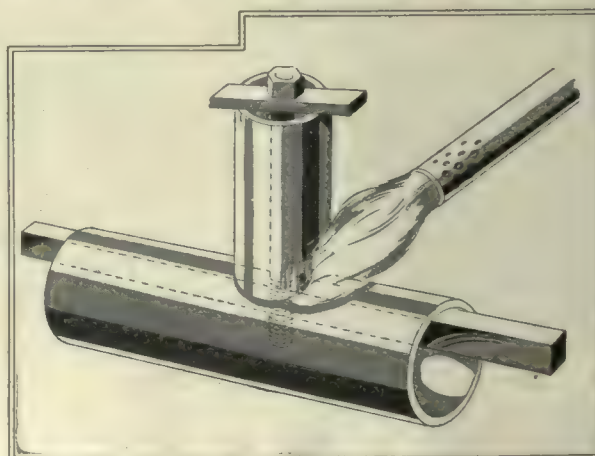
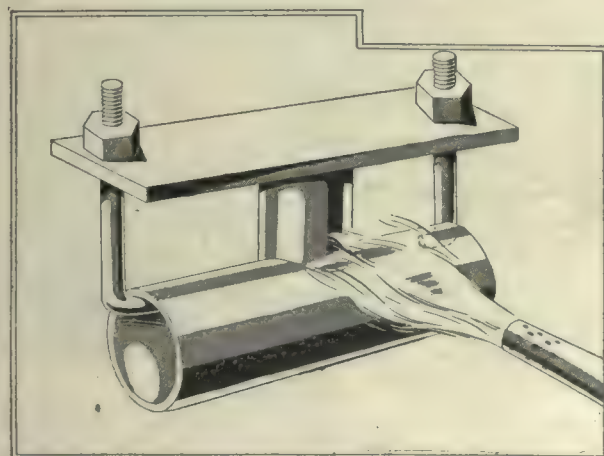
KEEPS THE BAR STOCK
HIGH AND DRY



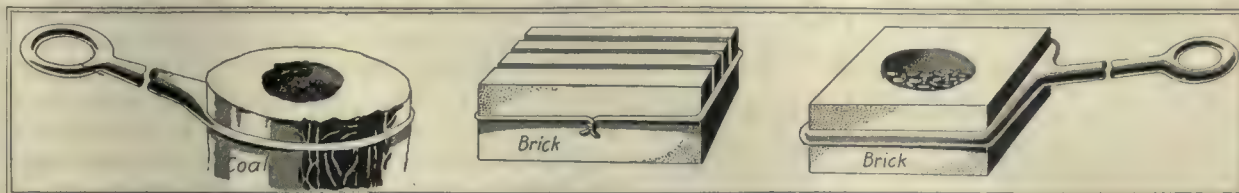
THE SMALL-SHOP SMITH'S HELPER



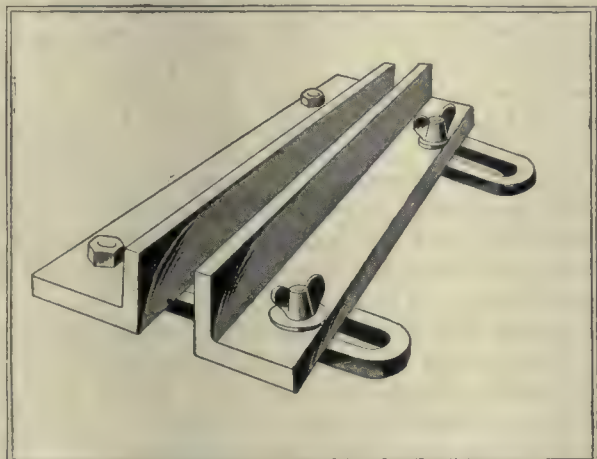
DOUBLE-END TONGS THAT
WILL NOT SLIP



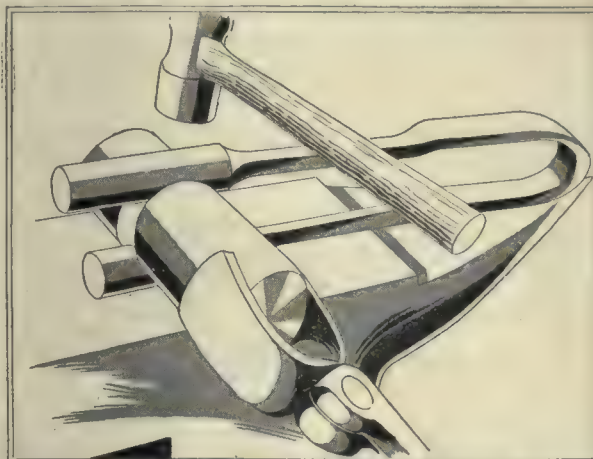
TWO LITTLE DEVICES THAT COME IN HANDY WHEN BRAZING PIPE
THE SMALL-SHOP BLACKSMITH IS A BUSY MAN



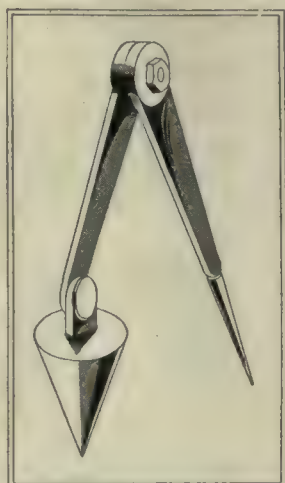
FOR HEATING SMALL PARTS THESE SIMPLE TRICKS ARE USEFUL



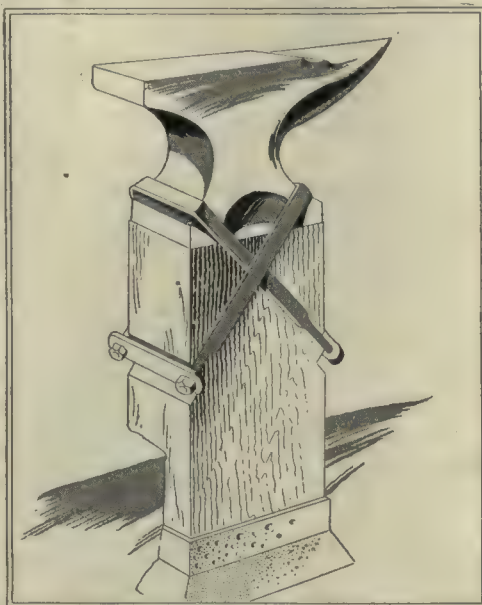
BLACKSMITH'S TAPER GAGE



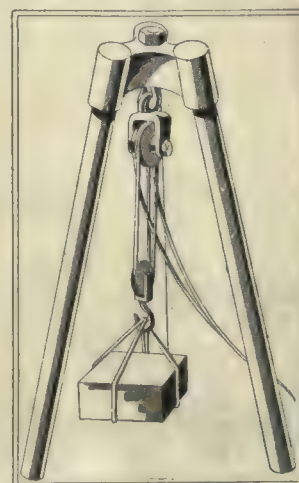
SPRING FULLERS ARE HANDY



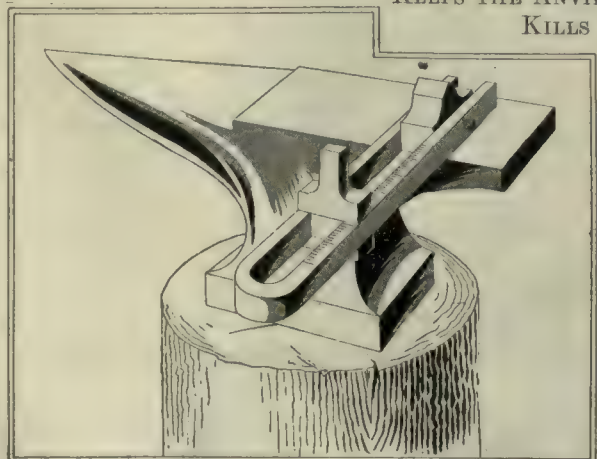
DIVIDERS FOR RING WORK



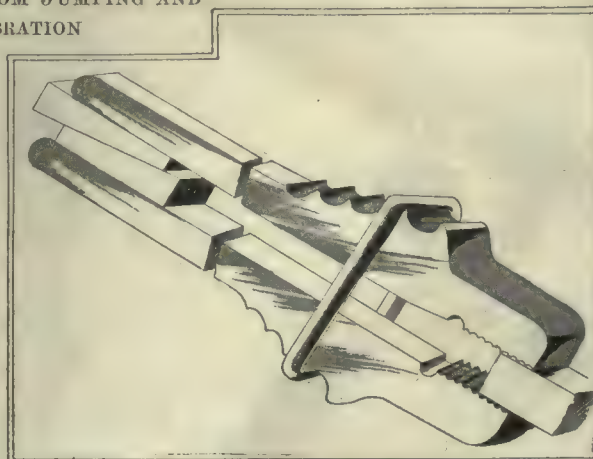
KEEPS THE ANVIL FROM JUMPING AND KILLS VIBRATION



CRANE MADE FROM IRON PIPE



STOCK-MEASURING GAGE FOR ANVIL



THESE TONGS TAKE A LARGE OR A SMALL BITE

THESE USEFUL KINKS WILL HELP HIM SAVE MONEY

Circular Cutter for Making Annular Grooves

BY WILLIAM A. HAWES

Face or end forming cutters that can be reground without altering their shape, working in conjunction with or taking the place of circular forming tools of the standard type, can be used to advantage on any screw-machine or chucking-lathe jobs. In a variety of drill-press operations also this style of cutter can be utilized, the first cost being little more than that of the familiar flat cutter keyed into a slot through a bar, and the length of service far greater.

In cases where something more than a plain countersink or counterbore is to follow a drill, as in making oil grooves

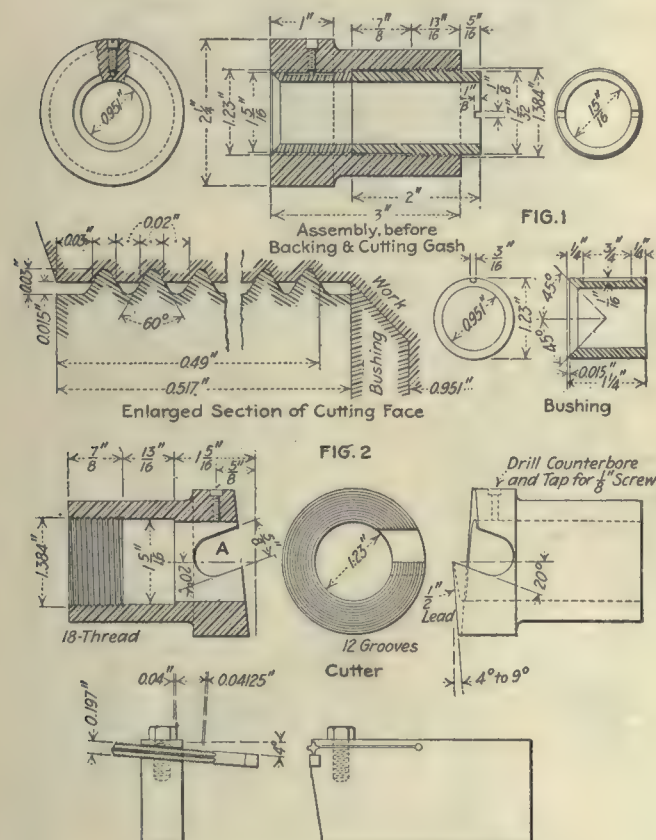


Fig. 3 Lathe Tool for Grooving Cutter

THE SERRATED CUTTER AND THE TOOL FOR SERRATING IT

in thrust bearings or packing rings in a flange or the like, the merits of a forming tool that can be restored to shape by grinding the cutting face are obvious. For taking heavy cuts or for machining pieces not having the convenient center hole or stem from which to "pilot" the cutter, the idea suggested could be carried out in cutters with two or more cutting faces.

The tool illustrated in Fig. 1 is for cutting the 12 circular grooves in the face of a fuse body, an aluminum casting with a projecting stem 0.950 in. in diameter in the center, formed at its base to an angle of 45 deg.

The bushing in the cutter runs over this stem with 0.001-in. clearance, keeping the tool and work concentric and determining the depth of the grooves turned. The setscrew through the cutter bearing on the bottom of the slot in the bushing prevents the bushing from revolving

or working forward. The thrust is taken by the threaded sleeve, screwed into the cutter and bearing on the back of the bushing, which is of course adjustable.

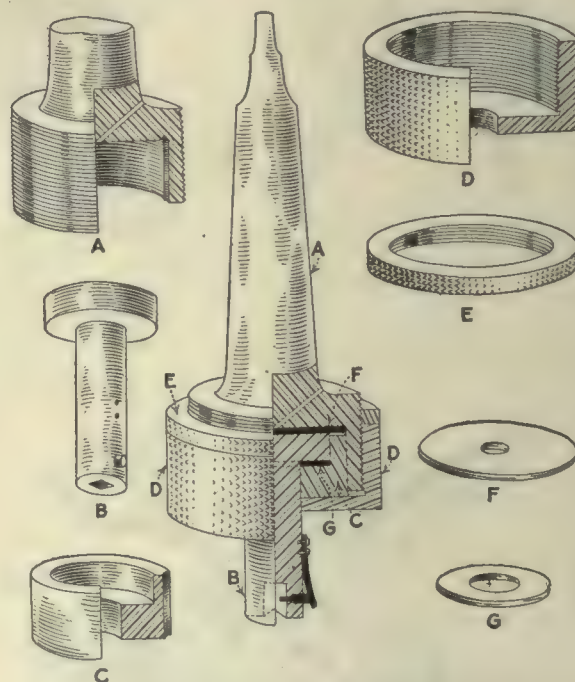
The plain lathe work being finished, the $\frac{5}{8}$ -in. 20-deg. gash A, Fig. 2, was cut and the spiral roughed out on the miller. The spiral was then turned to the correct pitch and square to its axis. To cut the 12 circular grooves in the cutting face singly, correct in location and depth would have been a tedious job, and the need of a gang tool for this operation was apparent. Some special screw taps in stock, 0.197 in. in diameter, 24 threads per inch, suggested the idea of using a tap as a lathe tool. The taps on hand, however, had one less thread to the inch than the required spacing. Moreover, the tap set on the center line would "clear" on one side of the teeth and drag on the other. It was found necessary, therefore, in order to equalize the cutting clearance, to incline the tap; a little further calculation revealed the fact that thus setting the tool at an angle to the center line of the work also corrected the pitch, or spacing, of the grooves.

A holder, Fig. 3, fitting the lathe tool post was made, and the operation of grooving the face of the cutters was satisfactorily completed. Inspection before hardening revealed an error of not more than 0.003 in. over all in spacing, which was considered insignificant.

Friction Tapping Chuck

BY WILLIAM J. JOHNSON

I present herewith a drawing of a friction tap driver that I designed and have had in use for eight months in the railroad shop where I work. During that time this chuck has never failed nor broken a tap. The reference



FRICITION TAP-CHUCK ASSEMBLY AND DETAILS

letters are to establish the positions and shapes of the components.

It will be observed that the number of parts has been kept to a minimum and this has resulted in a simple tool of unusual effectiveness.

Psychology of the Shop-- The Obvious

By C. B. LORD*

SYNOPSIS—A discussion of ability—particularly executive ability. Advantages of following the obvious in all things, including designing. Examples of complicated and obvious constructions in machines and devices.

Notwithstanding the enormous demand for foremen and superintendents at the present time, the visible supply is as large as ever and the actual supply as small as ever. Almost every works manager at the present time is asking himself, "Where can I secure good foremen; if I can't hire them how can I make them? What type of man shall I use—tool maker or production man—a man of mechanical or of managing ability?" So he picks the best man of each type and gives him a position of authority, only in the majority of cases to find that none makes good. Then, notwithstanding that his policy and intention may be to give preference to men in his own employ, he finds himself unable to follow this purpose out in practice, and again he resorts to advertising.

This has been our repeated experience, which I am told is similar to that of others. After we have obtained the new man by advertising, have come to the conclusion that he has absorbed all the training he is capable of without rebelling, and our patience has almost come to an end, we sit down and analyze the reason for his failure. In almost every case we find it is not in the large things that he has been lacking, but in the small things—he was unable to see the next obvious step. We have found many men to whom we could successfully intrust the initial steps of important matters and provided they were checked up on details and at the finish, the results were satisfactory. But they showed a marked lack of ability in these two essentials.

Psychologists tell us that certain individuals have what they term "general ability," a form that cannot be gaged or tested by the psychological tests so far devised, even though when separately used these tests may be able to demonstrate a man's ability in the supposed component parts of general ability. Defining executive ability is like trying to define some natural phenomenon. In the long run it is immaterial what its cause, but we know that its effect is to do things. It may be that all the lesser abilities are included in executive ability, or it may be that the sum of these abilities makes executive ability—we do not know. Personally I am inclined to the former belief.

THE TWO TYPES OF ABILITY

There are two types of ability—that acquired by experience, and native ability. These two may be found separately or combined, and many a man who has classed high in the initial stages of his employment because of his experience and observation elsewhere, has deteriorated rapidly when his box of tricks was empty. Our method of quickly arriving at maximum results with a new man

is to leave him to his own devices until he either betrays his limitations or proves his ability, and then add responsibilities as far as his limitations will allow. Not by the large things is he judged, but by the small.

No matter what else a man may possess, to be a successful executive three things he must have. The greatest of these three is imagination. The other two are analysis and a recognition of the obvious, which really means the ability to see the succeeding steps in the required process, whether it be familiar or strange. The distance ahead he can see these steps is the gage of his ability. Analysis is merely the ability to resolve the obvious elements in any problem or situation.

Why is it that apparently civilized man, of all creation, does not do the obvious thing naturally? An animal always does the obvious thing and therefore in its way is much more efficient than man—this, whether it is a case of feeding, natural selection, hygiene, self-protection, or in almost any other respect. And mainly for this reason, in their natural environment many animals that should not be are yet in fact the masters of men. The savage also, considering his tools, is more efficient than civilized man, and it has been a matter of consideration with me whether when we became a reasoning animal we did not lose our efficiency, and whether the higher we ascend in the scale of civilization we are not penalized by a corresponding lack of personal efficiency—speaking of course, as a whole and not as individuals.

The answer to this efficiency in the savage probably is that his needs and desires are elementary, and therefore the method of satisfying them is obvious. Ours are complicated and require complicated methods to fulfill them.

Some time ago, during a discussion on personal efficiency. I propounded the query as to whether any of those present could offhand name a single thing that the ordinary individual did right without training—either in relation to his own welfare or in his relations to his fellowmen. So far as I can see, this question is unanswerable. In my estimation, the reason why it is possible to so indict a people in the twentieth century is because the vast majority fail to recognize, or to do, the obvious thing.

WOMAN'S APPRECIATION OF THE OBVIOUS

In my original statement I should possibly have accepted woman to some extent. A woman is popularly supposed to be blessed with intuition. It is not intuition, or most of them would have different husbands than they have. But what really happens is that a woman usually goes from cause to effect without any intermediate reasoning—that is, her mind follows the path of least resistance. In other words she sees the obvious, and very often the results are remarkable to those of us who are unable to see as clearly. The fact that they are given credit for possessing some form of second sight illustrates the rarity of this trait in man.

*General superintendent, Wagner Electric Manufacturing Co.

It is our habit to call the Orientals an inscrutable race and credit them with almost superhuman attributes; but there is nothing in their history, philosophy or method of living to warrant such a belief. They themselves were not aware that they were inscrutable until we told them so. The real reason why they are baffling to us is because of their directness. This directness to our mind sometimes appears as indirectness, because instead of making up a complicated story to substantiate certain statements, they tell a direct lie—or as Li Hung Chang once said, "Their thoughts are more definite than their words." The average Oriental's method of thought is similar to the average woman's method of thought, and in both cases we are baffled by the obvious. Their religious practices are also obvious and simple, and their religion is superior to ours in that it teaches no fear of death. The penalty of an obvious philosophy like theirs, if carried to extremes, is fatalism; and philosophy, more than anything else, is so carried.

Those who have been able to see the reasonably obvious have been persecuted or derided, according to the age in which they have lived, from the time of Galileo to that of Taylor. After centuries of medical practice, we are at the present time commencing to follow the obvious course in the mending of breaks and limbs—using splices, clamps and screws as we would for a mechanical break—and the net result is the absence of hideous deformities that used to follow complicated operations, with a lessening of fatalities. The time for an operation for appendicitis has been reduced from nearly four hours to twenty minutes.

People are superstitious because they cannot see the obvious or analyze supposed supernatural manifestations. Practically all puzzles are predicated on a simple, obvious solution that escapes the would-be solver. This, of course, is not applicable to those puzzles that are a matter of skill, such as the "Fifteen" puzzle, or "Pigs in Clover." Comical parts on the stage are mostly all based on doing the obvious thing. This is also applicable to a certain class of joke and humorous story. Detective stories are largely based upon the reader's inability to identify the obvious. I believe it was Gaboriau, the originator of detective stories, who said that "the best place to hide a thing is in plain sight."

WONDERFULNESS OF THE OBVIOUS

The fact that a thing is obvious has in times past been considered wonderful—as witness the old sayings of "diamond cut diamond," "*similia similibus curantur*" and similar sayings. These two would tend to show that it was considered notable that like cured like, or that it was the obvious thing to do. Others like "the mill never grinds with the water that has passed" and similar proverbs demonstrate that it was, and is, customary to make note of the obvious. There are no proverbs that I can recall at the present time that relate to complicated matters. They are really a record of the obvious.

In engineering it has been found beneficial oftentimes to have an engineer design apparatus he is totally unacquainted with, because one familiar with it could not follow the obvious track without invariably producing a complicated design, based on former traditions. The old formula of "it can't be done" is based entirely on following the complicated and not the simplified route.

Probably the most glaring instance we have of our inability to do the obvious in industrial life is illustrated

by our constant change of drawings, the inability to do a thing right the first time. Our excuse generally is that we have insufficient time for consideration, but what we really mean is that it takes us too long to see the obvious.

Assuming the foregoing statements to be generally true, it follows that the complicated is attractive to most men; and the present design in machine tools shows this tendency, the supplier, of course, catering to the tastes of the buyer. The complicated features are pointed out to us as necessities, and the simple ones as something out of the ordinary. This is strikingly shown in two machines of different makes used for the same purpose. The advertising claims of one emphasize the number and variety of operations that may be done. The claims of the other emphasize its simplicity and accuracy. We have thus an example of the two methods, the complicated and the obvious.

THE COMPLICATED AND OBVIOUS IN MACHINE TOOLS

Before going farther, I wish to say that I have no desire to pass upon the final results achieved. There are upholders of both types of machines, and I hold a brief for neither. I merely use it as an illustration of what I have in mind.

One machine was built around a certain operation. This necessitated for other operations tools that were not standard. This in its early stages led to considerable complication and delay and was by some considered a fatal weakness in the machine, in spite of its excellent performance. In the other machine this operation is done by an obvious simple method, and many have used this machine because of its simplicity, contending that a simple machine in the end was the best and that a machine was not better because it was complicated enough to do a multiplicity of operations.

It has also for some time been the tendency on lathes to go to the extremes of complication and to furnish a multiplicity of feeds (in some cases as many as 64), and the advertisements sent out by the lathe manufacturers have emphasized the number of feeds that could be procured. In my estimation the average buyer was paying more than he should in order that the machine might satisfy the wants of possibly 10 per cent. of the purchasers. These have not appealed to us, and the result has been a search for a more simple machine, the use of which is obvious. Mechanics, or time setters, capable of intelligently choosing feeds and speeds or using the attachments furnished with most millers, are not plentiful, nor are so many feeds and attachments necessary. I was much amused on visiting the factory of one of the advocates of this multiple-feed proposition to find that all the holes in the feedbox were plugged except three. This is also our practice, using only three feeds—these three, however, varying on different machines for different material.

For nearly a century we have all been marking a gear tooth, then counting the teeth, and then recounting them, and then forgetting whether we included the marked tooth twice or not at all. Then someone suggested marking the space and counting the teeth, which at least doubles our chance of being correct. The comments on it in the columns of the *American Machinist* give further proof of the interest the obvious method excites.

For a century we have either been losing parts because cotter pins dropped out, or we have sworn because we

could not spread it after it was in place; but the idea of a self-opening one struck no one until recently, and it is not only more efficient but easier to manufacture.

Another example of doing the obvious is in the tying of knots. Every knot used on a ship is made the easiest and most obvious way for the purpose for which it is intended, and yet no land-lubber can tie a simple knot, but always uses a much more complicated one.

As in all cases, the rule of the obvious has its exceptions—if extremes that meet can be termed exceptions. For instance, it took many years for a wheelwright to learn that the obvious way to prevent a wheel from dishing was to make it dished. It also took many years to find out that the best way to keep fence wire straight is to kink it.

The evolution of most inventions has been from complication to simplicity. This same tendency is apparent in the laws, in mechanics and elsewhere. It seems to be the simple things of life that escape us, and when we discover them we usually say, "How simple, why did I not think of that before?"

Even broad-minded, learned men are not exempt from this trait. I was very much amused in reading Munsterberg's articles on psychological tests to note that his apparatus for a given test was in the beginning very complex, and how it was gradually simplified and made practical. The first form to my mind showed the natural bent of his mind, the final result was that of analysis and training.

The whole structure of scientific management rests upon analysis and a recognition of the obvious, and while it has been carried to excess in many cases and has different schools of application, it stands a monument to the man who could see the obvious. On the other hand, doing the obvious thing does not always mean doing that which seems the easiest at the moment. That is expediency, and doing the obvious without relation to the future. Doing it once, in time of trouble, may do; but doing it often is like repeatedly taking money from the cash drawer with the idea that you will make it right some time. Expediency is counterfeit ability and must be practiced with extreme care.

Heavy Work in an Hawaiian Shop

SPECIAL CORRESPONDENCE

SYNOPSIS—Operations on large parts of sugar-mill machinery, including irrigation pumps, housing caps, boxes and a long column.

In a previous article on the plant and methods of the Honolulu Iron Works Co., Honolulu, Hawaii, illustrations have been presented of heavy sugar-mill equipment constructed by this concern. Those views in most cases illustrated the machinery in process of erection or fully installed. It is the purpose in the present article to show some of the big individual parts as actually handled and some of the important machinery for different operations.

A BIG FLYWHEEL

The illustration (Fig. 1) shows a large flywheel of typical design and proportions, built by this company for Hawaiian sugar plantations. This wheel is shown resting upon floor blocks and supported in an upright position by a chain slung from the overhead crane serving the main bay of the shop. As the wheel stands upright the top of its rim is on a level with the craneways and almost in contact with the bottom of the crane itself.

The wheel is made in halves with four arms to each section. The halves are secured together by four studs through the hub with nuts on each end and with heavy sidekeys or links in the faces of the rim.

The wheel measures 18 ft. in diameter and weighs 55,000 lb. Such flywheels are to be seen in plantation mills about the Islands, on big Corliss engines used for driving heavy sets of cane-crushing rolls.

Another important piece of work of an interesting nature, because of its size and the character of operations required upon it, is illustrated by Figs. 2 and 3. These show a single-chamber water end for a sugar plantation irrigation pump having a capacity of twelve million gallons of water per day. This big casting is shown

in place on the table of a vertical boring and turning mill, the cross-rail of which has been lifted to a point where it is supported by struts and jack screws placed at either side, as clearly shown in the photograph.

The casting is secured to the table of the mill by chuck jaws at the base, by numerous straps around the lower flange and by long straps entering the opening at the front and back. At the extreme height to which the cross-rail and tool heads have been adjusted a special platform for the operator is made necessary, this being erected at the right-hand side of the mill, where the workman can conveniently manipulate the crank handles and hand-wheels.

In Fig. 3, two of these chambers mounted on their base are shown on a Niles 18-ft. horizontal boring mill, for boring out the lower openings at one setting, facing the flanges and taking other cuts of similar nature. When in position on the floor-plate of this machine the tops of the castings are fully 18 ft. above the base, and the boring and other operations necessary require a high degree of skill upon the part of the machinist in charge of the work.

These big pumping units constitute an important part of the mechanical equipment of sugar plantations, where a great amount of irrigation is often essential for the satisfactory growth of sugar cane. In some cases nearly a hundred million gallons of water are pumped every day to the ditches, which irrigate 8, 10 or possibly 12 thousand acres of growing cane. One plantation alone has something like \$850,000 invested in irrigation equipment.

The housings for sugar-cane crushing mills are heavy castings. The parts that carry the boxes for the rolls are planed or slotted out at front, back and top to receive the boxes, which are planed to suit their seats. The open ends of these housings are adapted to receive big, heavily designed caps, which are secured in place by through bolts of large diameter. These caps, placed

in a long row on the platen of the planer, are planed up a number at a time.

Fig. 4 shows a group of work of this kind on the platen of a Bement 10-ft. planer. This view was taken from the rear of the planer housings and shows the method of locating the caps in a row and clamping them down

by straps at the end and by shorter straps between each pair of caps.

Fig. 5 illustrates a pair of roll boxes in a fixture on the big horizontal boring machine. Here there are two large parallels of cored section on the bedplate of the machine to bring the fixture to a convenient height for

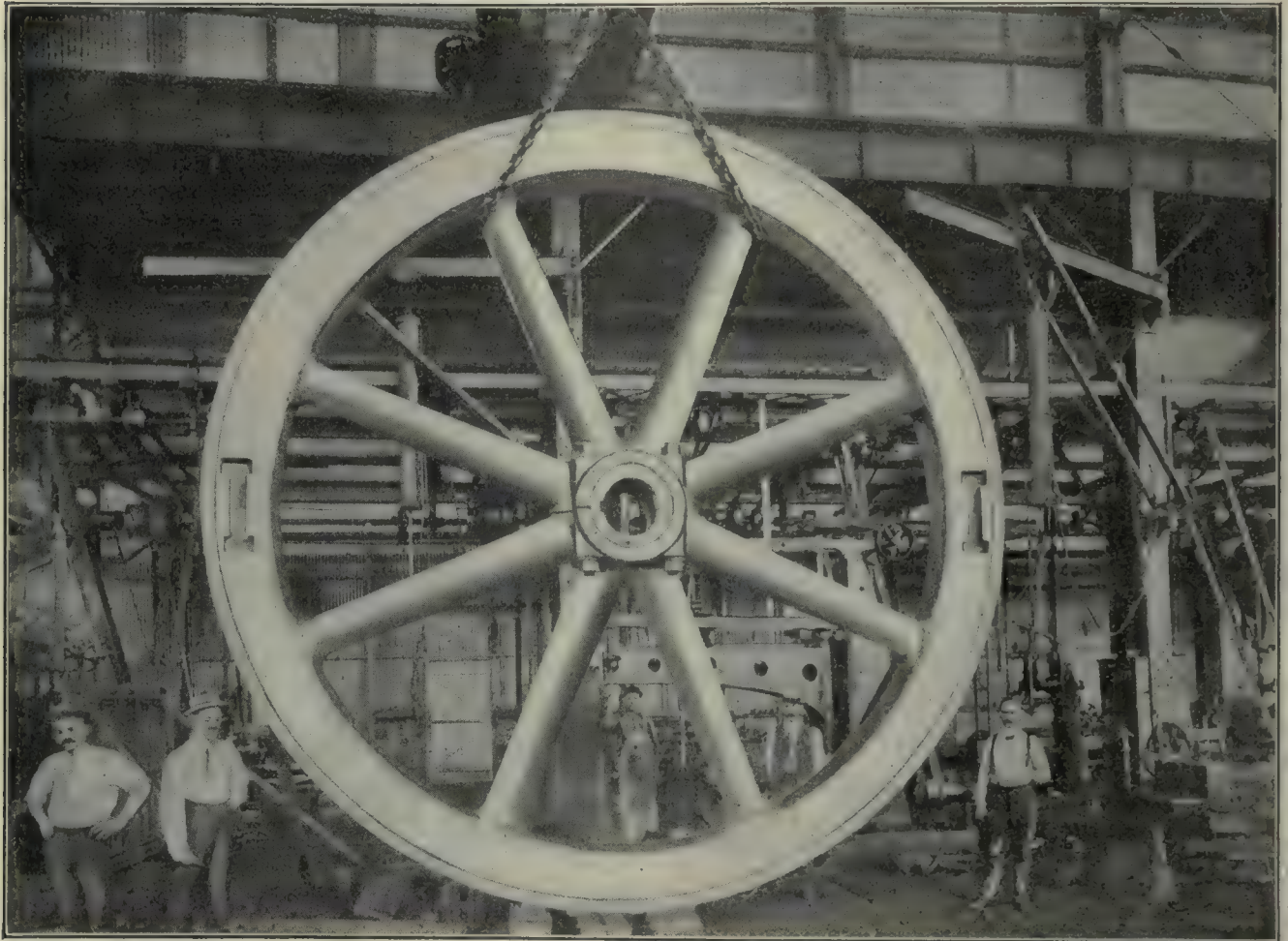


FIG. 1. A LARGE FLYWHEEL USED ON HEAVY SUGAR-MILL MACHINERY

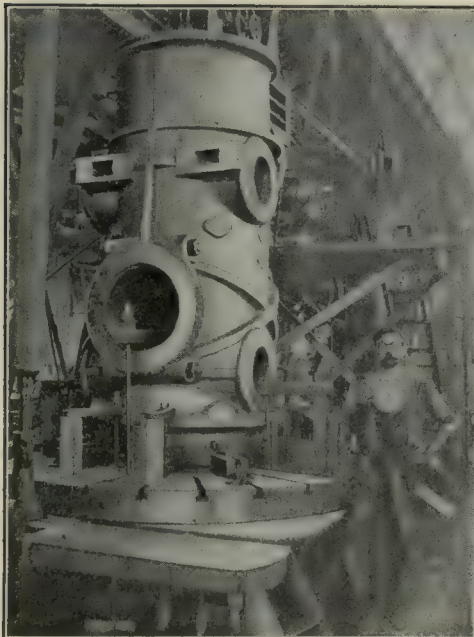


FIG. 2. SINGLE-CHAMBER WATER END OF IRRIGATION PUMP

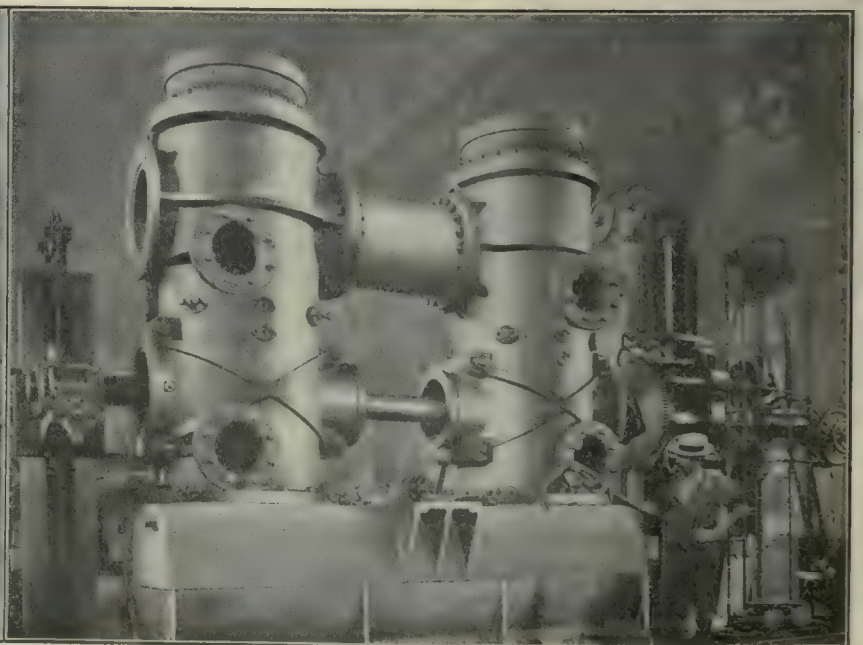


FIG. 3. HORIZONTAL BORING OPERATION ON IRRIGATION PUMP

the operations. The holding fixture consists of a ribbed casting planed out in the form of a yoke of the same dimensions as the housings which will later receive these boxes, and in this fixture the two halves of the box are secured in the same relative position in which they will afterward be placed in the housings of the sugar mill.

from the body of the column, are faced off by operating the cross-slide in the same manner as a perfectly flat surface would be finished. The top of the column has a round flange, which is gripped in the four chuck jaws to secure the work and positively drive it while the lower end is mounted on a big pipe center, as shown.



FIG. 4. PLANING A STRING OF SUGAR-CANE CRUSHING-MILL HOUSING CAPS

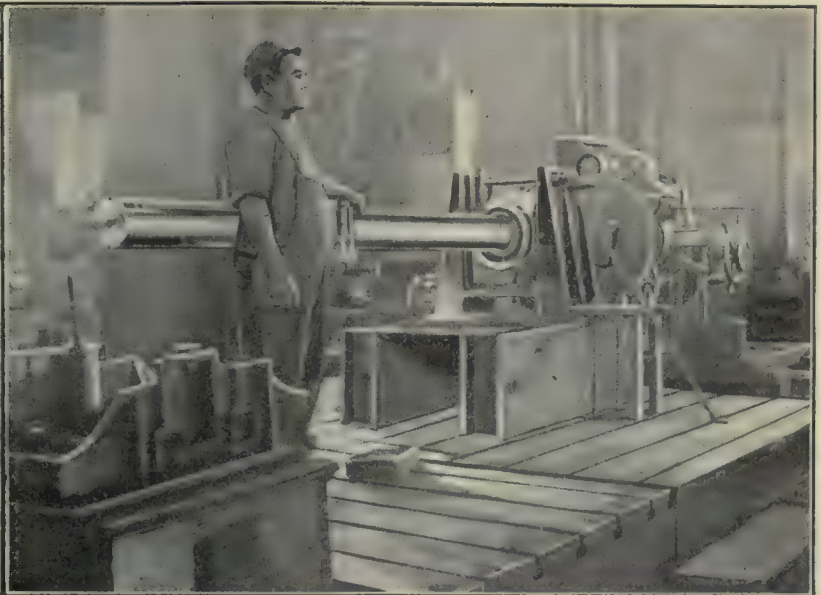


FIG. 5. BORING ROLL-BEARING BOXES WITH THE AID OF AN UNUSUAL FORM OF FIXTURE

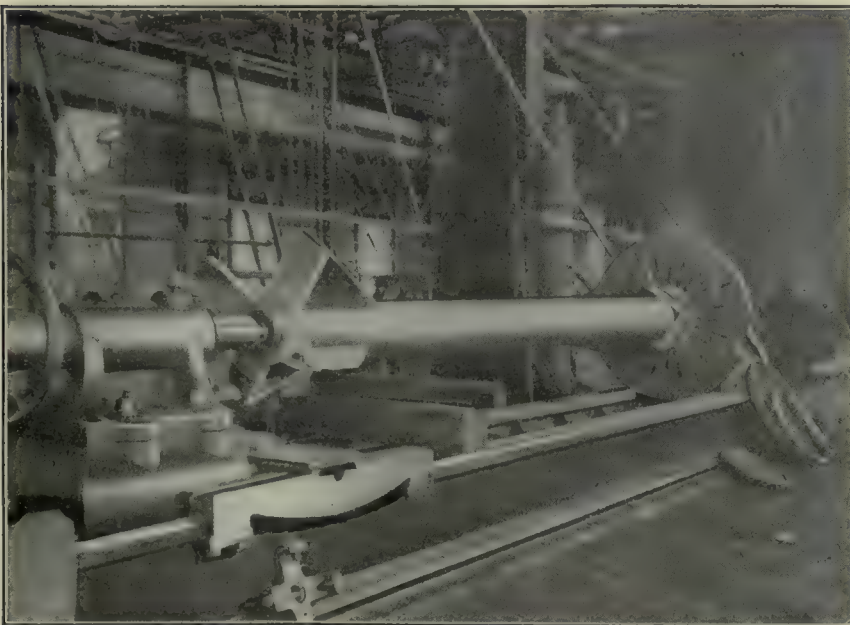


FIG. 6. A COLUMN-FACING OPERATION

It will be noticed that the tops of the fixture are tied together by through bolts. The two halves of the box being bored are separated about 1 in. by two parallels so that when they are erected in the frame of the crushing mill they will be adapted to receive a pair of shims, which may be reduced as required to take up wear between the roll journals and their bearings.

Fig. 6 illustrates a characteristic job on a long lathe—the facing of the ends of a long column. This column has a foot in the form of a cross with one arm removed. The three projecting arms, which are strongly ribbed

A number of sizes of spur gears are made, the teeth of which are machined on the table of a big slotter. These gears are in various diameters from, say 2 ft. to 12 ft. or more and constitute the driving train for various sets of cane-crushing rolls. The gears are of very coarse pitch and usually of broad face. The vertical slotter in this shop is often found to be the only machine on which certain work can be satisfactorily handled, just as is the case with many of the big jobs in railroad repair shops. Frequently the shape of the casting or its bulk is such that the planer, no matter how large it may be, will not carry between the uprights, and when the limitation as to planing operations is not due to the capacity between housings, there are frequently occasions where the form or location of the surface to be finished does not admit of using a planer tool thereon.

In sugar-mill machinery practice the slotter is a tool of marked utility and of many possible applications.

✽

Oxidization and Volatilization—If 100 lb. of ordinary brass were to be carefully melted, then cooled and re-weighed, it would be unlikely that more than 98 lb. of material would remain. The loss is occasioned by oxidization and volatilization. The total loss in handling, including the melting, ranges from 3 to 7 per cent., varying with the nature of the alloy, the class of work and the shop practice. The cause for the melting loss will be found in the difference in fusing temperatures of the various constituents of the alloy. The melting point of copper is 1,083 deg. C., while that of tin is 232 deg. C.—“Railway Mechanical Engineer.”

Jigs Used in Manufacturing Knitting Machines

BY ROBERT MAWSON

SYNOPSIS—In this article are shown jigs used in machining parts of textile machinery. The tool used on the cam gear is fitted with an indexing device to obtain the correct locations for the drill. The small jig for the stop-lever casting is made with a cam lever that not only holds the part to be drilled, but locates it with one motion. The tools are giving good satisfaction in service and, as may be seen by referring to the time given, are producing parts on an economical basis.

The Jenckes Knitting Machine Co., Pawtucket, R. I., manufactures a variety of machines for hosiery making. This article deals with jigs used in machining some of the parts of these machines. The tools are of modern design and employ many features of interest. In their design the desire has been to facilitate manufacture by

employing thumb-screws and other quick fastening devices, so that the minimum amount of time is required to put in the part and remove it from the jig.

An indexing jig of interest is shown in Fig. 2. It is of simple construction and the design is such as to furnish a rugged mechanism to withstand plenty of the unintentional abuse which such a jig receives in the ordinary shop.

The use of the open washer, shown in Fig. 4, is of decided advantage where quick changing of the work is a necessary feature. A half turn of the nut permits this split washer to be slipped off of the bolt and the work to be readily removed.

A latch cam for the purpose of securing work in a jig is illustrated in Fig. 6. It will be noted that this construction furnishes plenty of leverage and a delicate means of adjustment and may be applied with considerable advantage to a number of pieces of work similar to those given.

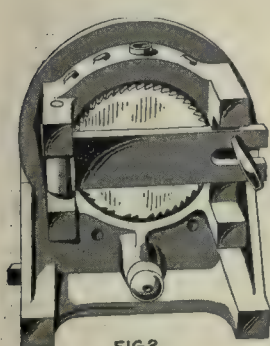


FIG. 2

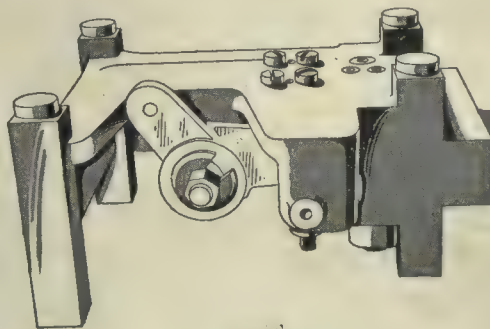


FIG. 4

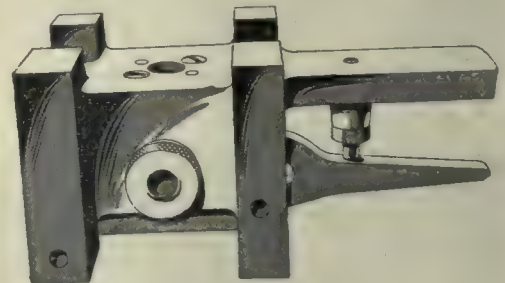


FIG. 6

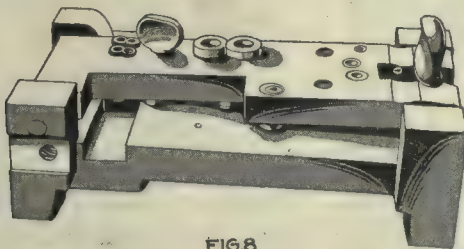


FIG. 8

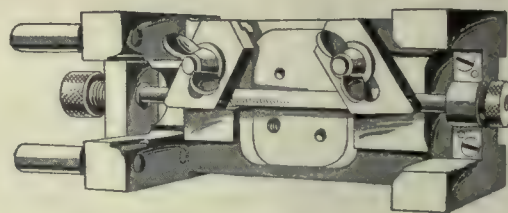


FIG. 10

JIGS USED IN MACHINING KNITTING-MACHINE PARTS, WITH WORK SHOWN IN POSITION

FIGS. 2 AND 2-A

Operation—Drilling cam gear, Fig. 1. The casting is placed on a pin, being located in the large center hole, which has been previously machined. It is then turned around on the pin to a stop pin for location. The cover, being fastened down, holds the casting in place. Positions for the drill-guide bushings are provided with the index pin shown at the lower part of the tool.

Holes Machined—One D-drill, one No. 31 and four holes drilled for 12-24 threads.

FIGS. 4 AND 4-A

Operation—Drilling ratchet-pawl lever, Fig. 3. The casting is placed on a pin fitting into a previously bored hole and swung around against a stop. An open washer and nut hold the part in position.

Holes Machined—One $\frac{1}{4}$ -in., one No. 19 and one $\frac{3}{8}$ -in. drilled.

FIGS. 6 AND 6-A

Operation—Drilling stop-lever cushion, Fig. 5. The round steel pin is placed in the jig, resting in two V-blocks. The

latch-cam cover, being fastened down, holds the piece in position.

Holes Machined—One $\frac{3}{8}$ -in. drilled to a stop for depth from each side of the jig and one $\frac{1}{2}$ -in. drilled. The latter hole partly cuts the pin in two. The pin is then removed and sawn apart, making two elements.

FIGS. 8 AND 8-A

Operation—Drilling rack-pinion shaft, Fig. 7. The blanked part is placed in the jig, being located against stop pins. The cover, fastened down with the thumb-screw, holds the part in position.

Holes Machined—One hole drilled for 10-24 threads, three No. 47 drilled and two $\frac{1}{8}$ -in. drilled.

FIGS. 10 AND 10-A

Operation—Drilling rack-pinion shaft, Fig. 9. The shaft, which has been cut to length, is slid in the jig against a stop screw. Two clamps operated by wing-nuts hold the part in position.

Holes Machined—One No. 30 drilled $\frac{1}{16}$ in. deep and one hole drilled $\frac{1}{2}$ in. deep to suit 6-32 threads.

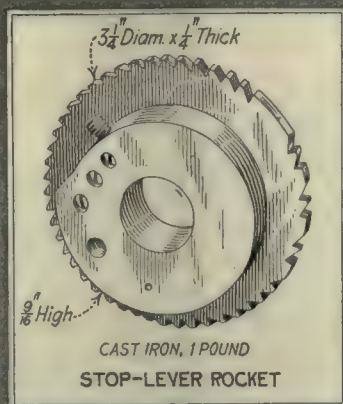


FIG 1

TIME OF OPERATION, 2 2/5 MINUTES

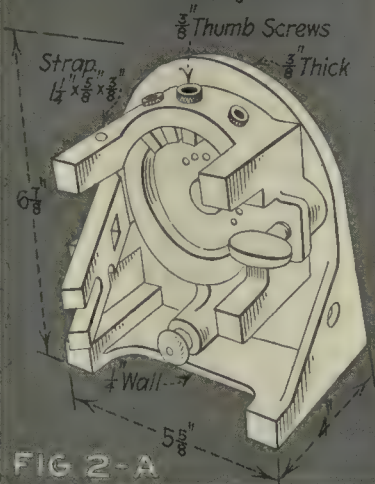


FIG 2-A

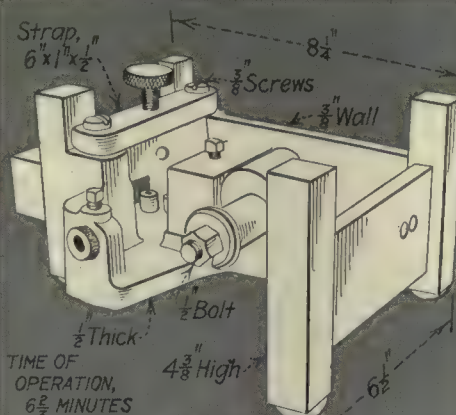


FIG 4-A

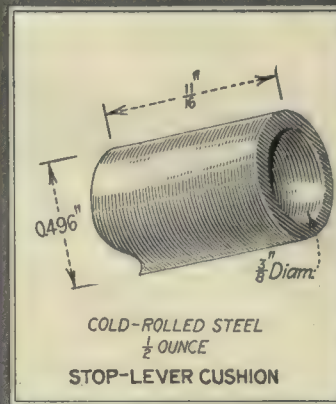


FIG 5

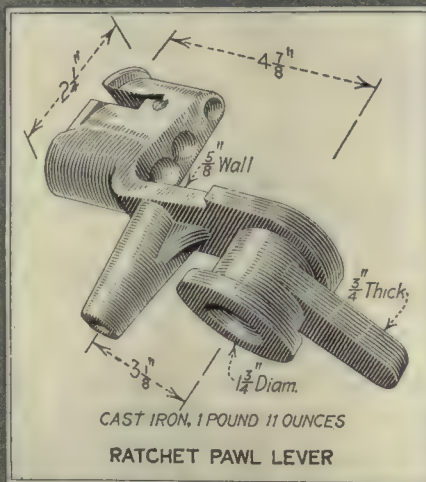


FIG 3

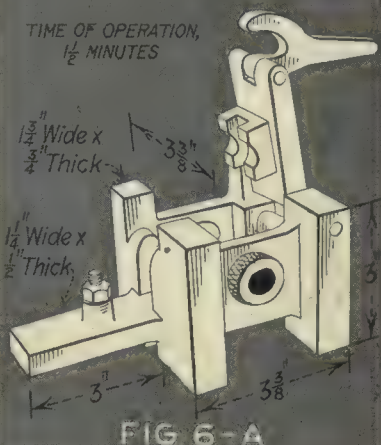


FIG 6-A

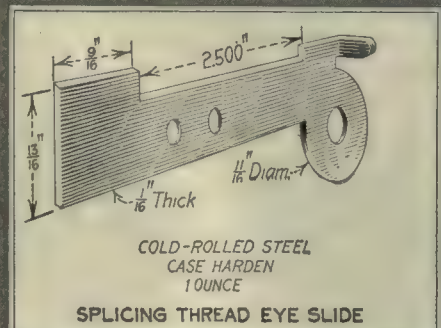


FIG 7

NOTE
ALL BUSHINGS USED FOR
GUIDING TOOLS ARE BLACK-
ENED. ALL JIG AND FIXTURE
BODIES ARE CAST IRON,
STRAPS AND FASTENINGS,
MACHINERY STEEL; GUIDE
BUSHINGS ARE TOOL STEEL,
HARDENED AND GROUND

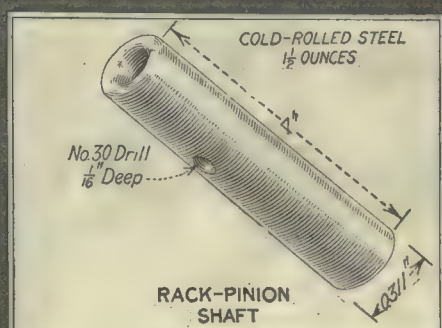


FIG 9

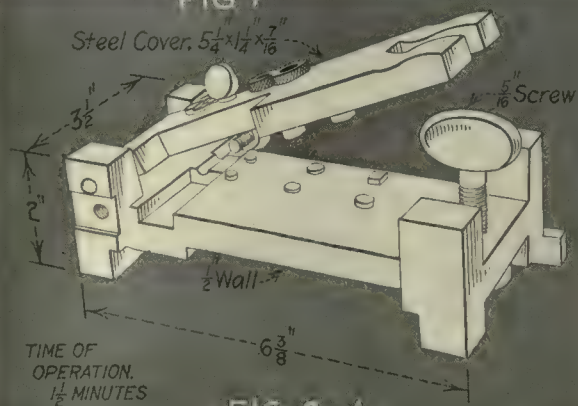


FIG 8-A

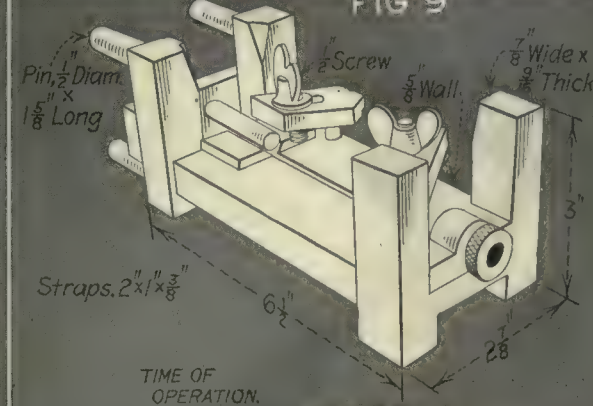
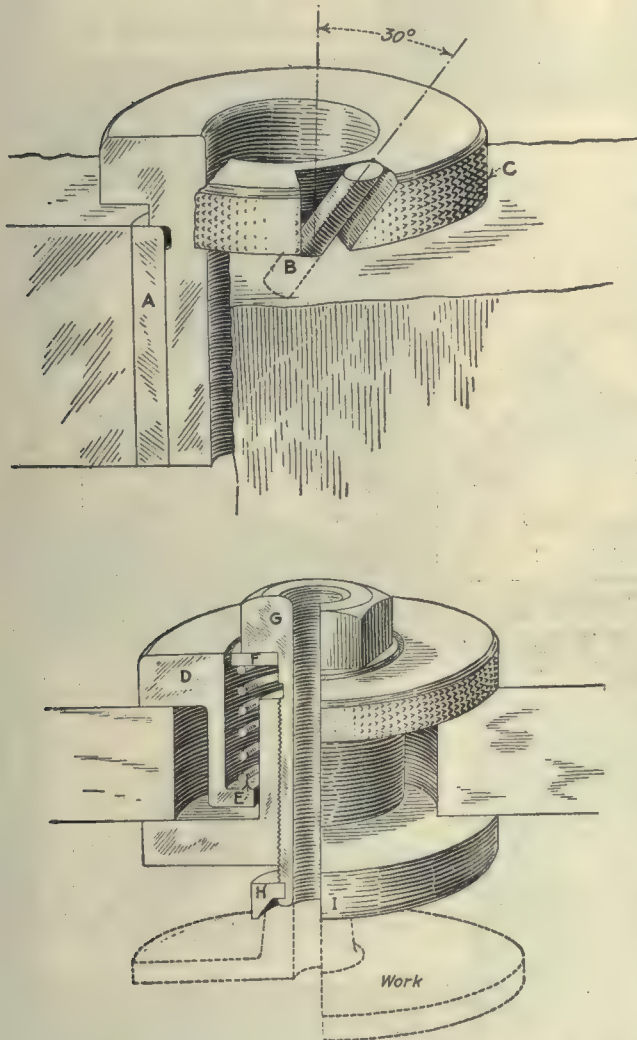


FIG 10-A

Two Unusual Jig and Fixture Bushings

By W. BURR BENNETT

The accompanying sketches illustrate two unusual but very practical bushings for jig and fixture work. In Fig. 1 is shown a lock for slip bushings. It is quite an improvement over the ordinary makeshifts and is composed of a minimum number of elements. The slip bushing *C* is retained in the usual liner bushing *A*. In the head of the slip bushing is milled a notch with one side straight and the other at 30 deg. with the axis.



TWO UNUSUAL JIG BUSHINGS

A pack-hardened stud *B* is threaded into the body of the jig at an angle of 30 deg., thus registering with the notch in the slip bushing. This stud not only keeps the bushing from rotating in the direction of the arrow, but because of its angle keeps it from creeping upward.

In Fig. 2 is shown a bushing that, while seldom used, is often very handy. This bushing *G*, which is in reality a screw bushing, is provided with a swivel cup *H* and is free to float through a considerable area, so as to align with a boss on the work. The requirements are that the hole shall be concentric with the boss and not at a fixed distance from any other hole. The spring *E* serves to retain the lower plate *I* and the upper plate *D* against the body of the jig and also to furnish enough initial

friction pressure so that the lower plate *I* will not rotate when the bushing *G* is screwed down on the work. The washer *F* is used to keep the spring from cramping.

To Facilitate Crane Operation and Insure Safety

By W. A. LAILER

In our erecting shop a great deal of material is moved from one place to another by means of a 25-ton crane, operated from an overhead box. The operator complained a number of times that accidents nearly happened because he could not distinctly see the exact position of the crane hook and the slings and links that were placed on it. This was due to the distance and the angle at which he observed the work, together with the fact that the shop floor and the material thereon were about the same color as the hook itself.

To overcome this difficulty we mixed up a very thin grade of white paint, which was turned over to the operator so that, whenever necessary, he could paint the hook white. The white hook stands out in strong contrast against the dark background, and the operator reports a vast improvement over the old conditions.

Causes of Machinery Accidents in California

By L. R. W. ALLISON

During a twelve-months period in California 5,421 accidents were occasioned by classes of machinery tabulated herewith, out of a total of 62,211 accidents occurring through all causes in various branches of industry. The State Industrial Accident Commission has made an accurate and thorough study of the specific causes of the machinery accidents in an effort to devise additional rules and protective measures, where possible, to reduce this total of mishaps. The results of this research, summarized here, are of particular interest:

Cause of Accident	Total Number
Air hammers and riveters and all compressed-air engines and devices.....	77
Backfires of motors and engines when cranking or starting	623
Belts, power transmitting, main and secondary.....	373
Chain transmission	59
Drills, dies, punches, metal stamps and presses.....	326
Dynamos, gas or internal-combustion engines, motors or steam engines.....	334
Elevators, platform, including skips and buckets....	239
Electric fans, motors, etc.....	24
Emery wheels	152
Feed rolls of all classes, including mangles and body ironers in laundries.....	138
Gears and cogs.....	287
Hoisting apparatus other than platform elevators....	465
Joiners, edgers, slicers, stayers, planers, sanders, stickers and veneers.....	172
Pile drivers, rope drivers and bulldozers.....	9
Saws, band and circular.....	481
Setscrews	37
Shafting and conveyors.....	123
Shears, cutters, grinders for foodstuffs.....	95
Shears, cutters, grinders for metal, paper, textiles, etc. Miscellaneous:	106
Metals and machinery.....	309
Mines	25
Oils	7
Printing and manufacturing paper.....	164
Power and light.....	7
Textiles	108
All other machines.....	247
Objects thrown by machinery, as boards from saws, etc.	47
Pumps	44
Machinery without mechanical power.....	343
Total	5,421

Of this number of machinery accidents, 584 brought permanent injuries, while in the total volume of accidents in all lines of industry 1,292 reported cases resulted disastrously.

Manufacturing a Top Plate for a Typewriter--I

BY FRANK A. STANLEY

SYNOPSIS—The operations involved in machining this casting include profiling the top and bottom and milling the type-guide seat, the cutting of 28 slots to receive the type-bar mechanism, the index-drilling of holes in the periphery, etc. Tools and operations are illustrated in detail.

One of the most important members of the typewriter manufactured by the Noiseless Typewriter Co., Middletown, Conn., is the part known as the top plate, which is a gray-iron casting in the form of a fan opened out to a little greater angle than 90 deg. and having in its upper surface 28 radially disposed slots for receiving the sliding

The top plate is shown clearly in Fig. 1, where enough dimensions have been retained to give an idea of the general proportions. As there represented, it will be seen to be a casting a little less than 12 in. across the maximum width and having a maximum depth of 7 in., this being the radius to which the arc forming the outside of the casting is formed. The front end of the top plate is faced at an angle of 108 deg., and the extreme point is cut back to a depth of 0.029 in., leaving a flat surface 0.08 in. wide. This is to receive the type guide, described in previous articles, which is designed to receive the type body and retain it absolutely in alignment at the point of printing.

The type bars as they slide to and fro are guided side-wise in accurately formed notches in a circular comb,

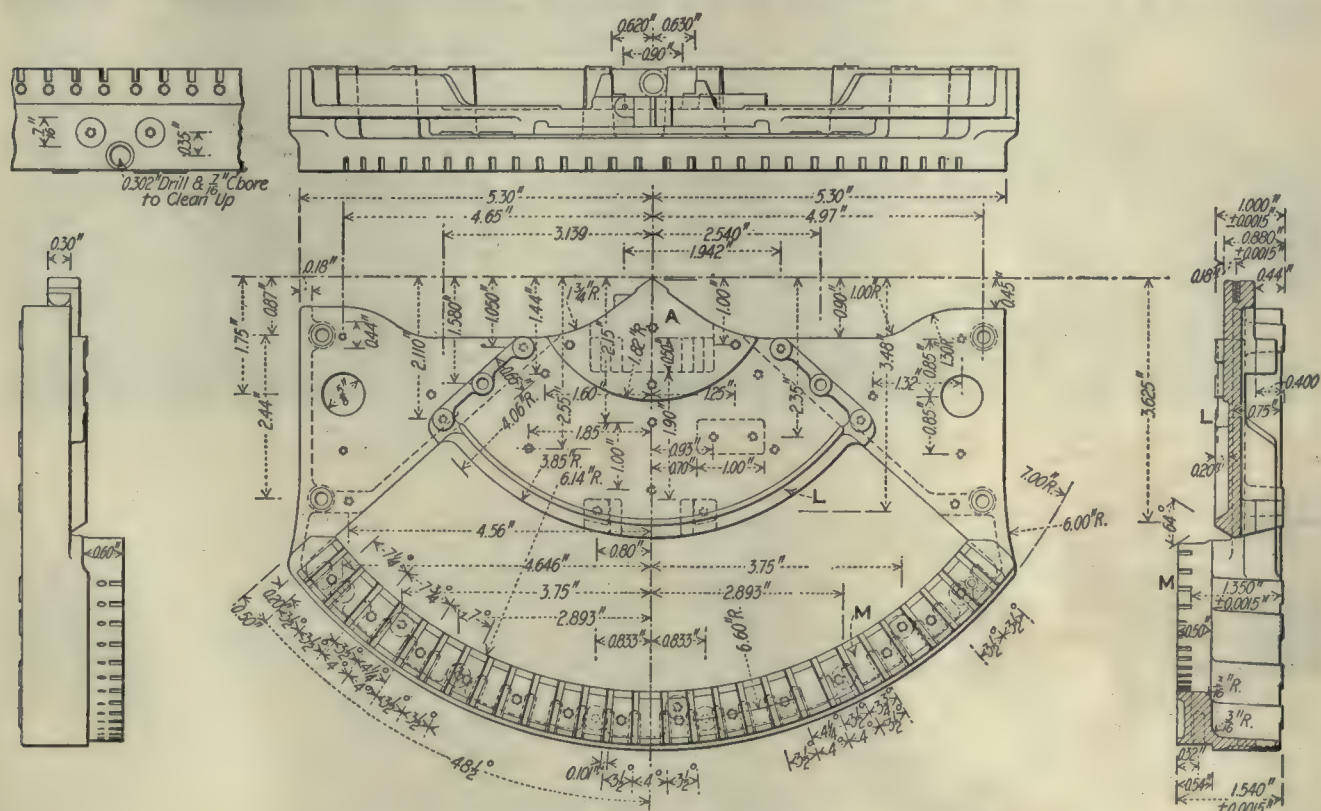


FIG. 1. TOP PLATE FOR THE NOISELESS TYPEWRITER

type bars. This plate is attached to the top of the main frame of the typewriter and has on its under surface an accurately machined slot or guide that receives the slide or tongue on what is known as the center tie, which in turn carries the typewriter carriage.

This center tie, with its carriage, is adjusted toward and away from the front of the machine by the indicator at the front, to allow any given thickness of paper to be written upon or for any number of sheets, as in manifolding. The top plate thus not only serves as an accurate retainer and guide for the 28 type bars with their printing characters, but also carries these type bars at all times in a definite relationship to the center tie and to the printing platen mounted upon the front of the typewriter carriage.

these openings being exactly in line with the milled slots in the top plate, wherein are mounted the supports for the toggle mechanism that operates the type bars. As they slide, the type bars rest upon a hardened and ground flat plate in the form of a segment, which is attached to the surface of the top plate at A, Fig. 1, this hardened plate being cut away to leave comparatively narrow bearing surfaces quite sufficient to support the bars properly and at the same time to allow them to float freely and to keep the plate perfectly clean from an accumulation of dust or other foreign substance.

In getting this top-plate casting ready for general machining operations the first important process is to place it bottom side up on the profiling fixture shown under the machine in Fig. 2. Here the various bosses and

the feet upon which it will later rest on the frame of the typewriter are surfaced to a definite height, and the guiding slot to fit the slide on the center tie already referred to is milled out with a cutter, as shown.

The construction of this profiling fixture incorporates some interesting features of importance to the tool designer and tool maker. It should be noticed that the crosswise guiding slot which assures a definite relationship between the top plate of the typewriter and the center tie with its platen carriage is the first important surface

bottom of the work, is clamped by a thumb-screw bearing upon a shoe plug, the inner end of which is finished at an angle to correspond with the sloping notch cut in the outer face of the spring plunger. This angle is such that it will not tend to cause the plunger to be further lifted into contact with the bottom of the work, but nevertheless will prevent the plunger from being pressed downward under the cut.

To hold the work down, there are three clamps at the top, two of which at the back may be seen at *HH*, of

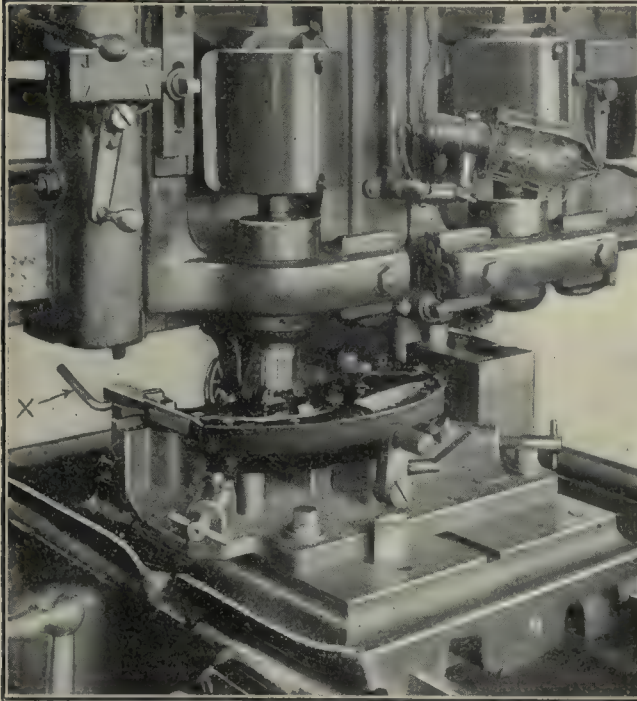


FIG. 2. PROFILING THE CROSS-GUIDE SLOT IN TYPEWRITER TOP PLATE

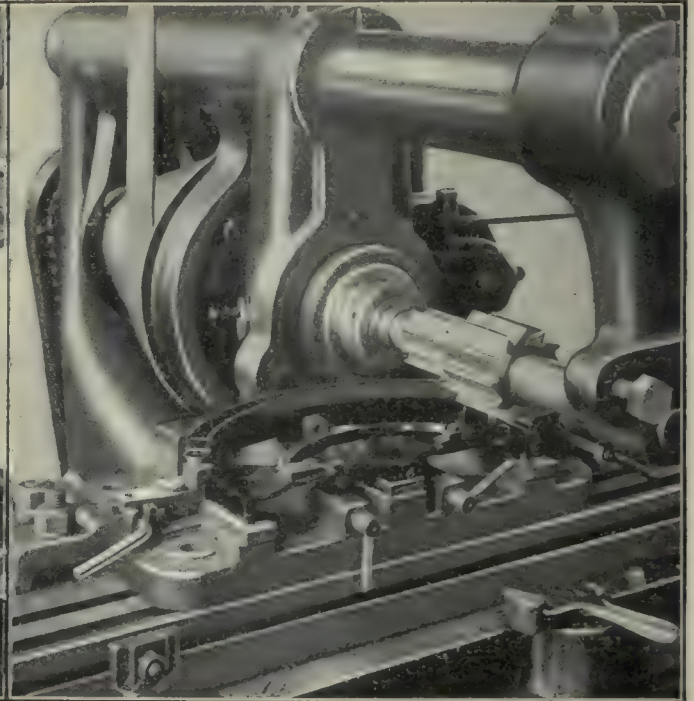


FIG. 4. MILLING THE TOP SURFACES OF THE TYPEWRITER TOP PLATE

machined in order that this slot may be used in successive operations as a locating point from which all other slots are cut, all important holes jigged and all other surfaces of consequence finished accurately.

Fig. 3 shows the work in place, bottom side up, just as illustrated in Fig. 2, and brings out clearly the method of locating and securing the casting in position for the profiling cut. When placed in this fixture, the top plate to be profiled rests upon three fixed supports at *BBB* and is pushed back against hardened stops *CC* to locate it from the front wall of the casting. Its position sidewise or centrally in relation to the longitudinal axis of the fixture is determined by the two jaws *DD*, which are operated in unison to act upon opposite sides of the casting similarly to vise jaws, by means of the horizontal spindle *E*, which acts upon the two jaws uniformly and, when turned back, permits the compression springs at *FF* to throw the jaws open and release the work from their grip.

In addition to the three fixed supports *BBB* under the casting there are four spring plungers at *GGGG*, which are allowed to come up under the side and contact with the corners and center of the work, thus supporting the latter under all conditions. A detail of one of these plungers is shown in the section at the right-hand side of Fig. 3. As there indicated, it will be seen that the plunger, when elevated by its spring into contact with the

slotted form so as to slide to and fro easily to release the casting and be again moved forward over the fresh piece of work. These two clamps are mounted upon springs on studs, with a rocker washer above and with a thumb-screw at the back to elevate the rear ends when the front ends are to be forced down upon the top plate to be machined. This arrangement is clearly seen in the end elevation. The clamp *I* in front is quite similar in its action.

CONTROL OF THE PROFILING TOOL

The profiling cutter, which not only serves to mill off the bosses and seats on the casting, but also to cut the important guide slot to fit the slide on the center tie already referred to, is controlled in its lateral position and guided by means of the taper guide pin *J* fitting in the slot *K* formed by two hardened-steel plates attached to the profiler fixture casting. This feature is also clearly shown in Fig. 2. The taper guide pin in combination with the corresponding taper inner surfaces of the guide slot may be adjusted up or down to move the profiler fixture bodily to right or left. Thus the exact desired position of the important guide slot in the top plate of the machine is retained at all times. The depth of the slot cut in relation to the tops of the bosses and seats is secured, as desired, by means of the notches in the stop bar on the saddle carrying the profiler head.

Upon comparing Fig. 3 carefully with the fixture in Fig. 2, it will be seen that there are a few slight modifi-

cations in the clamping apparatus. These changes in no wise affect the principle of the tool; but have been adopted to add to the general convenience of operations. Thus at X, Fig. 2, will be seen a bent handle in place of the original thumb-screw to elevate the rear end of the two back clamping straps, thus bringing the forward end down upon the work. These small handles carry upon their axes where they pass through the casting a small eccentric portion that acts to lift the clamp at the rear, as explained. Projecting as they do at either side of the main casting,

For this purpose two peripheral milling cutters are used, as in Fig. 4, the work being passed directly under them as if it were a rectilinear job instead of in the form of an arc. The surface at L, Fig. 1, is known as the type-bar seat, while the surface at M is finished preliminary to the cutting of the 28 slots in which is mounted the mechanism for operating the type bars themselves. A few details of the fixture itself may be of interest.

It has already been pointed out that the cross-slot in the bottom of the fan-shaped top-plate casting machined

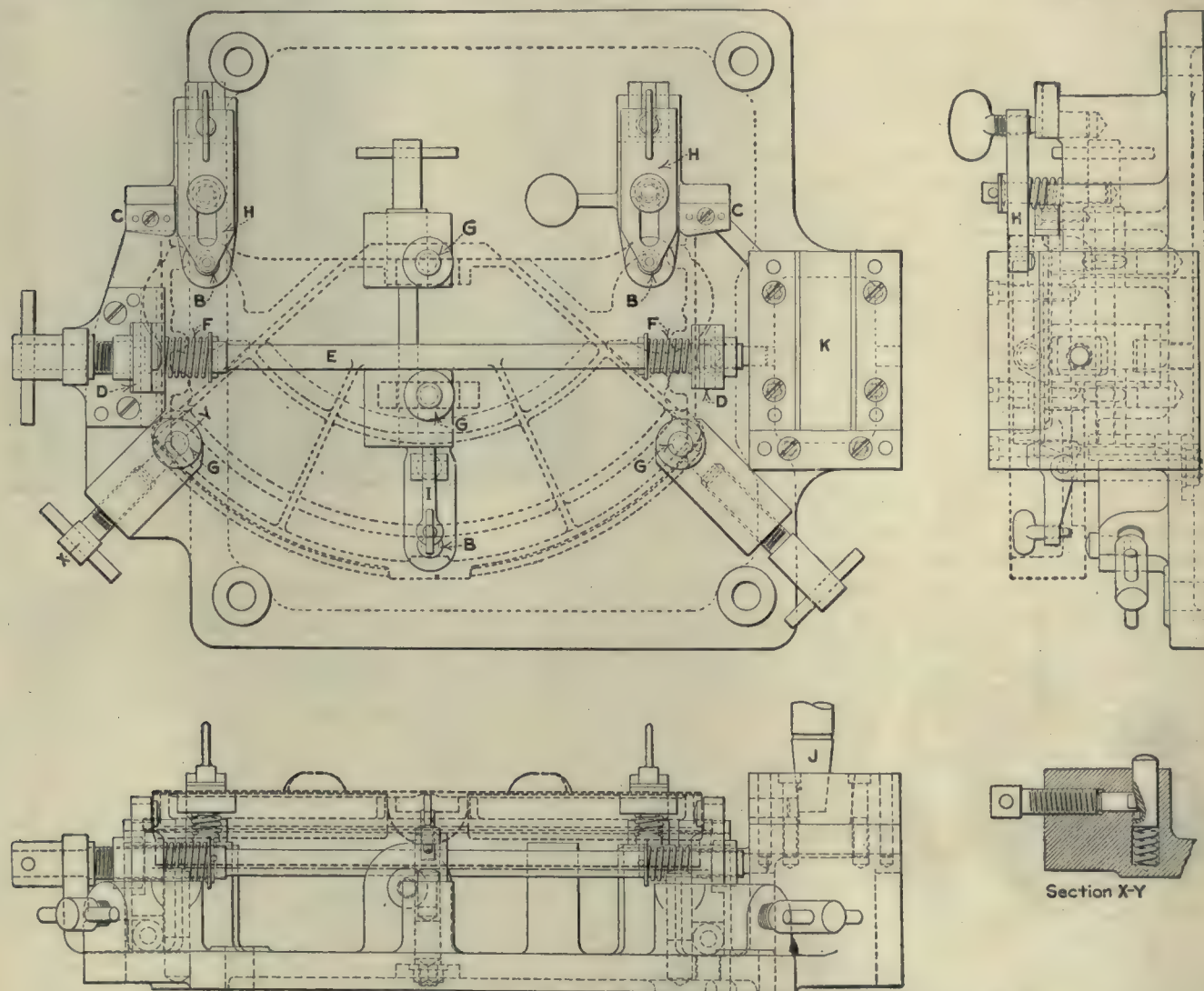


FIG. 3. DETAILS OF PROFILE FIXTURE USED ON TYPEWRITER TOP PLATE

they are more easily reached than the vertical thumb-screws originally used, and to just that degree are more readily operated to facilitate the removal and replacing of work. Similarly, there is a slight change in the clamp at the front of the casting, whereby greater facility of operation is secured with corresponding advantage in the matter of saving time and bother in taking work out or putting fresh castings in to be profiled.

A MILLING OPERATION

Following the profiling operation in Fig. 2, the top plate is turned over. While held on the fixture shown in Fig. 4, the two arc-shaped surfaces at L and M, Fig. 1, are machined smoothly, to the right height from the base of the casting and to an accurate difference in height in relation to each other.

out in the profiling process to form the guide to fit the slide on the center tie is later used in all important fixtures as a locating medium for the work. Referring to Fig. 4, it will be seen that the top plate to be machined is here put in place in the fixture with the pointed end toward the operator, the work being right side up and resting upon the bosses and seats machined in the profiling operation in Fig. 2. At each side of the casting there is a short clamp hook to project over the edge of the work and having at its rear end an eccentric lever like the ones already described, consisting of a bent rod with a small eccentric portion on the body thereof. When this is turned up quarter way at the rear end of each strap, it lifts the rear end of that member and consequently draws down the hooked forward end upon the piece of work to be secured.

United States Munitions*

The Springfield Model 1903 Service Rifle

The Fixed Base and Final Barrel Operations

SYNOPSIS—The fixed base is attached to the butt end of the barrel and becomes an integral part of it. The operations on the fixed base are described, as are also the concluding operations on the barrel group.

The fixed base, details of which are shown in Fig. 157, is a drop forging of Class D steel, the stock being supplied in round bars of 1.4 in. These are forged singly and also machined singly with a few notable exceptions, in which some fixtures are made double for holding two bases at one setting. As with the fixed stud, the hole is bored and reamed, and nicely fitting mandrels are used

*Copyright, 1916, Hill Publishing Co.

OPERATION A. FORGING FROM BAR AND HOT-TRIMMING

Transformation—Fig. 158. Number of Operators—One. Description of Operation—Forging from bar. Apparatus and Equipment Used—1,000-lb. Billings & Spencer drop hammer. Gages—Fig. 159. Production—80 per hr.

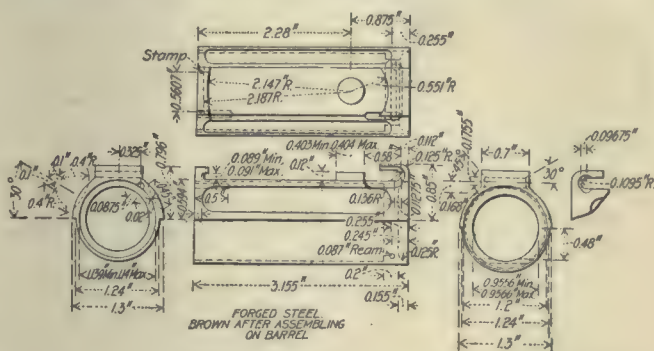


FIG. 157. DETAILS AND WORKING LIMITS OF THE
FIXED BASE



FIG.158 OP.A

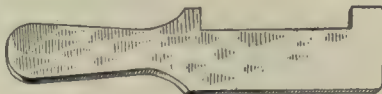


FIG.159

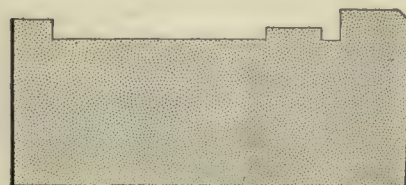


FIG.160

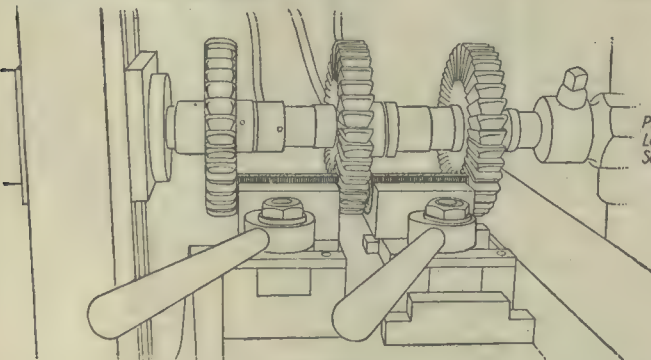


FIG. 161

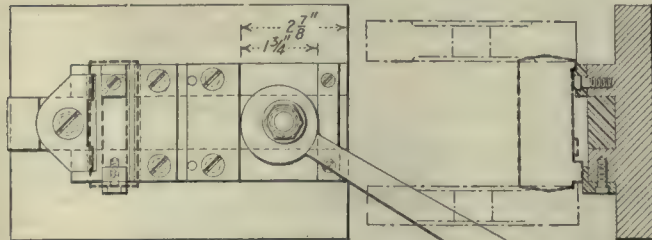


FIG. 162

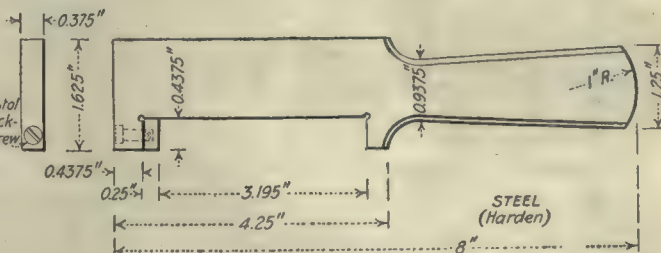
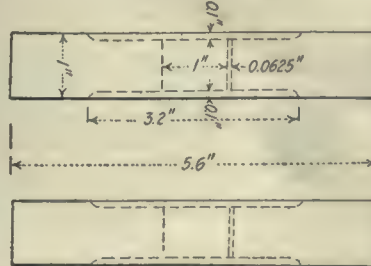


FIG. 164



35 Teeth L.H. on Face and Sides

FIG. 163

OPERATION 1. STRADDLE-MILLING BOTH ENDS

Transformation—Fig. 160. Machine Used—Pratt & Whitney Lincoln type belt-drive mill, Fig. 161. Number of Machines per Operator—Two. Work-Holding Devices—Work held in grooved-jaw vise, Figs. 161 and 162. Tool-Holding Devices—Cutters held on standard arbor, Fig. 161. Cutting Tools—6-in. facing mills, Fig. 163. Number of Cuts—Two. Cut Data—Feed, $\frac{1}{8}$ in. per min.; speed, 60 r.p.m. Coolant—Cutting oil put on with brush. Average Life of Tool Between Grindings—500 pieces. Gages—Length, Fig. 164. Production—200 per day. Note—Fixed bases are handled in boxes that hold 50 each.

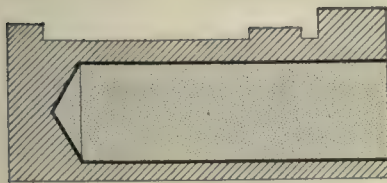


FIG. 165



FIG. 166

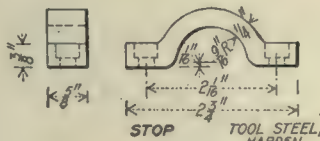
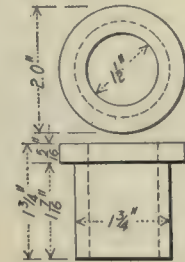


FIG. 167

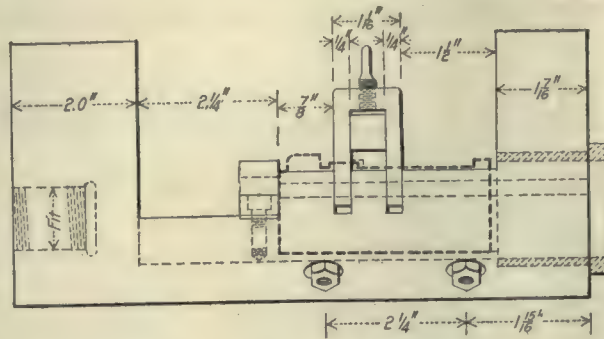
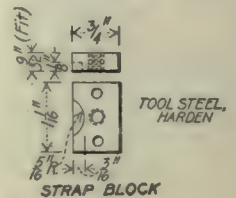
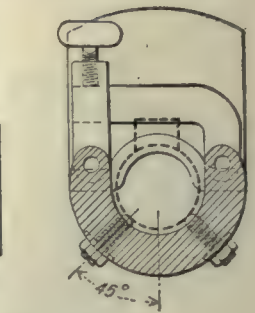


FIG. 168

OPERATION 2



STRAP BLOCK



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for locating and supporting the work in many of the milling operations. The sequence of operations follows:

- A. Forging from bar and hot-trimming
1. Straddle-milling both ends
2. Drilling large end of bore
5. Drilling small end of bore
8. Squaring front end
6. Reaming bore and squaring end of base
9. Milling both sides lengthwise
- 9½. Burring and filing to finish width
10. Milling entire top surface of base crosswise
- 10½. Burring operation 10
12. Hollow-milling pivot stud
- 12½. Burring operation 12
13. Graduating zero windage points
14. Profiling rear lug for seat of rear end of movable base
15. Shaving for windage screw
- 15½. Burring operation 15
16. Milling outside of walls of base
19. Squaring and counterboring front end of base for hand-guard tenon
20. Shaving upper and undercut circles on rear lug
21. Filing movable base seat
22. Polishing and cornering
25. Milling bevel seats for windage screw

OPERATION 2. DRILLING LARGE END OF BORE

Transformation—Fig. 165. Machine Used—Barnes Manufacturing Co. 20-in. gang drill. Number of Machines per Operator—Four. Work-Holding Devices—Work held in upright stand fixture, Figs. 166 and 167. Tool-Holding Devices—Taper collet. Cutting Tools—High-speed twist drill. Number of Cuts—One. Cut Data—Speed, 180 r.p.m.; feed, ⅜ in. per min. Coolant—Compound; ¼-in. stream. Average Life of Tool Between Grindings—20 to 30 pieces. Gages—Depth, Fig. 168. Production—70 per hr.

OPERATION 5. DRILLING SMALL END OF BORE

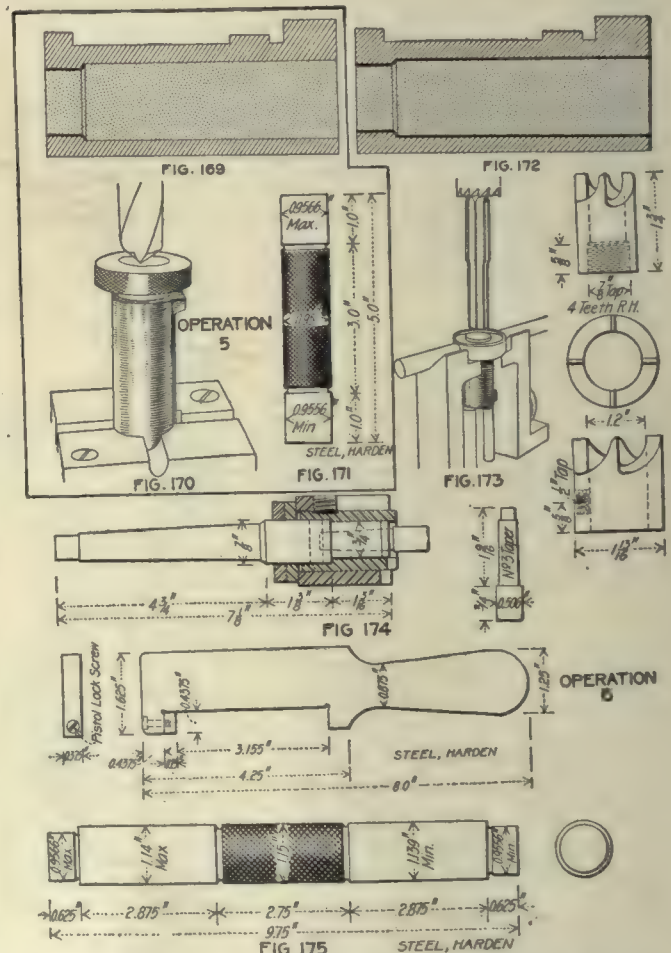
Transformation—Fig. 169. Machine Used—Pratt & Whitney upright drilling machine. Number of Operators per Machine—One. Work-Holding Devices—Work set into plate using lug for stop, Fig. 170. Tool-Holding Devices—Drill on taper shank. Cutting Tools—High-speed drill, for 0.956-in. hole. Cut Data—Speed, 160 r.p.m.; feed, ⅜ in. feed. Coolant—Cutting oil; ¼-in. stream. Average Life of Tool Between Grindings—50 pieces. Gages—Plug, Fig. 171. Production—25 per hr.

OPERATIONS 6 AND 8. REAMING AND SQUARING

Transformation—Fig. 172. Machine Used—Pratt & Whitney upright drilling machine. Number of Operators per Machine—One. Work-Holding Devices—Work held in holder; this goes in fixture, Fig. 173. Tool-Holding Devices—Taper-shank socket. Cutting Tools—Step reamer for both diameters; facing cutter on reamer, Fig. 174. Cut Data—Speed, 160 r.p.m.; feed, about 1½ in. per min. Coolant—Cutting oil; ¼-in. stream. Average Life of Tool Between Grindings—About 10 pieces. Gages—Plug and length, Fig. 175. Production—25 per hr.

OPERATION 9. MILLING BOTH SIDES LENGTHWISE

Transformation—Fig. 176. Machine Used—Pratt & Whitney Lincoln type belt-drive miller. Number of Machines per Operator—Two. Work-Holding Devices—Work held in



ture mandrels fitting holes in bore and clamping at ends, Figs. 177 and 178. Tool-Holding Devices—Cutters held on standard arbor. Cutting Tools—Two sets of forming cutters, Fig. 179. Number of Cuts—Two. Cut Data—Speed, 60 r.p.m.; feed, ⅜ in. per min. Coolant—Compound. Average Life of Tool Between Grindings—1,000 pieces. Gages—Thickness of barrel, location of shoulders, length and contour, Fig. 180; gage 180-A indicates location of shoulder and lugs on top of base and also shows contour of outside of base; 180-B gages the bevel beside the lugs and above lightening cuts. Production—25 per hr.

acid. Let this mixture stand (stirring it occasionally) until the acid "cuts," or takes up, all of the iron that it will. After the muriatic acid becomes saturated with the carbonate of iron, pour the acid off carefully into a glass

demijohn, being careful that none of the remaining sediment goes with it. Add 9 qt. of grain alcohol. This completes the tincture of steel.

For making the browning solution proper, take 6 oz. of this tincture of steel, 6 oz. sweet spirits of niter, 1 oz. nitric acid, $\frac{1}{2}$ oz. sulphate of copper, 1 oz. corrosive sublimate, 2 qt. soft water. Mix them in a glass-stoppered bottle, to prevent evaporation. Let the solution stand for 24 hr., if possible, although it can be used immediately, but does not give as good results.

The browning solution is applied with a sponge, as previously mentioned. This method is found much more satisfactory than the dipping process. After the barrel is entirely covered, it is placed in a rack, Fig. 242. When the rack is full, it is rolled into a steaming cabinet at the end of the browning room. Here it is subjected to a steam bath for about 1 hr. The length of time depends largely upon the condition of the atmosphere, as in humid weather a much shorter exposure is required. This steam bath forms a coating of red oxide, or rust, all over the barrel, which should not remain too long in the steam cabinet, or a surplus coat of oxide will be formed and have to be brushed off.

When the barrels are properly rusted, they are boiled in clear hot water for about 5 min. in the tank, Fig. 241. This "sets" the rust and turns the barrels a dull black. They are next brushed with fine wire, or "card," wheels to get a smooth surface. The brushing also polishes the barrels and prepares them for the next coating of the browning solution. These operations are repeated until the barrel has been through the process three times. When the barrel is finally brushed and polished, it has a fine surface and a coating that will stand considerable wear. The plugs are then pulled out from each end, and the barrel is oiled on the outside, completing the work on the barrel until it is brought out for assembling.

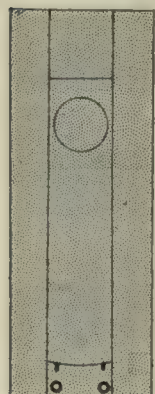


FIG. 193

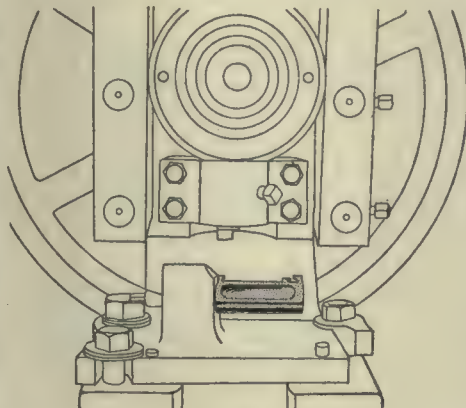


FIG. 194

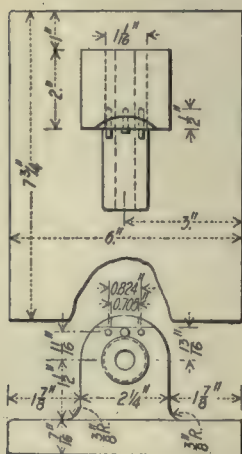


FIG. 195

OPERATION 13

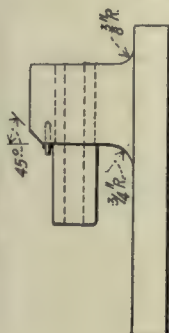


FIG. 196

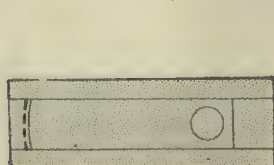


FIG. 197

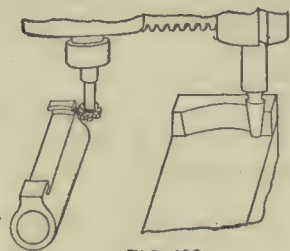


FIG. 199

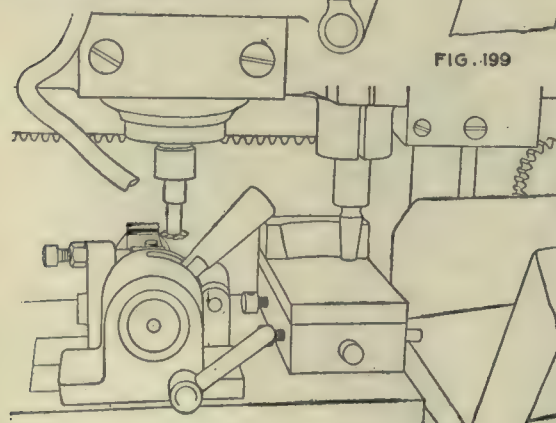


FIG. 198

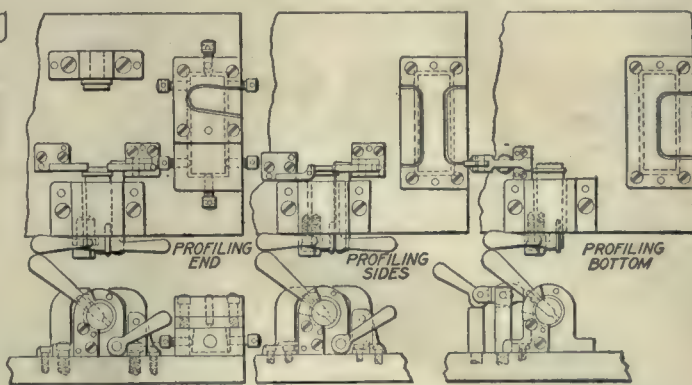


FIG. 200

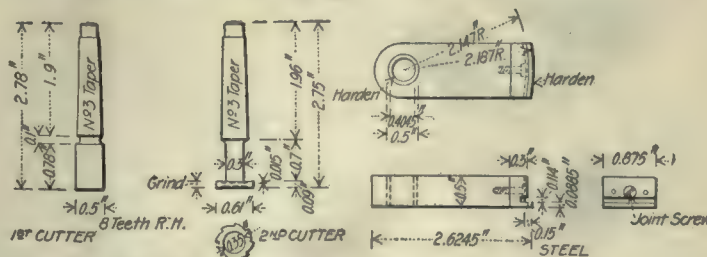


FIG. 201

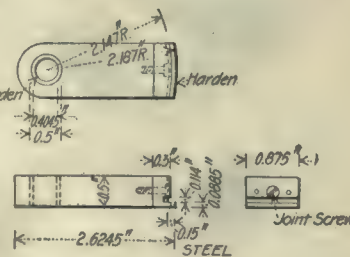


FIG. 202

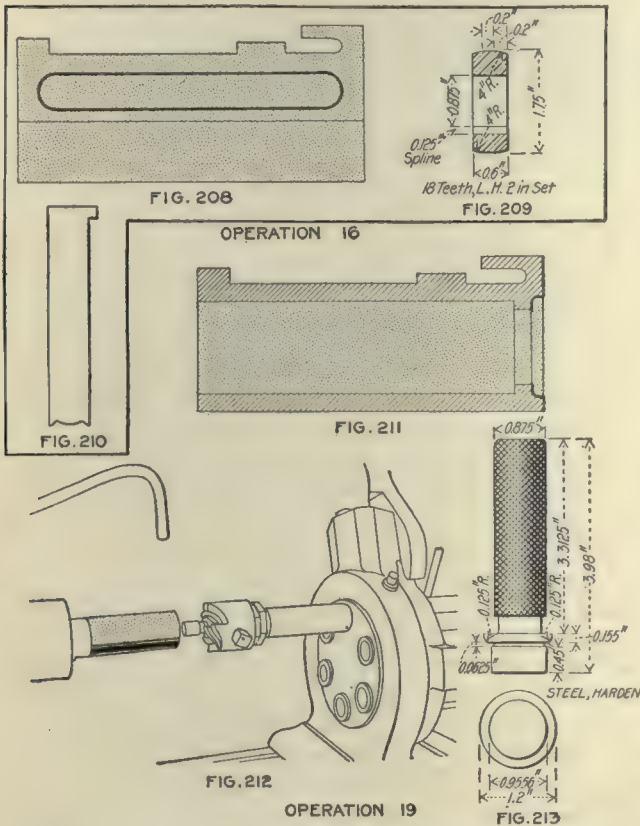
OPERATION 13. GRADUATING ZERO WINDAGE POINTS

Transformation—Fig. 193. Machine Used—Snow, Brooks & Co. trimming press. Number of Operators per Machine—One. Punches and Punch Holders—Stamping punch, round shank. Work Holders—Cast-iron fixture with lug, pin and stock to hold base and locate face for stamping, Figs. 194 and 195. Average Life of Punches and Dies—75,000 pieces. Lubricant—None. Gages—Fig. 196. Production—350 per hr.

OPERATION 14. PROFILING REAR LUG FOR SEAT OF REAR END OF MOVABLE BASE

Transformation—Fig. 197. Machine Used—Pratt & Whitney profiler. Number of Operators per Machine—One. Work-Holding Devices—Clamping fixture, Figs. 198 and 200, using mandrel; machining diagram, Fig. 199. Tool-Holding Devices—Taper shank. Cutting Tools—One $\frac{1}{2}$ -in. slitting cutter; one side and bottom mill, high-speed steel, Fig. 201. Cut Data—

Speed, 900 r.p.m.; hand feed. Coolant—Compound; two $\frac{1}{4}$ -in. streams. Average Life of Tool Between Grindings—About 150 to 200 pieces. Gages—Fig. 202, also used in operation 20. Production—50 per hr.



At the muzzle end where the plugs swell out around the bore, a ring of bright metal will appear. This is treated by brushing a coating of copperas, or blue vitriol, over the bright ring and following with a coating of sulphide of ammonia. This treatment oxidizes the copper and turns it to approximately the same color as that left by the browning solution. The end of the muzzle is thus left all black,

preventing the reflection of light, which is so dangerous in modern warfare.

The operations on the fixed base may be said to act as an introduction to the operations performed on the receiver, which will be described in ensuing articles. While there is no comparison in complexity of operations between these two parts, they are handled in a similar way largely by milling, drilling and shaving operations. Profile milling does not enter widely into the manufacture of the fixed base, whereas profile operations are frequent upon the receiver. Both of these parts originate as drop forgings, and the work done upon each is such as to leave a mere shell of metal when finished.

OPERATION 15. SHAVING FOR WINDAGE SCREW

Transformation—Fig. 203. Machine Used—Bement & Miles Co. crank press. Number of Operators per Machine—One. Punches and Punch Holders—Special punch, Fig. 206. Work Holders—Special fixture, Figs. 204 and 205. Average Life of Punches and Dies—60 pieces for each grinding. Lubricant—Cutting oil; $\frac{1}{2}$ -in. stream. Gages—Width and length, Fig. 207. Production—60 per hr.

OPERATION 15½. BURRING OPERATION 15

Number of Operators—One. Description of Operation—Removing burrs from bottom of cut, operation 15. Apparatus and Equipment Used—File and scraper. Gages—None. Production—300 per hr.

OPERATION 16. MILLING OUTSIDE OF WALLS OF BASE

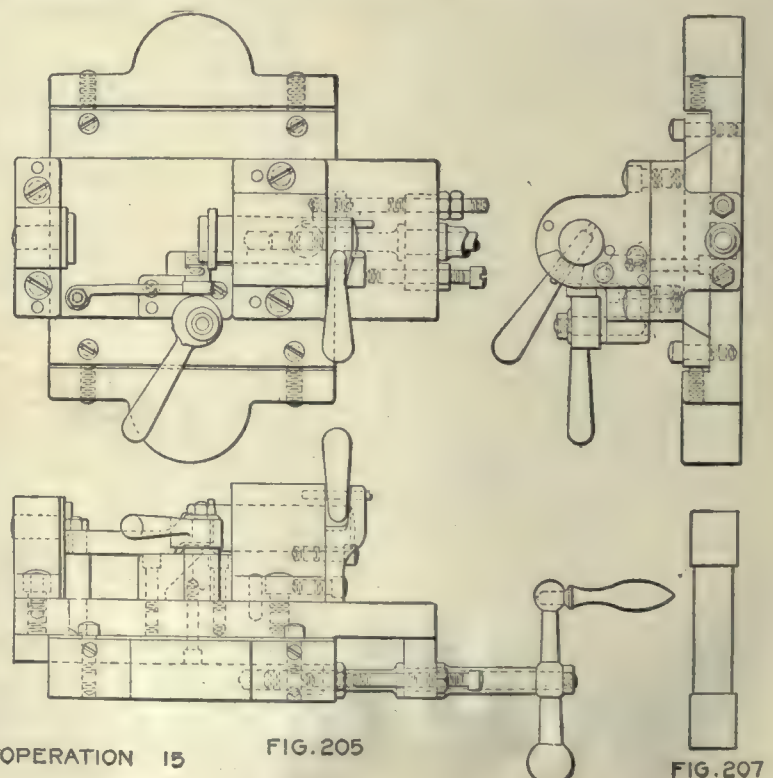
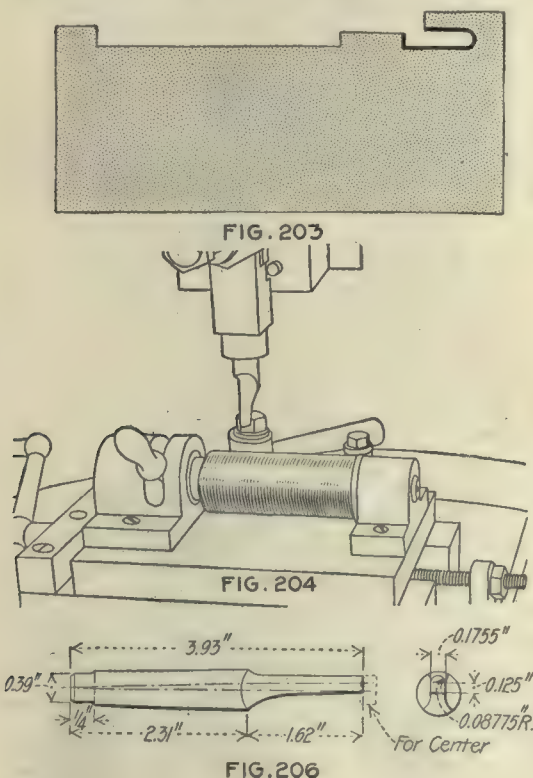
Transformation—Fig. 208. Machine Used—Pratt & Whitney Lincoln type belt-drive miller. Number of Operators per Machine—Two. Work-Holding Devices—Work held in vise fixture similar to Fig. 182. Tool-Holding Devices—Cutters held on standard arbor. Cutting Tools—Milling cutter, Fig. 209. Number of Cuts—Two. Cut Data—1-in. feed; speed, 90 r.p.m. Coolant—Compound; two $\frac{1}{4}$ -in. streams. Average Life of Tool Between Grindings—1,000 to 1,500 pieces. Gages—Depth, Fig. 210. Production—25 per hr.

OPERATION 19. SQUARING AND COUNTERBORING FRONT END OF BASE FOR HAND-GUARD TENON

Transformation—Fig. 211. Machine Used—Pratt & Whitney hand screw machine. Number of Operators per Machine—One. Work-Holding Devices—Work held on pin, which acts as a stop, Fig. 212. Tool-Holding Devices—Tool held in turret of machine. Cutting Tools—Counterbore and facing mill combined with pilot. Cut Data—Speed, 250 r.p.m.; hand feed. Coolant—Compound. Average Life of Tool Between Grindings—500 pieces. Gages—Plug, Fig. 213. Production—85 per hr.

OPERATION 20. SHAVING UPPER AND UNDERCUT CIRCLES ON REAR LUG

Transformation—Fig. 214. Number of Operators—One. Description of Operation—Shaving burrs and sizing up. Apparatus and Equipment Used—Plug base held in vise and hand shaving tool, Figs. 215 and 216. Gages—Fig. 217. Production—75 per hr.



Some of the fixtures made at the Springfield arsenal are of necessity elaborate in design and approach special tools in complexity. It is hard to draw the line in some instances between a special tool and a complicated fixture and to say under which heading the apparatus should be

defined. This is particularly true regarding the inspecting fixtures. It will be noted that many of these are nice examples of the tool maker's art, and an inspection of them will give an idea of the grade of skill required in a rifle shop toolroom to produce satisfactory appliances.

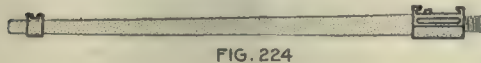


FIG. 224



FIG. 225

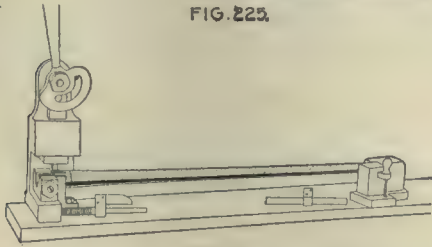


FIG. 226

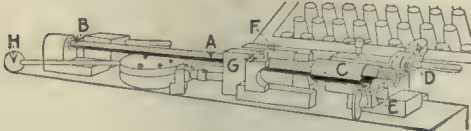


FIG. 228

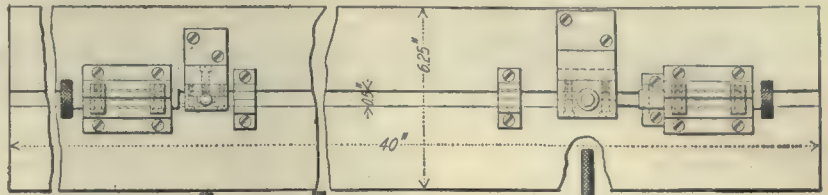


FIG. 229

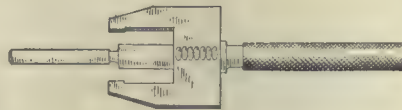


FIG. 227

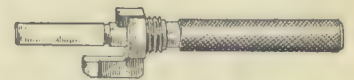


FIG. 230

OPERATION 40



FIG. 231

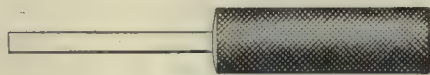
FIG. 232
OPERATION 41

FIG. 233



FIG. 235

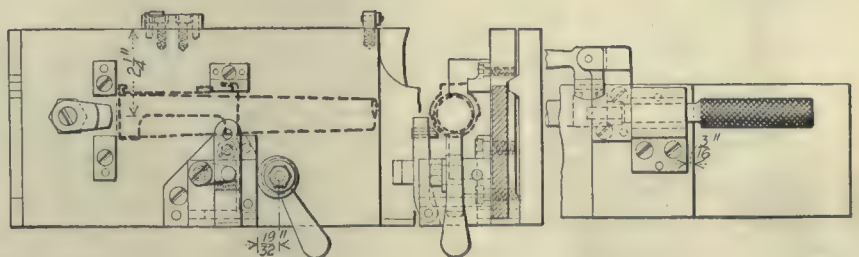


FIG. 234

OPERATION 42

OPERATION 40. ASSEMBLING FRONT STUD AND FIXED BASE ON BARREL

Transformation—Fig. 224. Number of Operators—One. Description of Operation—The stud is driven on over the spline on barrel by means of the small set shown in Fig. 225; the depth of the hole in the end of the set determines the distance of the stud from the muzzle; the fixed base is forced on with the hand press shown in Fig. 228. Apparatus and Equipment Used—The barrel A is placed in the press, Fig. 228, and the front stud is located by the block B; the fixed base C is in position ready to be forced into place; the butt end is held by the strap D, which is fastened by the clamp E; the two swinging jaws F and G are then closed around the barrel in front of the fixed base, and a pull of the handle H forces it into position; the side line on the fixed base now replaces the draw line for all future measurements. Gages—The bench fixture, Fig. 226, tests the location of the stud with the draw line; the finger gages, shown in front of the barrel, test the diameter of the fixed stud; other gages are shown in Figs. 227 and 229, the latter testing the location of the shoulder on the fixed base with relation to the fixed stud; the gage in Fig. 230 tests the location of the fixed-stud shoulder with the extractor cut. Production—75 per hr.

OPERATION 41. DRILLING AND REAMING FRONT SIGHT, FIXED STUD AND BARREL FOR SECURING PIN

Transformation—Fig. 231. Machine Used—Pratt & Whitney two-spindle vertical drilling machine. Number of Operators per Machine—One. Work-Holding Devices—Work held in fixture sliding on table. Tool-Holding Devices—Tool held in drill chuck. Cutting Tools—.082-in. drill, No. 45; .087-in. reamer. Number of Cuts—Two. Cut Data—Speed, 600 r.p.m. Coolant—Water. Average Life of Tool Between Grindings—200 holes. Gages—Plug, Fig. 232. Production—60 per hr.

OPERATION 42. REAMING AND DRILLING FIXED BASE ON BARREL

Transformation—Fig. 233. Machine Used—Pratt & Whitney upright two-spindle drilling machine. Number of Operators per Machine—One. Work-Holding Devices—Work held in fixture, Fig. 234. Tool-Holding Devices—Tool held in drill chuck. Cutting Tools—Drill and reamer, same as in operation 41. Number of Cuts—Two. Cut Data—Same as for operation 41. Coolant—Water. Average Life of Tool Between Grindings—200 pieces. Gages—Plug, Fig. 235. Production—50 per hr.

OPERATION 43. PINNING FRONT STUD AND REAR BASE TO BARREL

Number of Operators—One. Description of Operation—Driving in stud. Apparatus and Equipment Used—Hammer and header. Gages—None. Production—85 per hr.

OPERATION 44. DRILLING REAR-BASE SPLINE-PIN HOLE

Transformation—Fig. 236. Machine Used—Pratt & Whitney two-spindle centering machine. Number of Operators per Machine—One. Number of Holding Devices—Fig. 237 and 238. Tool-Holding Devices—Tool held in drill chuck. Cutting Tools—Drill No. 45; 0.087 in. reamer. Number of Cuts—Two. Cut Data—Same as operation 41. Coolant—Oil with brush. Average Life of Tool Between Grindings—200 pieces. Gages—Plug, Fig. 239. Production—80 per hr.



FIG. 236

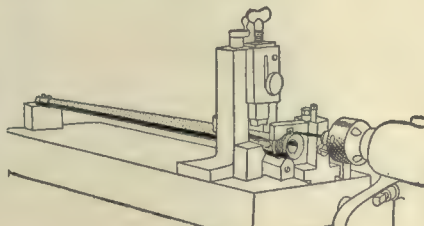


FIG. 237



FIG. 239

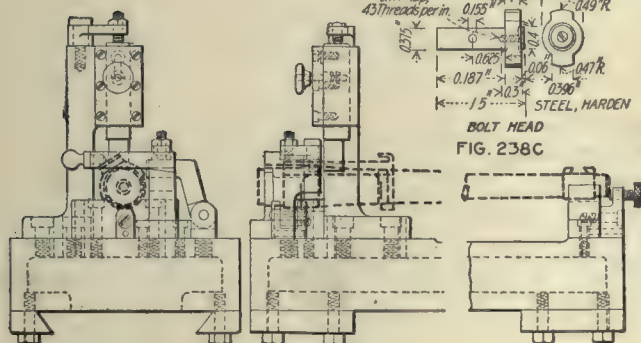
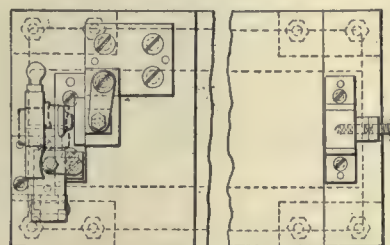


FIG 238

OPERATION 44

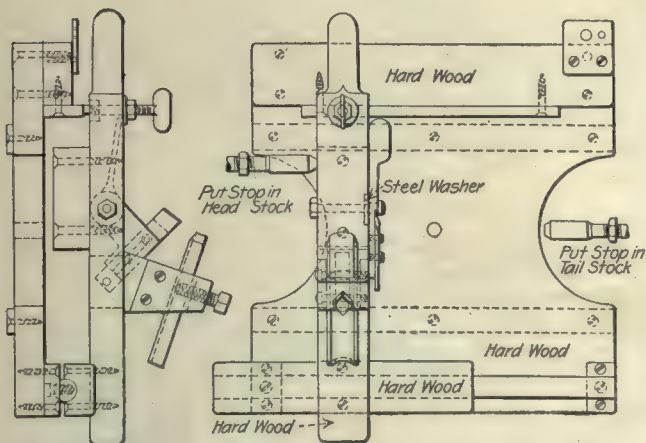


FIG. 243. ARRANGEMENT FOR TURNING WOODEN PLUGS
FOR BARRELS

OPERATION 46. GRINDING AND POLISHING END OF SECURING PIN

Number of Operators—One. Description of Operation—Work held in hands and grinding head of pins down flush with base. Apparatus and Equipment Used—Bench grinder made in arsenal. Gages—None. Production—40 per hr.

OPERATION 47. BROWNING
(Previously described.)

OPERATION 2. RIFLE ASSEMBLY

Final reaming of chamber to secure correct head space. This is done after receiver is screwed to barrel, the finishing reamer going through bolt and being held in position by it. Fig. 238-A shows the reamer in position in the bolt and Fig. 238-B with the bolt locked in position in the receiver. This reams the chamber with reference to the bolt and gives proper head room. The bolt is slid into place in the receiver and locked, then the screw A draws it back against front end shoulders. The locking nuts B determine the depth of the chamber. The chambering reamer is then forced into the barrel by the handle shown, the fine threaded screw C being to secure the adjustment of the locknuts B, which stop against the bolt.

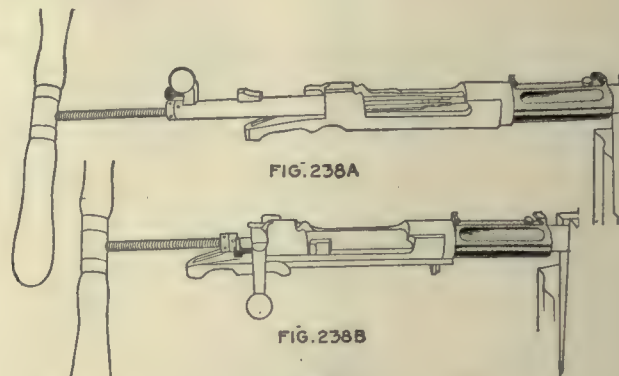


FIG. 238A

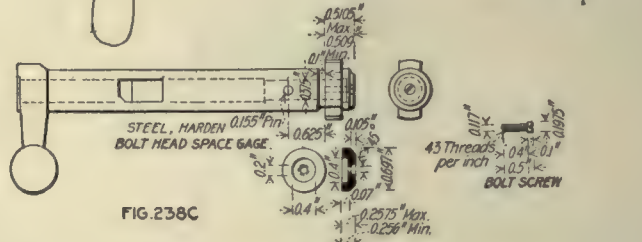


FIG. 238C

Prize for Mechanical Hands

The Société Nationale de Chirurgie, of Paris, in a circular letter received in New York City, announces that a person who wishes to remain anonymous has offered to the Société a prize of 50,000 francs, to be given to the maker of a mechanical apparatus for use by men who have lost the use of their hands. The circular reads:

All competitors must belong to allied or neutral nations. They are to present to the Society mutilated men who have been using their apparatus for at least six months. The Société de Chirurgie will experiment with each apparatus on mutilated men for the length of time it thinks fit. The apparatus rewarded is to remain the property of its inventor. The competition will be closed two years after the end of the war.

MM. Faure, Kirmisson, Quenu, Rieffel and Rochard, who make up the committee elected by the Société, inform the public of the condition of the competition, as stated by the donor, and beg any person wishing to compete to send his application and apparatus to M. le Secrétaire Général de la Société Nationale de Chirurgie, à Paris, 12 rue de Seine.

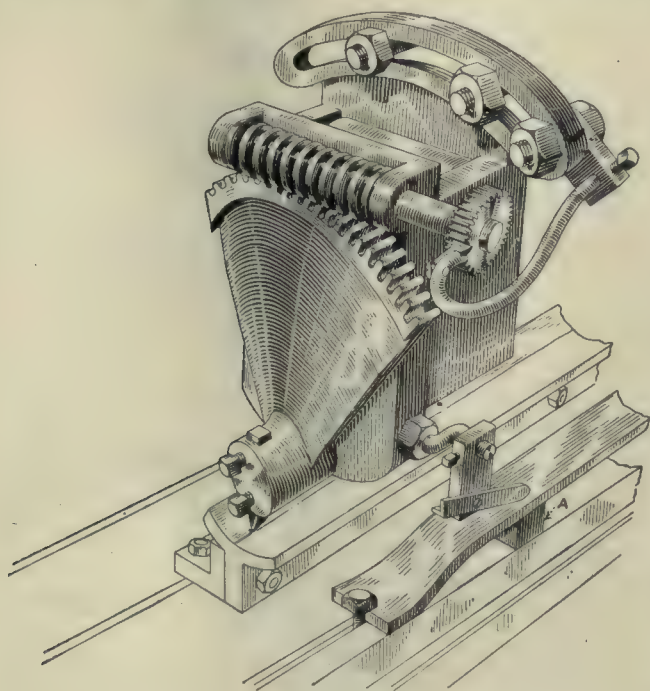
Reinventing Ancient Devices is a constantly recurring subject, but if by this means anything hitherto useless is made useful it ought to be satisfactory. It is difficult to see, as is generally inferred, that someone has been defrauded in the operation. The value of any mechanical appliance is in what it accomplishes, not in the combination of parts or pieces, and the man who makes it work, by additions or amendments, is the one who benefits the public. Too much solicitude for those who buy and use such appliances is apparent. They judge by results and are not likely to be defrauded to any extent. If the device, whatever it may be, possesses no value, it is not likely to sell, and the one most injured is the one who attempts the selling. If it is of value, the fact of its being old or new does not change its value.—"Railway and Locomotive Engineering."

Letters from Practical Men

Tool Lifter and Feed for Arc Planing

In order to plane a number of 3x3x $\frac{3}{8}$ -in. T-rails as depicted in the illustration, I rigged up the lifting and feed attachment shown. These rails were 6 ft. long, and before being planed were formed up with a punch and die in a press. The side of the rail attached to the angle plate was planed and fastened with four bolts.

It will be noted that the feed and amount of lift of the tool in order to get the desired feeds for roughing



THE LIFTER AND FEED ATTACHMENT

and finishing cuts are regulated by elevating or lowering the small block *A* under the strip on the planer bed.

The attachment serves a double purpose, as it lifts the cutting tool clear of the work on the return stroke and feeds the tool around the required amount by turning the worm and sector. After setting up and a trial, I found that it worked out well and did an accurate job.

Wheeling, W. Va.

EDWIN E. DEIST.

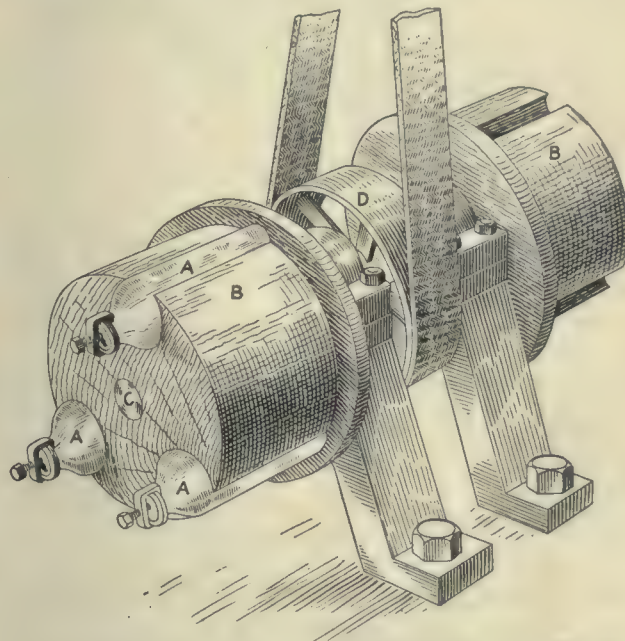
Polishing Small Hardened Parts

In a shop manufacturing small steel parts it was at one time customary to polish a great many of the hardened parts on polishing wheels by hand until the machine illustrated was designed and put into use. It entirely did away with handwork and produced better results.

The work is placed in six containers *A*. These may be glass fruit jars or milk bottles, though for continued wear cast iron is better. They must be fitted with tight-fitting tops and clamps or other means for holding the tops securely in place. A wooden frame *B* is attached

to the shaft *C* and holds the containers. A belt pulley *D* drives the shaft *C*.

In operation the work is placed in the containers and covered with a solution consisting of a piece of cyanide (about the size of a chestnut), a handful of sal soda and a quart of water. The cover is clamped in



TUMBLING MACHINE FOR SMALL WORK

place and the containers put into the frame *B*, held in position by suitable clamps, not shown. The whole is revolved at about 60 r.p.m. for two or three days, or until the required degree of finish is obtained. The pieces are then taken from the solution and dried by tumbling them in sawdust in the regular tumbling barrel.

Long Island City, N. Y.

DONALD BAKER.

Preventing Breakage of Electric Bulbs

Incandescent lamps are lost often by breaking the small frail tip where the glass of the bulb is sealed. I have saved many lamps by pressing a ball of stiff putty about $\frac{3}{8}$ in. in diameter over this tip, thus protecting it from any chance blow.

C. W. MEGGENHOFEN.

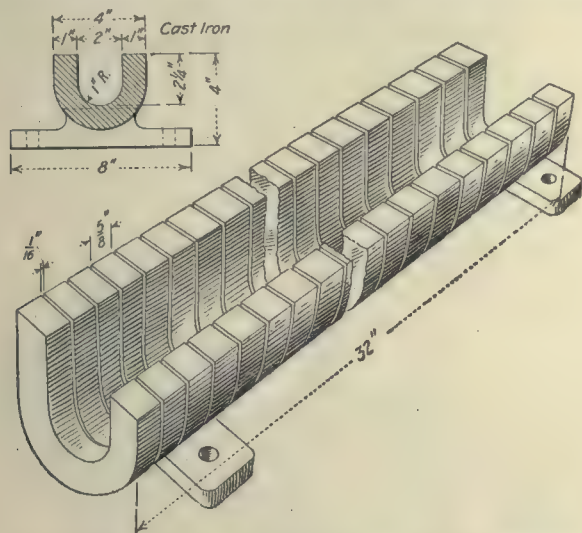
Indianapolis, Ind.

Jig for Cutting Hard Grease

The illustration shows a jig for cutting hard grease into uniform lengths. We get hard grease in barrels, just as lard is shipped, but the grease is a good bit harder. We cut it out in chunks, put it into a pneumatic press, and it comes out in long round sticks $1\frac{7}{8}$ in. in diameter, just the size for driving-rod grease cups of all locomotives. In using this device one of these long pieces is laid in it, and small chunks are cut off with-

out moving the main piece. Experiments show that each chunk weighs 1 oz. Of course, other railroads, factories, manufacturing establishments, etc., may use hard grease in different diameters, but the drawing conveys an idea that may be applied.

This device is very simple in construction. It is made of cast iron, has four lugs with screw holes for bolting



JIG FOR CUTTING UNIFORM-SIZE GREASE PLUGS

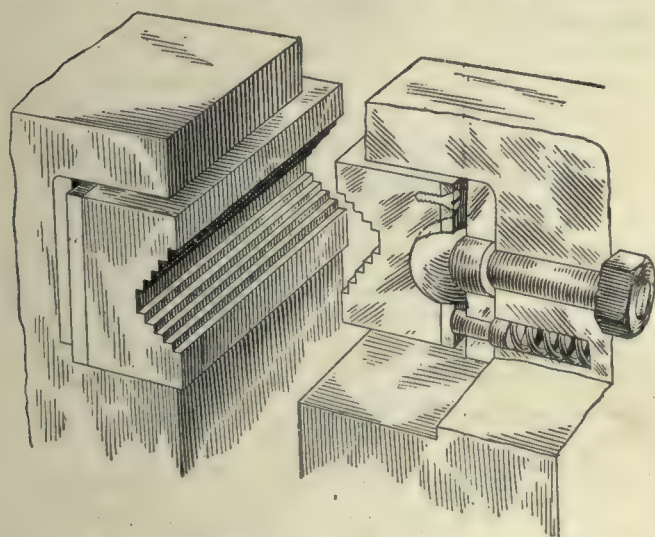
to a bench and has 47 slots sawed in it, as shown. It is cheap, too, which is also another good point in its favor.

JOSEPH K. LONG.

Renovo, Penn.

Floating Jaws for Bolt Cutter

Having some very crooked stock to thread on both ends, we devised the vise jaws illustrated. The results convinced us that some such scheme should become a standard part of all bolt cutters. The device is not a full floating fixture, but by passing the stock through the jaws and



THE FLOATING JAWS

into the chasers, thus centering the work before tightening the jaws, we secure very good alignment, and the work can still float vertically.

We found it necessary to apply a spring, as shown, to support the jaws in a vertical position. By removing the

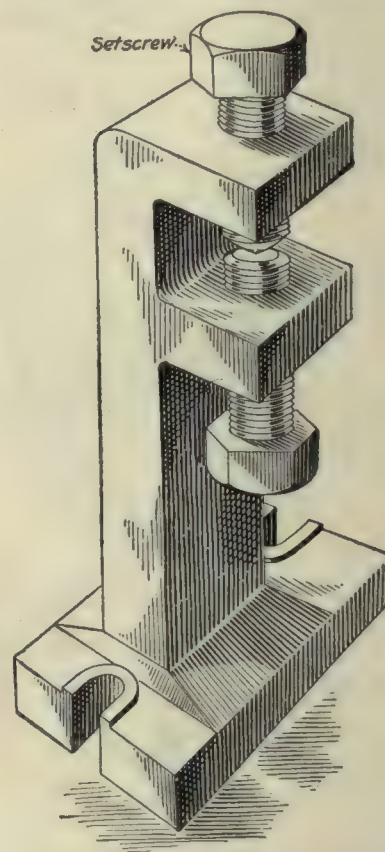
nut the standard jaws, if desired, can be inserted; but while the swivel jaws are a necessity for some work, they are good for all work.

EDMUND R. STEVENSON.

Detroit, Mich.

Clamping Bracket for Springy Work

The drawing shows a device that can be conveniently used on a shaper, miller, etc. It frequently happens that a piece of work will have considerable overhang beyond the chuck, or parallels, and jacks or blocking must be used and the work clamped down in order that it may be



CLAMPING BRACKET FOR SPRINGY WORK

held firmly and be free from springing. In all cases such as these the clamping bracket shown may be used to great advantage.

The bracket is set at the required distance and is bolted directly to the table; or, if necessary, the bracket itself may be raised on parallels to obtain the proper height. The work is then securely clamped between the points of the two setscrews shown, and is leveled by adjusting the upper and lower screws.

As will be noted, the clamping bracket is simple in design, and it would probably be a good idea to have some cast in steel, or even cast iron, and assign several to each shaper, miller, radial drill, etc.

Plainly, a bracket of this sort will save a great deal of time in hunting up blocking, clamps and jacks, and setting them.

The setscrews should be unusually heavy in proportion to the rest of the bracket, so that the greatest point of wear—the threads—may be strengthened.

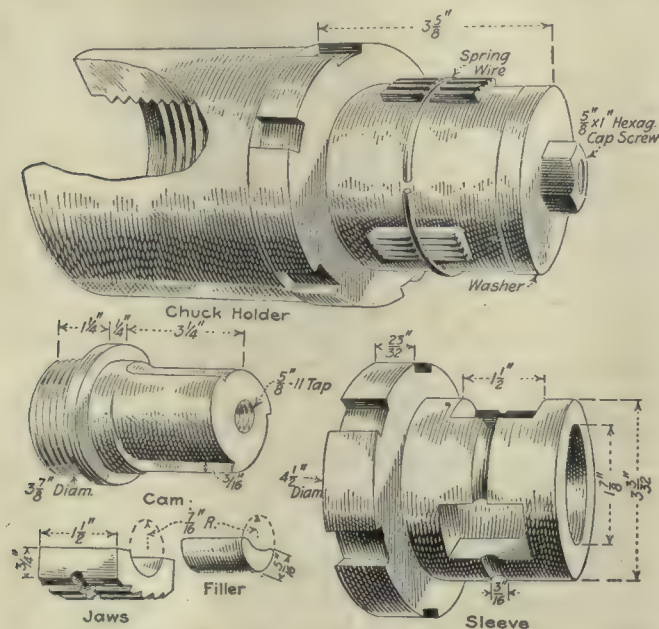
Plainfield, N. J.

J. B. MURPHY.

Discussion of Previous Question

Driving Center for Rough-Turning Shells

The device described by Mr. Homewood on page 251 recalls to me that a year ago I assisted in tooling up and afterward took charge of a department where the rough-turning of 4.5-in. high-explosive howitzer shells was carried out. We designed a somewhat similar driver, but found after a short time that the points of the threads, or serrations, mashed down or chipped off, owing



DRIVER FOR 4.5-IN. HIGH-EXPLOSIVE SHELLS

to the billets being forced to the same place every time. The shells slipped with disastrous consequences. Later, the chuck here shown was developed, and it is now giving every satisfaction. It gives a positive drive, and as a machinery salesman said, "It is quicker than air."

Other points in favor of this chuck are (1) the operator need not stop the lathe; (2) no wrench or wheel is necessary; (3) experience has proved that little or no repairs are required; (4) as it is smaller than the finished shell it is not in the way of the toolholder; (5) as it is very short, tailstock projection is reduced to a minimum; (6) no excessive end thrust is required on the tail center to keep the shell on tightly (as is the case with mandrels of the type described by Mr. Homewood), this naturally reducing the wear on the tail center and the thrust collar on the lathe spindle.

To take a shell off, all one has to do is to run back the tail center. The long overhang of the heavy rotating billet loosens, the chuck collapses and the shell readily slides off. The operator soon becomes proficient in giving the billet a slight left-hand turn when withdrawing or inserting the billet, which is all that is necessary.

The sleeve is provided with wrench slots, in case of emergency.

The first chuck we made ran continuously without any attention for six months night and day, on 4.5-in. shells, turning an average of 9 to 11 per hr., the highest individual record being 160 in 12 hr. A single tool was used on the heavy engine lathe. The feed was 16 per in.

St. John, N. B.

CHARLES F. WHYTE.

Data on Cylinder and Piston Grinding

On page 860, Vol. 44, A. D. Marcotte asks for data on piston and cylinder grinding. While I have not had experience on grinding pistons and cylinders as a commercial proposition, the following comments may be interesting:

The liners and pistons of Diesel engines at a certain factory were always ground in a lathe after boring and turning. At first, we used a specially made overhead drum and a grinding spindle manufactured in the shop, but the quality of the work did not come up to expectations.

I later substituted an electric grinder held in a bar of 4-in. square mild steel set out sufficiently to reach the liner end. The work was first ground dry, but afterward I fitted a flexible hose for water supply. The liquid selected was ordinary weak soda water.

The liner was held in the chuck, and two steadies were used. The amount of stock removed varied from 0.008 to 0.012 in., preferably the former if the bore was round. The diameters were from 12 to 14 in. in the bore, according to the make of engine.

The grinder was manufactured by the United States Electrical Tool Co., of Cincinnati, and worked in the orthodox way from the electric-light mains. The wheel was about 5 in. in diameter of aluminum of K 24 combination. This wheel had originally been of a larger diameter and was turned down to suit the job.

Leather pads were put between the clamping strip and the grinder shank where it was held at the outer end of the bar, and similar pads were placed under the clamps of the tool rest, which held the fixed end of the bar.

The lathe and work revolved in the ordinary way—toward the operator—and the grinding wheel was used on the back side of the liner bore, cutting downward. These liners varied in length from 42 to 48 in., according to bore and different makers' practice. With the aforementioned rig the finish was all that could be desired.

The clearance given between piston and liner was 0.004 in. to a maximum of 0.006 in. on diameters of 12 in., and up to 0.007 in. on diameters of 14 in. In some cases both piston and liner were of cast iron; in other cases the piston was cast iron and the liner steel.

The average clearance to be found in gas and oil engines of British manufacture varies from 0.004 to 0.008 in. on diameters of 9 to 14 in. Diesel engine clearances are about the same.

In Italian Diesel engines the clearances are somewhat greater, reaching 0.009 in., while in oil engines of Scandinavian make, of which the Tuxham engine made by the Tuxham Maskinfabrik, Copenhagen, may be taken as a representative example, the clearance on 6-in. diameter is 0.0045 to 0.0055 in.

P. G. BRADFORD.

Johore, Straits Settlements.



Blueprints Without Tracings

I have noticed quite a number of articles on the subject of blueprints without tracings (the latest on page 35) and would like to make two suggestions that may do away with a few objections to using pencil drawings on bond or detail paper.

First, when making the drawings, get the part or tool drawn in lightly until certain that it can be finished with a minimum of erasures; then put a sheet of carbon paper under the paper with the carbon side up and finish the drawing with a 2H pencil. This grade of pencil is not so soft that it will easily smear; yet "body" is given to the lines by having the carbon lines on the back of the paper, and it will be found that an excellent blueprint can be obtained.

If it is necessary to erase, rub out the carbon line first, the paper being held on a smooth hard surface. Rub through a "mask," which may be made by cutting a shaped hole in a piece of tracing cloth if a metal one is not obtainable.

The storing of thin paper drawings is not an easy thing, as they are easily creased and torn. If they are laid flat in a drawer and a sheet of cardboard placed between every ten (five if very large), they can be kept very well. The regular arrangement of the cardboards makes it easy to find the drawings when required.

Nottingham, England.

ALBERT F. GUYLER.



The Advantages of Machinist Draftsmen

F. J. Badge asks, on page 31, "Why do not more machinists become draftsmen?" They do not do so for a very good reason—they have far too much common-sense. (I am speaking, as a draftsman, of the conditions obtaining in England and am taking average cases.) What object is there in a machinist leaving his trade and entering the drafting profession? More money? Not by a long way. Shorter hours? Perhaps, but with an adequate reduction in pay. As a machinist a man is at least classed as a mechanic. As a draftsman he will be classed among clerks and typists. This happens in various ways. A newspaper advertisement gave a recent instance of this kind of thing. Men were wanted for a particular branch of service in which some little knowledge of mechanics was required, and the advertisers were kind enough to intimate that clerks and draftsmen were not required.

The piecework bonus alone earned by many machinists would more than pay the "salary" of the average draftsman. When you take into account the varied knowledge that is expected of the draftsman—shop experience and knowledge, mathematics, mechanics, etc.—my impression is that, as far as money is concerned, the draftsman's job is in a bad way. I know that those who preach the

"always room at the top" doctrine will object, but as stated above I am only taking average cases and am not dealing with the supermen. As a case in point I might mention that of an iron polisher whose piecework bonus alone (without including his wages) came to ten shillings a week more than the "salary" paid to a draftsman who was designing complicated speed and feed boxes, single-pulley drives and various machine tools.

At the beginning of the war, when trade was somewhat dislocated, clerks, draftsmen, timekeepers, typists—in fact, all that heterogeneous collection known as the staff—in a large number of cases had their salaries cut down by from 20 to 33 per cent. If the hours had been reduced in proportion, there might have been some reason for the cut, but they were not. Were the mechanics' and machinists' wages reduced in a like manner? It was not even hinted at. Now a fact like this is somewhat remarkable, if you consider all that it implies. And this is where we get down to the facts that are responsible for the greatly different treatment of machinists and draftsmen. Machinists were, as usual, organized, and a reduction in wages could only have been brought about by consultation and agreement between the parties concerned. In their case no attempt was made at a reduction. Draftsmen were, as usual, unorganized (that is their own affair, of course), and in consequence employers made reductions how and when they pleased.

We will now take as an example a piece of more modern history. During the war the price of living has risen quite a considerable extent—due in part, it is whispered, to the maneuvers of certain wicked food manipulators. The wages of day workers—that is, those paid a certain fixed rate per hour, such as tool makers, millwrights, etc.—had not risen greatly beyond that paid in normal times. These men, naturally enough, claimed an increase in money; and being organized, they got it—an increase of 12½ per cent. The laborers, sweepers-up, etc., through their organization also got higher wages.

Draftsmen, unorganized, made a few spasmodic, disjointed efforts and, as usual, got nothing. Thus the intellectual department got hopelessly left by the sweepers-up.

Now the whole trend of modern life is toward coördination and coöperation of effort and interests. Employers in each trade federate together. Employees, with a few exceptions, do likewise. Now if you happen to be one of the exceptions, as a draftsman is, my contention is that you are in a somewhat unenviable position, being liable to be squeezed between the upper and lower millstones.

I put down the failure of draftsmen to grasp the weakness of their position to a mixture of stupidity and snobbishness, with a preponderance of the latter. (As mentioned, I am a draftsman myself and do not speak without intimate knowledge.) When one realizes that nearly all similar interests act in unison throughout the industrial world, it follows naturally that those who rely solely on their individual unaided efforts are likely to get badly left.

And further let it be noted that organization does not lower a man in the eyes of the world, as some of my fellow draftsmen would appear to believe, judging by their contemptuous attitude when the matter is discussed with them. Do not forget that one of the strongest organizations in this country is that of the medical profession; and although it is not called a trade

union, it is one of the most efficient unions I know of. But, then, doctors have the necessary foresight to appreciate the benefits and advantages that must accrue from a community of interests intelligently coöperating.

To sum up, we will take the advantages that will come to the machinist who takes Mr. Badge's advice and works up sufficient mathematics, trigonometry, drawing and a bit about nearly every trade in the factory to enable him to make his entry into the drawing office.

His wages per hour will be no more than in the shop and much less than a man makes on a good piece-work job.

In slack times his wages are liable to be reduced, and he will have no remedy except clearing out.

The machinist gets paid double for working on holidays. The draftsman gets nothing extra.

The machinist gets paid time and a half for working Saturday afternoons. The draftsman gets nothing extra.

The least the machinist gets for any overtime is time and a quarter. The least the draftsman gets is nothing at all.

As compensation, the draftsman gets paid for vacation, holidays and sickness. If, however, the firm is busy, the vacation and holidays are often not given; and if absence through sickness is prolonged or frequent, the order to quit is soon conferred upon him.

I think the query now becomes, "Why should a machinist become a draftsman?"

F. G. SMITH.

Coventry, England.

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Measuring Screw-Threads in the Small Shop

Mr. Murphy, in his article on accurate thread cutting, on page 210, mentions that for a certain thread-cutting job the newest and best lathe was used. It would have been well had he stated in the last paragraph the importance of having a good lathe and master or lead screw for accurate thread cutting. There are many toolroom tasks in which the skill of the workman can be made to overcome the lack of proper facilities. This is not true of thread cutting, however, as it is almost impossible to make the thread anything but a duplicate of the master thread. When Mr. Murphy speaks of the newest and best lathes I think of the days before the war, when shops in adding new lathes to their equipment really got the best. My experience in some small shops that recently have greatly increased their number of machine tools is that the newest are the worst, the tool makers preferring the old machines to the new when accurate work was to be done.

To return to accurate thread cutting, I have witnessed the making of Whitworth thread gages in several small shops lately, none of which were properly equipped for the work. The tool makers who were making these gages admitted that they were making a poor gage, excusing themselves by pointing out that they were doing the best they could under the circumstances. Polishing the gage with loose abrasive at the end of a stick instead of lapping with an accurate lap gave these gages a realistic appearance. If they were bright enough and measured O. K. at the top of the threads, they passed inspection and were delivered to some firm that was foolish enough to give such work to those who could

not be expected to do it right, owing partly to the fact that proper equipment was lacking and partly to the fact that they did not thoroughly understand thread cutting.

In such cases as the foregoing, I think that the party who placed the order was much to blame for the thread gages not coming up to standard. Tool makers do not refuse to undertake a job on the grounds that their equipment is unsuitable. They simply do the best they can with the tools at hand. I suppose the boss of the job shop looks at it in the same light.

To produce a precision thread is one of the most difficult and thankless jobs in the tool-making industry. If a real and conscientious tool maker settles down to the task of making a real thread gage, while others make them as described before, the real tool maker will take more time to produce a gage. He will also complain about the tools. The good tool maker may think: "Wait until they inspect these gages. I'll get some credit. The other fellow's errors will be detected." If the inspection consists of looking at the polish and perhaps measuring across the tops of the threads, you can see where the careful tool maker gets off.

Newark, N. J.

GUSTAVE A. REMACLE.

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What Is a Gage, a Die, a Jig, a Tool, a Fixture?

The situation that has arisen in connection with the Army Appropriation Bill, which may call for definitions of a gage, a die, a jig, a fixture and a tool, page 479, is one that often arises with inventory classifications of private manufacturers. As there are no standard definitions of these terms, much difference of opinion undoubtedly prevails. Having recently been mixed up with the definitions in inventory classifications, I will endeavor to define them; or rather, I will give the definitions that in my opinion will enable one to distinguish one of these devices from another, for that is really all that is necessary. It must be understood, however, that these definitions relate only to the devices used in the productive end of an organization. For instance, we know that a fixture in the machine shop is a special mechanical device, whereas in the office a table or a desk would be called a fixture.

Gage—A mechanical device designed to detect variations of measurement in the location of surfaces, holes, projections or other dimensions. Sometimes of an adjustable construction, and when so made should be set to a standard of measurement or by the aid of a measuring instrument. If constructed in such a manner that it will measure the amount of variation detected without the aid of other instruments, it ceases to be a gage and becomes a measuring instrument, which brings it under the classification of a tool.

Die—A mechanical device consisting of two or more parts which when brought together in a power-, hand- or foot-operated press, or similar machine, will change or alter the form of hot or cold metals by cutting, forming, bending or causing the metal to flow, or perform any combination of these operations at one time.

Jig—A mechanical device designed to hold parts, or one that can be attached to parts, which in either case has means whereby one or more tools that change or alter the form of the part can be suitably guided.

Fixture—A mechanical device designed to hold parts while manufacturing or inspecting them, and that will hold the parts in the position desired, the guidance of the working tool, if necessary, being accomplished by other means.

Tool—A hand-operated device, machine-tool attachment or measuring instrument that cannot be classified under any of the preceding definitions and that will alter the form or location of parts or assist in their production in any manner.

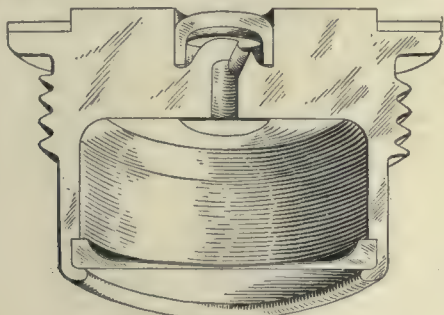
I realize that the foregoing definitions are susceptible to criticism, and that some of the readers may find them incomplete. In the event that this is so, I hope others will state their opinions on this interesting subject. So open to criticism are these definitions that I believe I could criticize them myself after having studied them over carefully, but would rather hear the opinions of other readers.

A. J. CHAMBERLAIN.

South Bend, Ind.

The Mark IV British Primer

Having read your articles on the manufacture of the Mark II primer, I show herewith the Mark IV primer, which is interchangeable with and simpler than the Mark II. It will be seen that the anvil, copper ball and plug, together with the projection and threaded chamber, have been dispensed with. The form and position of the cap chamber have also been changed, the cap now being inserted from the base of the primer. The



THE MARK IV PRIMER

general design of the cap chamber follows closely that of the 0.303-in. small-arm case. The anvil is formed in the body of the primer and has three equally spaced holes drilled through it, communicating with a central hole that connects with the powder chamber in the body of the primer. The cap chamber is slightly tapered, and the limits on the diameters are ± 0.0005 . It is rectified after machining with a master punch. Another change worthy of notice is the alternative of using a glazed-board closing disk in place of the brass disk in the Mark II primer.

A. R. WHITTLE.

Quebec, Canada.

The Art of Grinding

The remarks on the art of grinding on page 165 interest me. I, also, have used, sold and made grinding machines and wheels for all purposes. I have tried to study the grinding question seriously, and have often said as does Mr. Jacobs, "I know very little about it." My early experience with precision grinding was gained upon American machines that have long since been

superseded by heavier types. I found that most of my trouble at this time was due to the fact that wheels were marked as being of the same grade but in reality varied in hardness. Exact instructions as to speed and feed could not be given. Later, on my becoming connected with a firm that manufactured wheels largely for iron foundries, I met case after case where the wheel declared by one customer to be the best he ever used was rejected by another doing similar work as being much too soft or much too hard.

Perhaps one man looked at labor cost and the other at wheel cost. Possibly one workman pressed the wheel harder than the other. In the attempt to get data, some real live information that I could make use of, I built a testing machine. The idea was to apply to a wheel of known speed and weight a piece of metal of known weight under a known pressure. Then, by using the knowledge of the weight of metal ground away for a certain wheel loss, an efficiency figure would be obtained for purposes of comparison. In practice I found that a wheel that glazed under a light pressure did splendidly under a heavier pressure, and was a failure owing to excessive loss of material under still heavier pressures. From these experiments of many years ago I have always maintained and often proved, that on a light machine and slender work a soft wheel is required; and that in dealing with heavier work of the same material on the same machine a harder wheel can be used.

The nearer we get to rigidity and maintenance of alignment in the machine and stiffness in the work, the harder the grade and the coarser the grain of wheel that can be worked, and the less influence the speed and feed of wheel and work have upon the operator's ability to obtain satisfactory results. Thus as machines improve, slight differences in the hardness of the wheels have less effect.

All wheels of the same nominal grade and grit do not behave alike. How can they? All steel tools do not, although they may have been made from the same bar and have undergone the same heat treatment. When the wheel salesman fails, he wants to try his luck again. When we can get milling cutters to behave exactly alike all the time, then I will have more hope for the wheels and expect fewer visits from the wheel salesman.

Clydebank, Scotland.

ROBERT SHAW.

Preventing Loose-Pulley Trouble

On page 387 I noticed an article on loose-pulley trouble by Donald Baker. In my capacity as a draftsman I have had this same thing brought to my attention, and I thought you might be interested to know how trouble was avoided.

The application I have in mind is the placing of a Hyatt roller bearing in the hub of the pulley. The hub is bored to receive the outer race of the bearing. The roller assembly is then put in place and the race held in position by end plates. These end plates also maintain the bearing in its proper position and prevent the escape of the lubricant as well as the intrusion of any foreign matter.

Pulleys thus equipped have run three to four months with one charge of oil. They offer no installation troubles, since the rollers operate directly on the shaft.

Kearney, N. J.

EDWARD R. SANSOM.

Editorials

The Spectacle of Spoiling Work To Pass Inspection

A most glaring example of the lack of knowledge regarding screw-thread fits comes from a maker of munitions who is supplying a nation that is well known for the excellence of its mechanical lines. The product turned out by this manufacturer had a number of screw-thread fits, one in particular being very carefully gaged. It so happened that a large number of these parts got by the factory inspector with the outside diameter a mere trifle under size. The pitch diameter was practically perfect. They fitted a threaded ring gage satisfactorily, but the outside snap gage, which should not have been used at all, showed the work to be slightly under size.

In vain the maker tried to show the inspector that the fit was perfect and that for the outer diameter to be exact was practically of little account. "Orders is orders," and the pieces were condemned. But they were not thrown away; not by a long ways. If outside diameter was what they wanted, they should have it.

So a special rolling tool was made, with the lead a trifle off and the threads rolled so as to increase the diameter. At the same time it distorted the lead slightly so that the metal rolled up would not make the piece a loose fit in the ring gage. In this way all the rejected parts were saved—all passing inspection—and yet they were not so good a job as before they were "doctored for the inspector."

There is great need of a better understanding as to what really makes a good fit in many cases, especially in screw threads. That intangible something known as experience, based on a goodly supply of commonsense, is the best foundation for rational inspection.

The Spirit of Get-Together

From "What can I get out of the Government?" to "What can I put into my Government?" is a change of purpose that has come over many engineers during the last two years. Instead of passively accepting the rights, protection and benefits that come from citizenship in our great country, there is an earnest resolve to aid actively in supporting, strengthening and upbuilding the State. This is one of the most significant changes in American engineering thought that has grown out of the present world-wide disturbance of war.

Comments in these columns have emphasized some of the great things that engineers have been privileged to do in connection with national affairs. It is unlikely that the country as a whole adequately appreciates the work that has been done by the Naval Consulting Board, and particularly its committee on preparedness. This committee, with the same membership, is to be continued and charged with new engineering duties for the good of the country.

The preparedness work which has had such a noteworthy beginning and progress is to be taken over by the civilian committee of the Council of National Defense.

Although this committee has not yet been appointed, it is confidently expected that engineers will be prominent on its membership.

A few weeks ago the President requested the National Academy of Sciences to establish a research committee to assist the Government in solving some of the many problems that constantly come up in administering the affairs of this great nation. The Academy at once set to work to meet this wish and has already established a basis of coöperation between its own membership of pure scientists and the engineers of the engineering societies who are applied scientists.

This last act is also significant as it is a step in the getting together of two groups of men who should be closely associated. The men of pure science are the ones who reach out into the vast unknown of natural laws and phenomena. They are on the frontier of discovery. The engineers are their followers. The facts and principles and laws that the scientists discover and declare are used by others for the good of mankind.

Beyond these achievements are a number of other movements and forces which are aiming toward a union of engineers among themselves. It is estimated that there are 30,000 in this country, most of whom belong to some one of the great national societies, or affiliated associations. The vision of what this great body of men might do through concerted action has gripped the imagination of many. At the present time a study is being made of the possibility of organizing these thousands of men into a body which shall have for its purpose the bringing forward of the engineer into the position of influence in public affairs that is his due.

The number of these movements, the intensity with which the idea has seized many of our engineering leaders—these promise much by way of practical results.

Efficiency in High Places

"So far the only efforts that have been made in this direction [toward industrial efficiency] have been applied to the workman and they have apparently not helped us to solve our industrial problems. It is absolutely necessary for us to measure the efficiency of those in control, for without efficiency in management efficiency of the workmen is relatively useless, even if it is possible to get it. With an efficient management there is but little difficulty in training the workmen to be efficient. This has been proved so many times and so clearly that there can be absolutely no doubt about it. Our most serious trouble is incompetency in high places. As long as that remains uncorrected, no amount of efficiency in the workmen will avail very much."

Inefficiency of those in control! Incompetency in high places! These are the counts in the foregoing indictment of industrial managers. The quotation is from an address delivered by H. L. Gantt before a recent meeting of the Associated Industries of Massachusetts.

Five years ago, perhaps only three years ago, such plain speaking to those who control American industries would have been unthought of. At that time the gaze of everyone was directed toward the workmen. Efficiency engineers were preaching the doctrine, "If we could only make the workmen efficient all would be well." Today leaders in industrial thought would paraphrase that wish as follows, "All will not be well until our industrial managers become efficient."

This viewpoint shows that another definite stage in our thinking and acting in regard to industrial management has been reached. Eyes are being turned away from the workmen toward those who control industries. It is a great pity that the former stage was ever necessary. Mr. Gantt in the address referred to above sums up the benefits from the era of efficiency engineers as follows:

"Undoubtedly much good would have been done if they could have accomplished their purpose, but in many cases—I might almost say in most cases—the only benefit derived from the activities of these efficiency experts was the benefit that they themselves received, and the word 'Efficiency,' which would stand for so much, became obnoxious to all."

Efficiency medicine administered to the workmen alone failed to produce the economies and increase the output as was expected. Had these doses proved a complete remedy it would have been demonstrated that the workmen were actually the sole responsible units of the industrial organization. But the expected remedy did not work. Its failure but proves something that should have been seen from the first—real improvement must always begin at the top. For the average industrial structure is more like an image of clay throughout, than one having clay feet and metal upper parts.

Put a little differently, work for improvement in industry must take the form of improving the leadership. Quoting again from Mr. Gantt:

"The attempt to remedy our troubles through the efficiency of the workman alone would indicate that the workman was really the responsible man in an industrial organization, and that to him alone was due the credit for the economies and efficiencies that are produced. This is so far from the fact that it is hardly worth discussing. The workman bears the same relation to the management that the soldier in the ranks bears to the officers. No amount of bravery on the part of the soldier or efficiency on the part of the workman, can amount to much if he is improperly directed."

It is possible that the complaints that we hear about the *increasing inefficiency of labor* should be directed at the *increasing inefficiency of management*. A military or naval officer cannot be trained in a day. A shop manager cannot be trained overnight. We have no facts as to the relative increase in the number of workmen taken into our industries compared with the number of executives and foremen that have taken up the work of their direction. Is it not possible that the workmen have relatively increased several times more than their managers? Yes, seems a reasonable answer to this question, for workmen can be trained for repetitive tasks in as many weeks as it takes years to prepare a superintendent or foreman for his responsible duties.

Our great need in measurement and management today is a gage for efficiency in high places. When it is found, our present methods of shop accounting will have to be radically revised.

Workmen in Government Shops

There is a tendency in some quarters to sneer at, if not to condemn, the men employed in Government workshops. This is usually based on the time taken to do a piece of work rather than on the quality of the work produced. But in most cases it is because of a lack of knowledge of either the requirements of the work or the conditions under which it is performed.

When the huge rifle contracts began to come to this country, they were eagerly sought by men who were well known in mechanical lines and who looked upon it as an opportunity to not only make large profits but to show how modern shop methods and equipment could turn out rifles at a much lower cost than the Government plant.

No money was spared in equipment nor in salaries to executives, while workmen were offered wages that attracted them from the older shops. But in spite of all this the rifle contracts have proved the most disappointing of any of the war business, and if actual figures could be had, the costs would probably be much above those in the Government plant.

The only reflection on the managers of these plants is that they did not realize what they were attempting to do. The rifle looks like a simple proposition, just an aggregate of small components that any shop can make. So the proposition seemed in advance. But it really contains many more difficult problems than appear on the surface, among them the often unnecessarily rigid inspection of nonessential operations, the exact size of clearance cuts and the like.

Critics of Government shops, and particularly of the ability of the men employed therein, are not often aware of all the conditions either as to the work or the equipment. And while the latter could be improved in many instances, it must be remembered that the larger an institution the more difficult it is to look after such details. This can be found in the shops of any of the larger corporations or trusts. And if it can exist there, how much more will it be found in shops where the appropriations for improvements must come from Congress, where only a few who happen to come from arsenal or navy yard districts have any direct interest in the plants? The pork barrel seems to be too prominent a feature in Congress to secure good and appropriate equipment for Government shops.

A study of these shops, nowever, cannot fail to increase one's respect for the ability of the men who are directly responsible for the work they turn out. No one questions the quality of the product; in fact private firms often have difficulty in getting their products past the same inspection.

It seems to be a case where the men must produce a high-grade article with an equipment much less convenient and efficient than it ought to be. And this is surely much more of a credit than a reflection on the men in Government plants.

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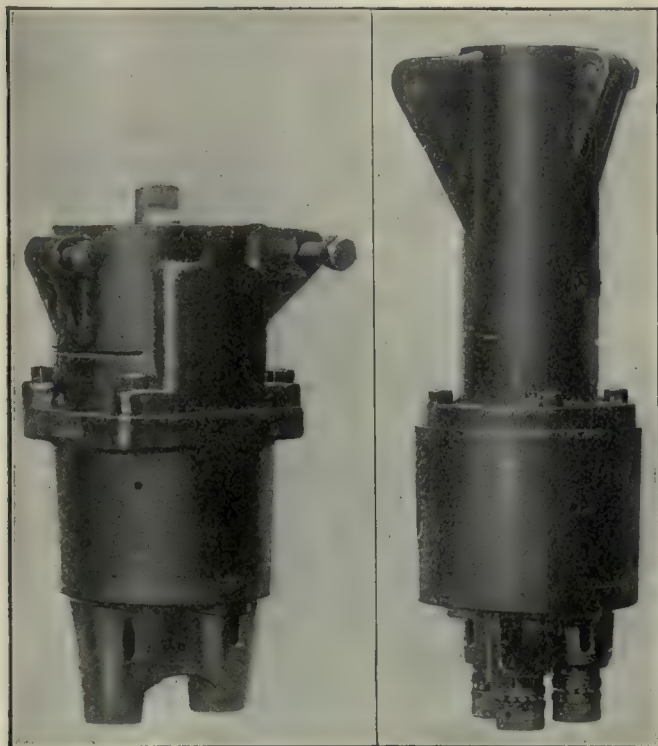
The requirements of a good drinking-water system are, in order of their importance, as follows: (1) The purity of the water should be unquestionable; (2) the supply should be adequate; (3) the water should be so distributed as to preclude all possibility of contamination; (4) the water should be of a proper temperature—J. A. Watkins.

Shop Equipment News

Multiple-Spindle Drilling Heads

The two forms of multiple-spindle drilling heads shown are the latest additions to the line made by the Nelson-Blank Manufacturing Co., Detroit, Mich.

The two-spindle head shown was designed especially for drilling two $\frac{3}{4}$ -in. holes, 3.82 in. apart, in 9-in. shell



MULTIPLE-SPINDLE DRILLING HEADS

depth. The spindles have No. 2 Morse taper and are made from chrome-nickel-vanadium heat-treated steel. The head is made in three sections—bottom plate, gear housing and adapter. The adapter is detachable, thereby permitting interchange to various machines at slight expense. The spindles are driven from idlers stationed opposite each other, meshed to the driver, by which arrangement it is designed to secure a true balance. The driver has a thrust bearing to prevent it from cutting into the bottom plate, should the pressure caused by the use of high-speed drills to their full capacity be greater than the grip of the adapter on the drill sleeve. All bearings are bronze bushed.

The three-spindle head shown is of a type built for any number of spindles and is designed to be especially adapted for drilling holes to a certain

depth, as the spindles are provided with vertical adjustment. Each spindle carries its own load and is driven by idlers meshed with the driver, the latter having a thrust bearing at the bottom plate. Adjustment of the spindles is provided by one half of a bushing being threaded and the other half having a perfect fit. Four slots are cut into this bearing so as to hold it in place when being adjusted, which is accomplished by a dog-pointed screw.

The spindles run right-hand, and as in the first described head the adapter is separate and interchangeable.

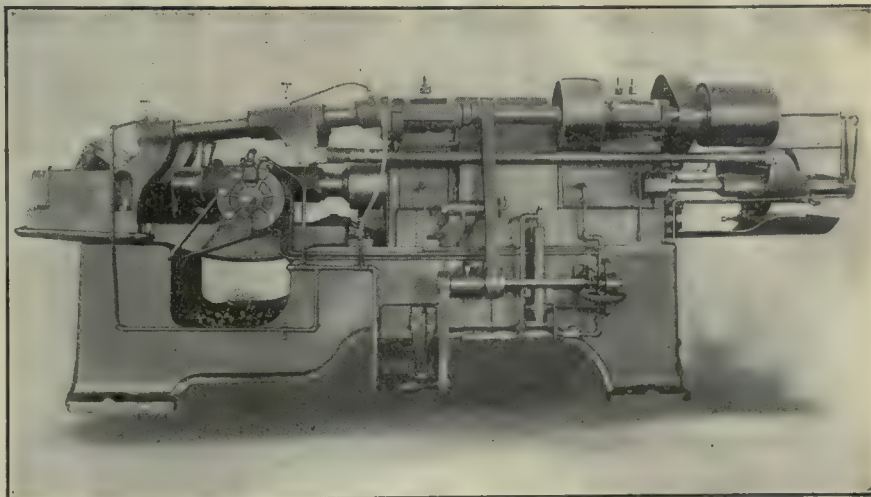
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Hydraulic Shell Lathe

The illustration shows a modification of the type of hydraulic lathe built by the Lombard Governor Co., Ashland, Mass., and described in detail on page 301, Vol. 44. The machine shown was designed primarily for the external operations on 6-in. high-explosive shells.

The spindle is 9 in. in diameter, about 4 ft. long, and is mounted in two long bearings that are cast integral with the frame of the machine. The rear end of the spindle is enlarged to 10 in. in diameter and forms a revolving piston in the rear bearing.

In the operation of the machine the spindle is started in its backward position, the forging having been clamped on the arbor. The spindle is started into rotation by a powerful hydraulic clutch that is operated instantly by a small valve; then by another valve the turning tools mounted in the holders are fed into the work. As soon as this has been accomplished, the forward axial movement of the spindle begins. Then the turning tools that divide the length of the shell into halves begin to remove the metal from the outside; the cutting-off tool begins



HYDRAULIC SHELL LATHE

to penetrate the forging, and these three tools continue to work until the front end of the forging strikes the drill. The feed is then slightly reduced as the drill cuts

through the closed end, and the facing tools finish this surface to the correct length. When the spindle reaches its extreme forward position, an adjustable stop strikes an automatic reversing valve and the spindle immediately returns to its initial position.

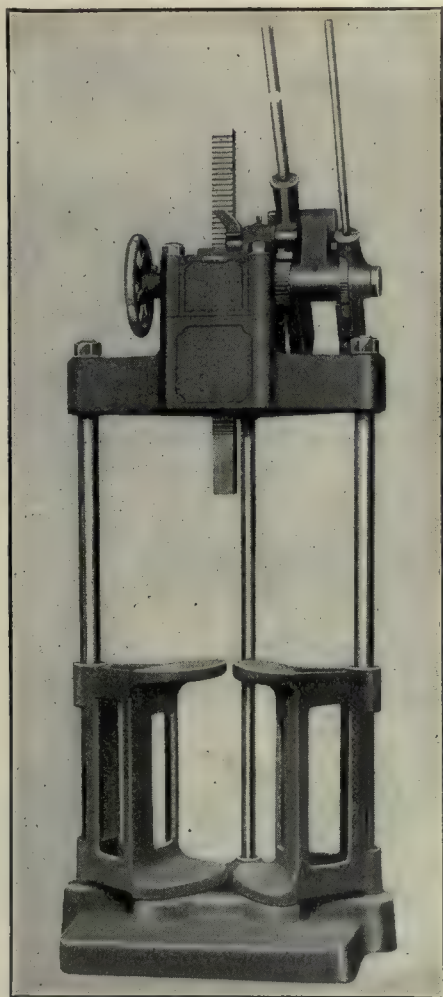
All these operations take place continuously, and at one time six tools are cutting simultaneously. About 30 hp. is required to drive one of these lathes. The operating oil pressure is about 200 lb. per sq.in.

❧

Adjustable Arbor Press

The special features of the arbor press shown are the swinging tables, which can be used in any position and thereby permit instant adjustment to accommodate various sizes and shapes of work, and the auxiliary pressure-applying handle.

In starting a mandrel into work to be turned in a lathe there are generally 4 or 5 in. where the mandrel



QUADRUPLE ARBOR PRESS

Compound handle moves ram $\frac{1}{8}$ in. per stroke; auxiliary handle moves ram $\frac{1}{2}$ in. per stroke; maximum pressure, 30 tons

moves easily. The small handle pushes the mandrel rapidly to its position, but is not powerful enough for heavy work. By pulling the other handle the compound feature gives it its final squeeze. In reversing the work the big handle starts the mandrel, or other work to be removed, and after so doing the smaller handle displaces it rapidly.

The machine is considerably lightened, eliminating the usual heavy cast-iron frame. The upright bars, in align-

ment with the ram, form supports for the swinging tables, tending to take up all spring. The ram is operated by two pinions on opposite sides, making it nonbinding and distributing the strain equally between both pinions. Disk bearings on the other two sides of the ram are designed to eliminate friction. The pinion shaft bearings are independent of the frame and are readily replaced when worn. Five-tooth ratchet pawls, operating over forty-eight tooth wheels, control the ram. A pawl holds the ram up when not in use.

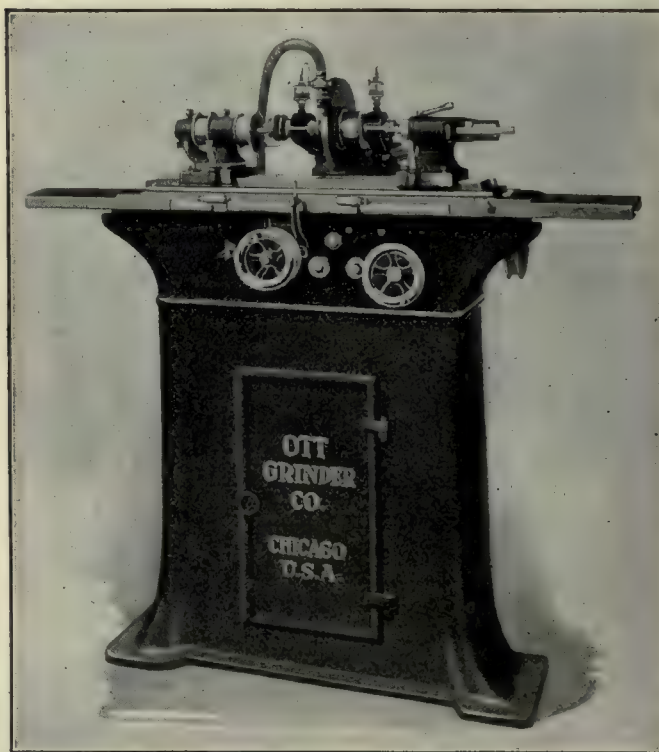
The press shown is the latest addition to the line made by G. T. Eames, Kalamazoo, Mich.

❧

Universal Grinder

In general the design and constructional features of the universal grinder shown will be gained from the illustration. It is a recently improved model produced by the Ott Grinder Co., Chicago, Ill.

The sliding-table travel is automatic and is controlled positively by adjustable reversing dogs provided with screw adjustment operating against the reversing lever, which is provided with an attachment by use of which



UNIVERSAL GRINDER

Range, 5x16 in.; swing over table, without water guards, 4 in.; swing over table water trough, 5½ in.; swivel table graduated to angle of 6 deg.; swivel table graduated to grind taper to 2½ in. per ft.; headstock graduated to 90 deg.; width of grinding-wheel driving belt, 1½ in.; diameter of grinding wheel, 8 in.; face width of grinding wheels, ¾ and ¾ in.; work speeds from 133, 178, 254, 363 r.p.m.; table speed from 34.5 to 121 in. per min.; width of countershaft main driving belt, 2 in.; horsepower required, 2; floor space required, 31x68 in.; net weight, 1,400 lb.

the table can be run past the point of reverse without disturbing the adjustment of the reversing dogs. Power is transmitted to the table by means of worm gearing, which imparts a steady movement, free from unevenness. Vee and flat ways, in which the table slides, are of extra width, giving large wearing surface, and are fitted with oilers, which keep the ways lubricated. The swivel table has its bearings on the sliding table. It is mounted on a

large, hardened and ground central stud and is arranged to swivel either way from the center for grinding tapers. It is controlled by means of an adjusting screw at the right end of the table.

The table-driving and reversing mechanism is non-self-centering and consists of gears and clutches, designed to be positive in action. This mechanism is contained in a bracket bolted onto the outside of the bed and is easily reached for oiling. Should it become necessary it may be detached by removing four bolts.

The automatic crossfeed operates at each reversal of the table or, if desired, at one end only, and can be adjusted to any feed within a range of 0.0001 in. minimum to 0.002 in. maximum feed. It is automatically thrown out when the work has been reduced to the required size. By the movement of a single lever on the front of the machine within convenient reach of the operator, the change from a fast to a slow feed can be made instantly without stopping the machine.

The crossfeed handwheel is graduated on its bevel flange to correspond with the teeth in the crossfeed dial, which indicates the amount of stock the wheel is removing at each feed.

Control of the sliding table is by a handwheel mounted on a sleeve that carries on its opposite end a clutch, which engages with the table drive clutch.

Stacking Tote Box

The type of tote box shown is electrically welded throughout. The handles are folded double and punched to afford a hook hold for dragging the box along the floor. The sides slope inward just enough to provide support for the box above and are folded onto the ends, yet the deviation of the sides from square is so small that rectangular work can be packed in as conveniently as irregular pieces. A $\frac{3}{4}$ -in. selvage around the edge of the box is designed to increase its stiffness.

The ends extend 1 in. above the sides and are folded over onto the selvaged edge of the sides, where the latter lap onto the ends. These raised ends are bent outward sufficiently to permit the box above to slip between.

Spot welded to the bottom and slightly shorter than the box are two half-round runners. These are beveled on the ends and so placed that, when the box is in stacking position, they are in contact with the edges of the box below, thus opposing any tendency of the sides to spring in under heavy weights. The upper corners of the ends are cut off at a 45-deg. angle. Embossed pieces are spot welded to the lower corners of the ends parallel with the upper corners and in such position as to act as guides in bringing the box to stacking position. These guides in conjunction with the runners also serve to prevent any sidewise shifting of boxes while being trucked. In dragging the box over the floor the runners present only line friction and remove wear and tear from the bottom of the box. By reason of the raised ends, space is provided above the handle for the card holder, in which

position it more readily indicates the contents of the box. The stacking feature of this form of box is indicated



STACKING TOTE BOX

Size, 20x12x6 in.; stock, 16-gage steel; handles, 14-gage steel

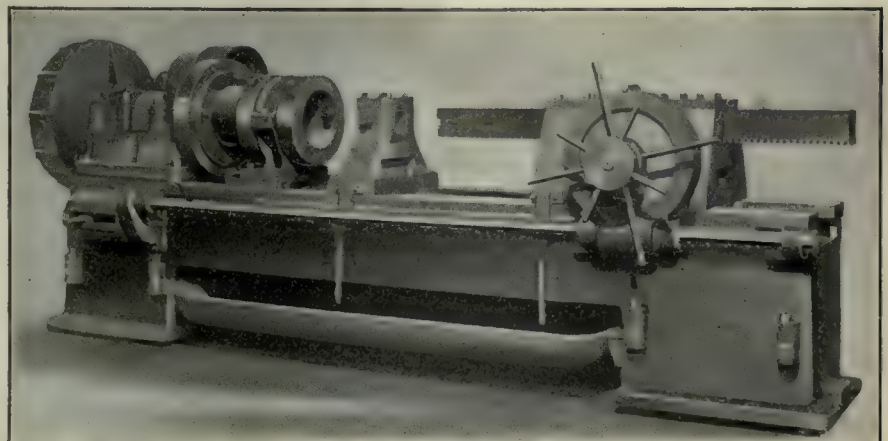
by the fact that a stack of ten boxes can be tilted to an angle of almost 45 deg. before buckling.

This type of tote box is a recent product of the New Britain Machine Co., New Britain, Conn.

Heavy Boring Lathe

The illustration shows the latest type of heavy boring lathe developed by W. & C. Douglas, Middletown, Conn., which represents a further development of the engine lathe (described in detail on page 391, Vol. 44) made by this firm.

The machine was designed to be especially adapted for boring 8- to 12-in. shells. It will be observed that the machine is equipped with a pot chuck and a steadyrest.

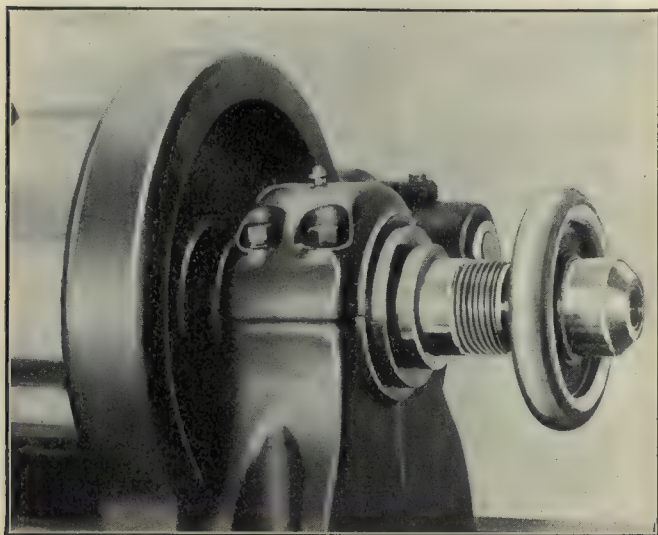


HEAVY-DUTY BORING LATHE

Length of bed, 13 ft.; swings over ways, 26 $\frac{1}{2}$ in.; diameter of spindle, 6 in.; hole through spindle, 2 in.; boring ram, 5 $\frac{1}{2}$ in. square, 74 in. long; travel of ram, 58 in.; distance from faceplate to face of tailstock, 90 in.; distance from faceplate to face of steadyrest, 81 in.; feeds per revolution of spindle, $\frac{1}{64}$, $\frac{1}{32}$, $\frac{1}{16}$, $\frac{1}{8}$; ratio of gearing, 20 to 1; size of cone step, 18x8, 15x8; countershaft pulleys, 18x8 in.

Lathe Collet Chuck

The form of collet chuck shown was designed for application to the lathe in a way that would eliminate the necessity of the operator going to the rear of the machine, as in the usual form, to tighten or release the chuck.



LATHE COLLET CHUCK

Capacity for round stock, $\frac{5}{8}$ in.; hexagon, $\frac{1}{2}$ in.; square, $\frac{3}{8}$ in.; diameter of handwheel, 5 in.; projects from end of lathe spindle, $2\frac{1}{4}$ in.

The chuck takes the place of center in the spindle. Its body, as well as the nosepiece, is made of heat-treated steel, and hardened and ground. The collet is made of tempered tool steel. It is split back about three-quarters

of the way from both ends, and when tightened up on the bar by means of the handwheel, it grips the stock the full length of the collet.

In applying the chuck it is only necessary to remove the spindle center and shove the taper end in its place. The collet is inserted by removing the nosepiece on which the handwheel is attached and placing it in the opening in the body of the chuck. The nosepiece is then screwed back in place.

The type of collet chuck shown is a recent product of the Globe Engineering Co., 42 Traction Bldg., Cincinnati, Ohio, and is made in two sizes, the dimensions of the smaller being given.

Helical-Gear Planer

In order to obtain correctly cut gears suitable for rolling mills, the engineering department of the Mesta Machine Co., Pittsburgh, Penn., has developed the herringbone-gear planer shown in Fig. 1. The tool only moves, and the gear blank is held rigid throughout the cutting.

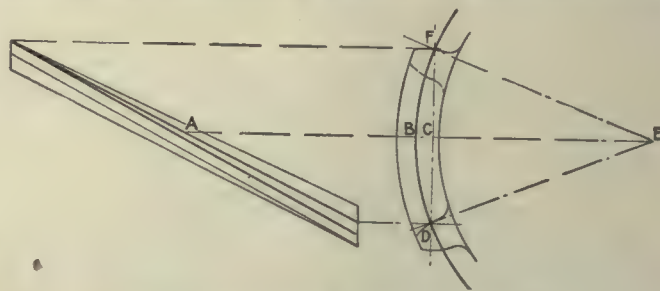


FIG. 2. LAYOUT OF HELICAL TOOTH

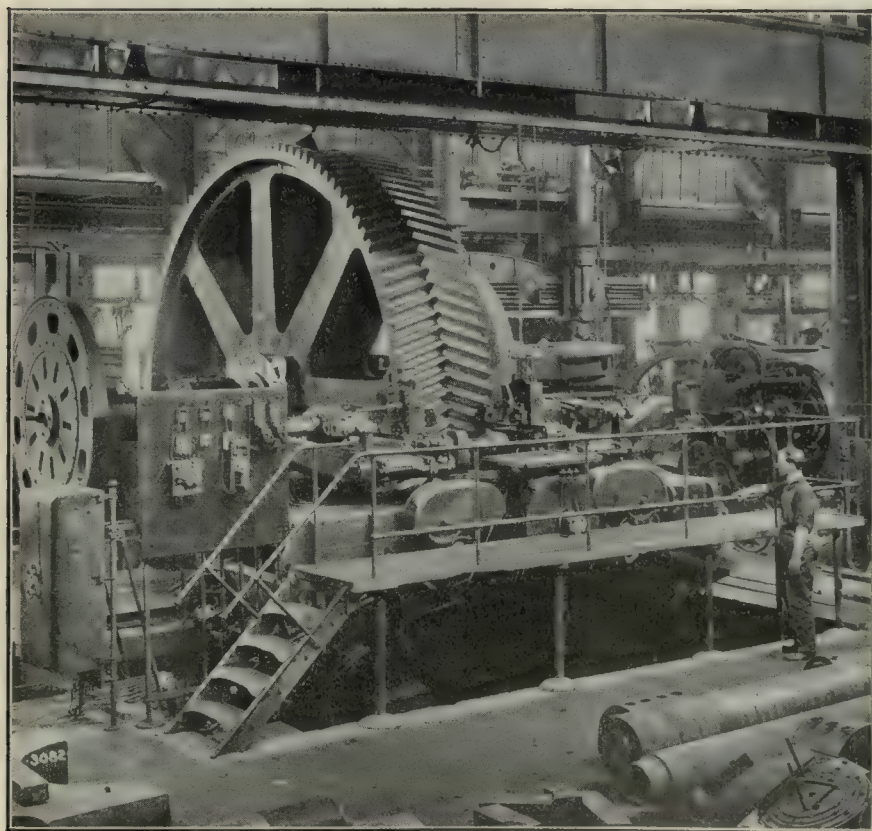


FIG. 1. HERRINGBONE-GEAR PLANER

Capacity limited only by pit capacity; set-up shown accommodates gears up to 22 ft. in diameter; maximum face, 5 ft. 6 in.; main drive, 35-hp. reversing motor; index head and pump drive, 5-hp. motors; floor space, 26x26 ft.; weight, 150,000 lb.

The motion of the cutting point of the tool in the machine must be helical, and the geometrical considerations in accomplishing the motion as finally evolved for this machine will be made clear by Figs. 2 and 3. The principal motion of the tool must be that of the tangent to the helix at point A, center of the face, Fig. 2. The tool must touch the contour of the tooth under the same angle during the whole of its stroke. Therefore, the tool must swing through the angle DEF. The tool must have a motion to compensate for the curvature BC of the gear. The principal motion is attained by letting the tool holder slide on an inclined plane, as shown in Fig. 3. The lead screws A, which are motor driven through bevel gears B, pull the tool holders. The angle is adjusted by moving the supporting blocks C by means of screws D. In the motion that changes the angle during the stroke, the arm E, pivoted on the shaft F, rocks as the tool travels along, by means of worm and worm segments. The angle through which the arm rocks is determined by the diameter of the blank, and change gears are used to accommodate varying gear diameters. The shape of the tooth is determined by pressing

the tool holder against a templet, similarly to the method used successfully on spur- and bevel-gear planers.

The curve described by the tool during each cutting stroke is a true helix within limits of 0.0005 to 0.001 in.

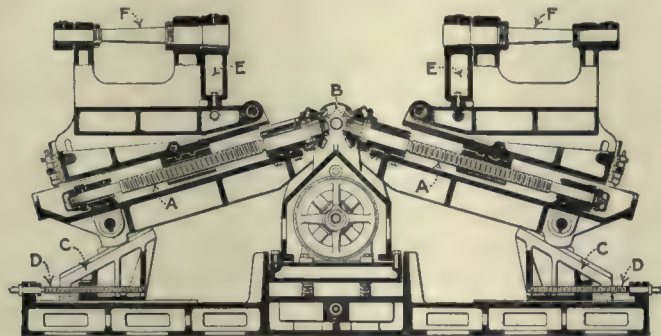


FIG. 3. DIAGRAMMATICAL REPRESENTATION OF THE INCLINED-PLANE CUTTING-TOOL ARRANGEMENT

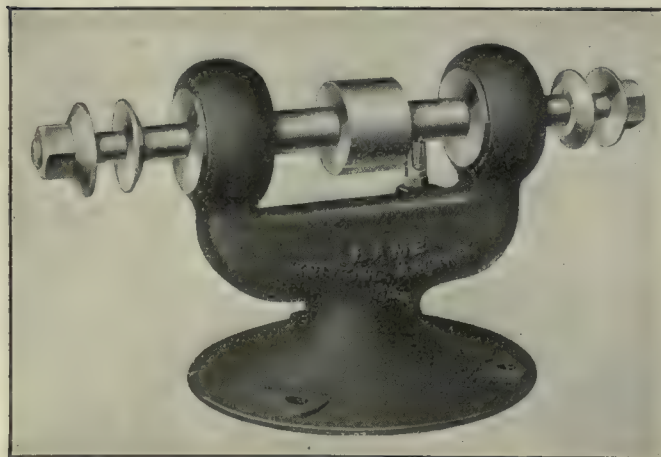
Errors due to deformation of tool and support and to wear of working surfaces are exceedingly small, because all parts are made of more than ample size in order to reduce such errors to the lowest possible minimum.

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Ball-Bearing Bench and Column Grinder

The illustration shows a bench grinder that has recently been developed by the Lamb Knitting Machine Co., Chicopee Falls, Mass. It is also made in the column type.

The grinder head is cast hollow to form a reservoir for the lubricating oil. The spindle is of steel and runs in self-aligning ball bearings. Oil is admitted to the reservoir and bearings through a glass column protected by a brass guard with sight slots so that the oil level is visible at all times. With the oil level halfway up



BALL-BEARING BENCH GRINDER

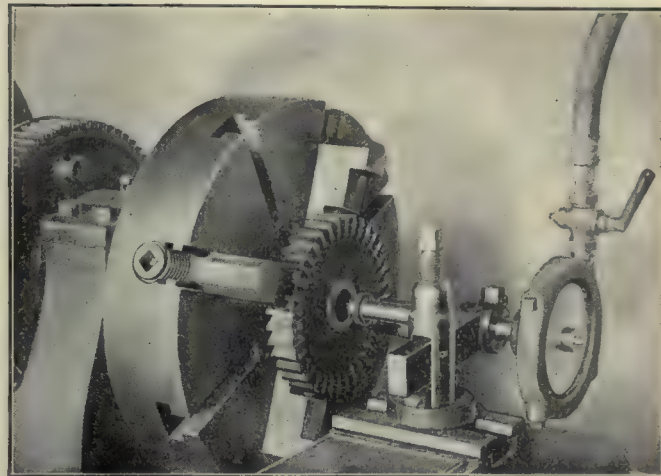
this tube the lower parts of the races of the bearings are below the level of the oil in the reservoir.

The head is secured to the column by three cap screws and is furnished separately as a bench machine if desired. The spindle is $1\frac{1}{8}$ in. in diameter between the bearings and is reduced at each end to $\frac{7}{8}$ in. in the bearings and to $\frac{3}{4}$ in. for the wheels, which are 6 in. in diameter by 1-in. face.

Pneumatic Internal Grinder

While the form of grinder shown was primarily designed for internal work, it will be seen that it is adapted for center and other classes of grinding, paralleling in this respect the common forms of portable electrically driven grinders.

The grinder is air-driven, working on the turbine principle, with the result that a compact construction is made



PNEUMATIC PORTABLE GRINDER

Dimensions of sleeve, $\frac{3}{4} \times 6$ in.; air pressure required, 50 to 100 lb.; speed, 20,000 r.p.m.; weight, $7\frac{1}{4}$ lb.

possible. As it is proposed to use the same size of wheel for center grinding as for internal grinding, the necessity for a special high-speed spindle is eliminated.

The tool shown is a recent product of William B. Mershon & Co., Saginaw, Mich.

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W. K. Millholland

W. K. Millholland, president of the W. K. Millholland Machine Co., Indianapolis, Ind., and for many years distinguished as a machine-tool designer of unusual ability, died on Oct. 9.

W. K. Millholland was born in Baltimore, Md., in 1856, and was educated in the public schools. He entered on his apprenticeship with the firm of Flynn & Emmerick, of Baltimore, in 1874, and served a five-years course. Flynn & Emmerick manufactured steam engines, and also did general machinists' repair work. In the third year of his service he was made gangboss, which position he held until he left the Flynn & Emmerick Co. at the completion of his time. During his apprenticeship Mr. Millholland entered the night school of the Maryland School of Arts and Designs, taking a five-years course from which he was graduated.

In 1879 Mr. Millholland entered into partnership with Mr. Matthews and established the firm of Matthews & Millholland in Baltimore, which conducted a general repair shop for five years. During this period Mr. Millholland invented the balance valve for high-speed engines, and numerous other devices.

In 1881 he married, and the following year moved to Akron, Ohio, where he was made general superintendent of the Falls Rivet Works, which position he held from 1882 to 1886. During 1887 he moved to Chicago, Ill., where he took a position with the M. C. Bullock Manufacturing Co., which is now the Sullivan Machinery Co., as general

foreman, where he remained for three years. In 1890 he became associated with the George C. Whitcomb Manufacturing Co. as superintendent, and was with the Whitcomb company for six years. In 1897 he became salesman for the Marshall & Huschart Machinery Co. and a year later went with the Gisholt Machine Co. as sales engineer, in which work he continued until 1906 when he organized the International Machine Tool Co. Mr. Millholland's last organization plans culminated in the establishment of the W. K. Millholland Machine Co. in 1909.

From a small beginning, with but four or five men, Mr. Millholland developed the business so that at the time of his death it carried more than 130 men on its rolls, four sons being engaged in the business.

Mr. Millholland is survived by his widow and seven sons.

Frederick W. Hoefer

Frederick W. Hoefer, president of the Hoefer Manufacturing Co., Freeport, Ill., widely known as a mechanical inventor of exceptional ability, and to whose sound business judgment the substantial growth of his company's business is attributed, died at his home in Freeport on Sept. 28, after a long illness. He was 62 years old.

Mr. Hoefer was born at Centennial, Stephenson County, Ill., in 1854, where his early life was spent in much the usual way. His business career started in that city when he opened a small buggy-manufacturing factory. Later he moved to Freeport and began working out some inventions in a room of the old court house building. In the summer of 1892 Mr. Hoefer and D. C. Stover formed a partnership and started the Stover Novelty Works. Mr. Hoefer was the active head of the concern. In 1896 Mr. Stover sold his interest to A. G. Hoefer, and a few years later the Hoefer Manufacturing Co. was incorporated.

In the meantime Chester A. Hoefer, a son of Frederick W. Hoefer, had purchased an interest in the business.

Along in 1896 Mr. Hoefer invented and developed along basic lines some wire-coiling machinery, which patents were so basic that practically no other machine of its type was developed and put on the market during the life of the patent.

The business grew quite rapidly until 1904, when a new building was entered—since which time the entire attention of F. W. Hoefer was along the lines of developing drilling and boring machinery.

In addition to his immediate business interests Mr. Hoefer devoted much of his time to civic affairs. Mr. Hoefer is survived by his widow and three children.

Personals

Clayton L. Sonen, until recently superintendent of the Heald Machine Co., Worcester, Mass., has become superintendent of the Arthur Colton Co., Detroit, Mich.

George F. Oliver, for the past year a member of the engineering staff of the Hopkins & Allen Arms Co., Norwich, Conn., has been appointed night superintendent of the plant.

H. O. Bernhardt, for two years production manager of the Pierce-Arrow Motor Car Co., Buffalo, N. Y., has been appointed manager of the Harroun Motors Corp., Wayne, Mich.

P. H. Reardon, president of the General Machinery and Supply Co., San Francisco, Calif., has resigned and disposed of his interests in the business. He is succeeded by Joseph A. Buckley.

Jay G. Coutant has been appointed to the newly created position of construction and utility engineer of the Morrow Mfg. Co., Elmira, N. Y. Mr. Coutant has been connected with construction work for the Willys-Overland Co.

Obituary

Michael Higgins, president of the Higgins Spring and Axle Co., Racine, Wis., and prominent in the civic affairs of that city, died on Oct. 9, aged 61 years.

Levi Seward Conant, for several years acting president of the Worcester Polytechnic Institute, and for many years professor of mathematics at Worcester, was killed on Oct. 11 by an automobile truck.

Henry Splitdorf, inventor of the Splitdorf ignition coils and a number of other electrical appliances now in general use, died at his home in New York City on Oct. 16 in his 83rd year. He was one of the first makers of telegraph instruments, and made the ones used by Morse, the inventor of telegraphy. Mr. Splitdorf was associated with Clark in the development of the Clark repeater, which made it possible for Thomas A. Edison to invent the multiple system of telegraphy.

Business Items

A. P. McCulloch Machine Co. has removed from Chelsea, Mass., to 216 High St., Boston, Mass., where increased facilities for contract work are available.

Wadell & Bowen Co. has taken larger quarters at 109-11 Tichenor St., Newark, N. J., in order to afford increased facilities for its line of

special machinery and tool work. The factory was formerly located in Rahway, N. J.

The S. P. Manufacturing Co., Cleveland, Ohio, has been organized by Paul D. Stafford and Irving H. Putnam, formerly associated with the Ferro Machine and Foundry Co., for the purpose of engaging in contract machine-shop work.

W. Adler has opened temporary offices at 32 Union Square, New York City, where he will be glad to hear from tool and machinery firms desiring representation in European and other countries in which he has travelers and established offices.

The Annual Fair at Lyons, France, will be held from Mar. 1 to 15, 1917, inclusive. Buyers from all parts of the world will be present, and it is desired to have as large a representation of American manufactures as possible. The State Department has placed \$500 at the disposal of the American Consul, which will enable him to distribute catalogs and other literature of American manufacturers who are interested. Catalogs can be mailed direct to the consul at Lyons.

The Haynes Stellite Co., Kokomo, Ind., has opened branch offices as follows: Roe L. Johnson, Mgr., 120 Broadway, Room 1846, New York City; A. F. Young, Mgr., 900 Lytton Bldg., Chicago; G. O. Litt, Mgr., 910 First National Bank Bldg., Cincinnati; J. T. Plummer, Mgr., 911 Citizens Bldg., Cleveland; J. J. Cruise, Mgr., 318 Telegraph Bldg., Detroit. Each of these branches has expert demonstrators and will carry a complete stock of standard size solid Stellite tools and arc-welded Stellite tools.

Ignacio Antuia, of the firm of Antuia y Charola, Elbar, Gulpuzcoa, Spain, who has been in this country for an extended period for the purchase of machinery and tools, is enthusiastic concerning possibilities of American machinery in Spain. Those manufacturers interested in the Spanish market are requested to send two catalogs, with export prices and discounts, to the American branch of his firm at 194 West St., New York City, and one catalog to Mr. Antuia direct at the home office in Spain. Mr. Antuia returns to Spain to take up an energetic campaign and expects to return to this country the early part of next year.

Trade Catalogs

Grinding Wheels. Waltham Grinding Wheel Co., Waltham, Mass. Catalog No. 16, pp. 84, 6x9 in. Illustrated.

"GoodActive" Belt Shifter for Cone Belts. Niles E. Larson. P. O. Box 250, Chicago, Ill. Circular. Illustrated.

Chicago Automatic Screw Machines. The John Macnab Machinery Co., 90 West St., New York City. Catalog. Pp. 16. 8½x11. Illustrated.

Metal-Cutting Saws and Machines. The Henry G. Thompson & Son Co., New Haven, Conn. Catalog No. 16, pp. 64, 5x8 in. Illustrated.

"Toledo" Pipe Threading Devices. The Toledo Pipe Threading Machine Co., Toledo, Ohio. Catalog. Pp. 14. 3½x6 in. Illustrated.

Bronze Bushings and Bearings. The Bunting Brass and Bronze Co., Toledo, Ohio. Catalog and Price List. Pp. 84. 5x8½ in. Illustrated.

Duntley Electric Sensitive Drilling Stand. Chicago Pneumatic Tool Co., Fisher Building, Chicago, Ill. Bulletin E-31. Pp. 4. 6x9 in. Illustrated.

Grinding Machines. Landis Tool Co., Waynesboro, Penn. Catalog. Pp. 26. 6x9 in. Illustrated. This describes the plain self-contained grinding machines for cylindrical and conical surfaces built by this company.

Machinists' Small Tools. Pratt & Whitney Co., Hartford, Conn. Catalog No. 9. Pp. 316. 4½x7½ in. Illustrated. This covers taps, dies, reamers, milling cutters, twist drills, lathe tools, etc., and contains tables of standard threads, machine screws, etc.

Forthcoming Meetings

American Society of Mechanical Engineers. Annual meeting, Dec. 5-8, Engineering Building, New York City. Calvin W. Rice, secretary, 29 West 39th St., New York City.

American Society of Mechanical Engineers. Monthly meeting, first Tuesday. Calvin W. Rice, secretary, 29 West 39th St., New York City.

Boston Branch National Metal Trades Association. Monthly meeting on first Wednesday of each month, Young's Hotel. W. W. Poole, secretary, 40 Central St., Boston, Mass.

Providence Association of Mechanical Engineers. Monthly meeting, fourth Wednesday of each month. J. A. Brooks, secretary, Brown University, Providence, R. I.

New England Foundrymen's Association. Regular meeting, second Wednesday of each month, Exchange Club, Boston, Mass. Fred F. Stockwell, 205 Broadway, Cambridgeport, Mass.

Engineers' Society of Western Pennsylvania. Monthly meeting, third Tuesday; section meeting, first Tuesday. Elmer K. Hiles, secretary, Oliver Building, Pittsburgh, Penn.

Rochester Society of Technical Draftsmen. Monthly meeting, last Thursday. O. L. Angvine, Jr., secretary, 857 Genesee St., Rochester, N. Y.

Superintendents' and Foremen's Club of Cleveland. Monthly meeting, third Saturday. Philip Frankel, secretary, 310 New England Building, Cleveland, Ohio.

Western Society of Engineers. Chicago, Ill. Regular meeting, first Wednesday evening of each month, excepting July and August. J. H. Warder, secretary, 1785 Monadnock Block, Chicago, Ill.

Philadelphia Foundrymen's Association. Meetings first Wednesday of each month, Manufacturers' Club, Philadelphia, Penn. Howard Evans, secretary, Pier 45 North, Philadelphia, Penn.

Technical League of America. Regular meeting, second Friday of each month. Oscar S. Teale, secretary, 35 Broadway, New York, N. Y.

Machining a Gas-Motor Crank Case

By FRED F. BOWEN

SYNOPSIS—This includes the unusual operation of roughing the crank-case joint on a buzz planer. It also shows the methods of handling the succeeding twenty operations and gives the time required for each.

The first operation on this crank case is to run it over a wood buzz planer as in Fig. 1. This is to remove the stock to within $\frac{1}{16}$ in. for finish on the vertical mill. This case when finished has no gaskets in it, but it is scraped to a surface plate. Oil pans and gear-case covers are surfaced to finish size where gaskets are employed.

and the other side drilled, leaving $\frac{1}{32}$ in. of stock to ream with four rose-shell reamers. Reaming is done in the same way. After this operation every jig is located from the plunger guide holes. Time, 15 min.

Operation No. 5 is to mill the hand hole or inspection hole and the magneto-bracket faces. This is done on an angle-plate fixture, Fig. 4, which is used on a vertical mill. It has two hardened and ground plugs *A* and *B* that locate the case from the plunger guide holes, up against the cylinder face, and is held by two clamps, *C* and *D*, through cylinder holes. Machine one side, reverse the case and then finish the other side. Both sides are machined to the same dimensions from plunger guide

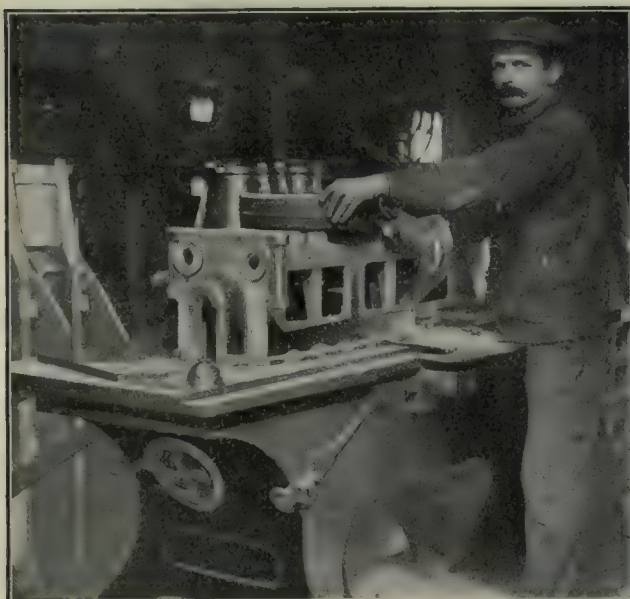


FIG. 1. ROUGH-SURFACING CRANK CASE ON BUZZ PLANER

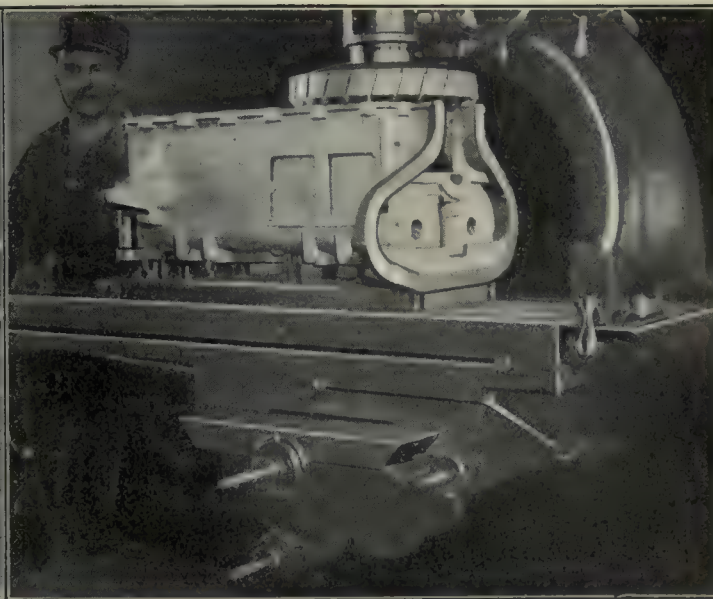


FIG. 2. FINISHING ON VERTICAL MILLER

Place a flywheel on top of the case as a weight to keep the case from chattering, as shown in Fig. 1. High-speed steel blades are used in the cutter head. This machine is run at 3,000 r.p.m. The blades are ground the same as for wood. You can remove $\frac{1}{16}$ in. of stock at one cut.

For finish milling use 1 part lard and 2 parts kerosene oil mixed, for a nice finish surface. Time, 7 min. per case.

The second operation is to mill the bottom in the fixture, as in Fig. 2. This fixture has three set locating plugs that locate from pattern points, and two spring plungers. Two studs and clamps, operating through cylinder holes, hold the case to the fixture. One cut is required to finish case. Time, 10 min. per case.

Operation No. 3 is to mill the cylinder face on a flat cast-iron plate fixture with four straps to hold case to fixture, taking one rough and one finish cut. Time, 16 min. per case.

Drilling and reaming the plunger guide holes in a jig, under an eight-spindle drill, constitute the fourth operation. This jig, shown in Fig. 3, locates from a center line laid out on the case. There are four slip drill bushings and four slip reamer bushings. Four holes are drilled on one side of the case, then the case is reversed

holes. The top of the fixture is milled off for placing the size block to set the cutter and to get the correct size. Time, 45 min. per case.

Next comes the sixth operation—milling the inside of the case on the bearing-cap seats. This is done on a vertical mill, locating the case on the cylinder face and clamping it to the table. Time, 30 min.

The seventh operation is to drill the stud and clamp holes in the bottom of the case. The studs in this case go clear through, so drill half way through with the jig located by plugs *A*, *B* and *C* into the plunger guide holes. The jig is shown in Fig. 5. Time, 35 min.

All holes on the top of the case are drilled in the jig shown in Fig. 6, this forming the eighth operation. Next drill the stud holes to meet the holes drilled in operation 7. The jig locates from the plunger guide holes as before. Time, 40 min. The camshaft core holes are then reamed under the radial drill to let in the boring bars; the time is 6 min. for this, the ninth operation.

Operation 10 covers the boring of the crank, cam- and magneto-shaft holes in boring jig, using a Lucas horizontal boring machine. We use cast iron instead of steel for bushings in the jig for boring bar bearings, and use heat-treated boring bars. Our experience is that cast-iron

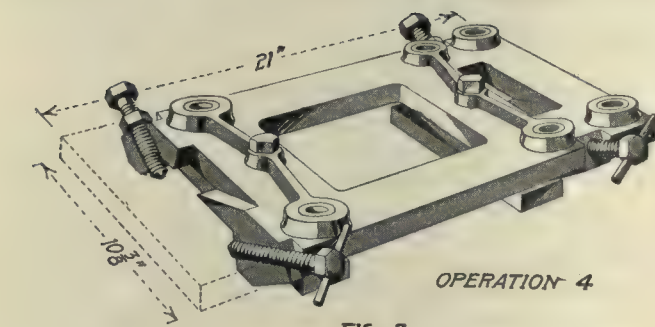


FIG. 3

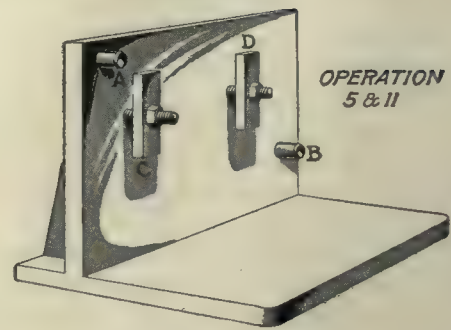


FIG. 4

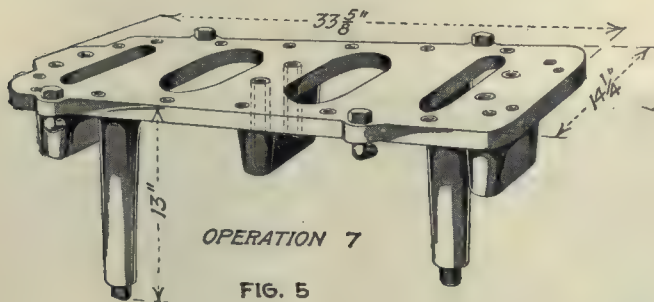


FIG. 5

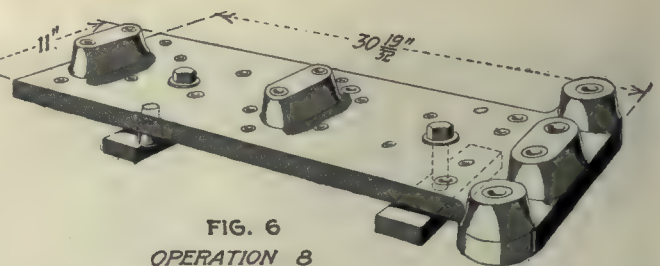
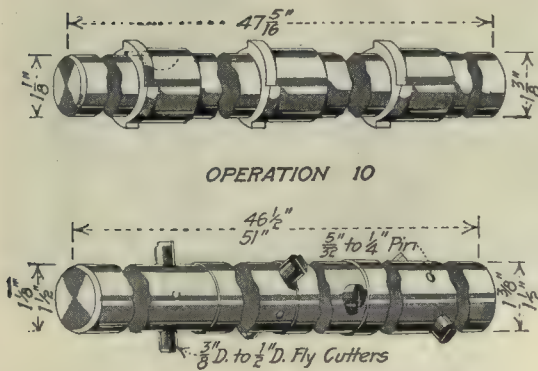
FIG. 6
OPERATION 8

FIG. 7

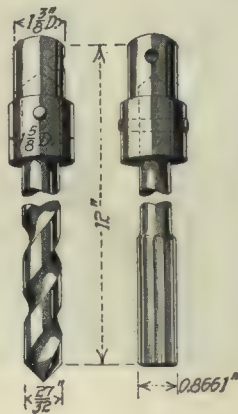


FIG. 8

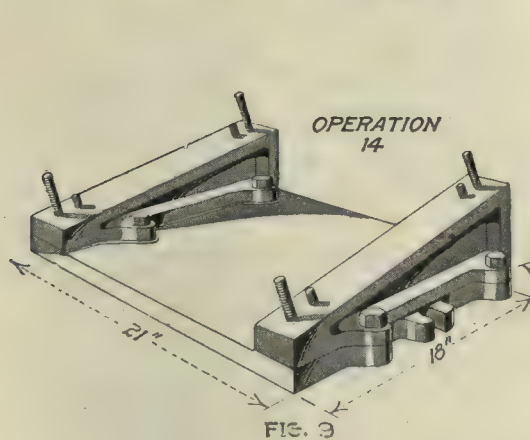
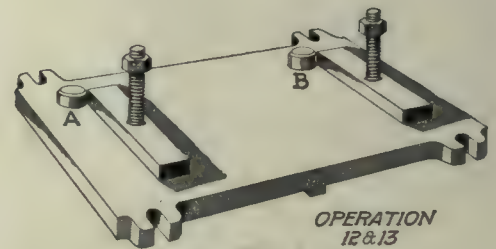


FIG. 10

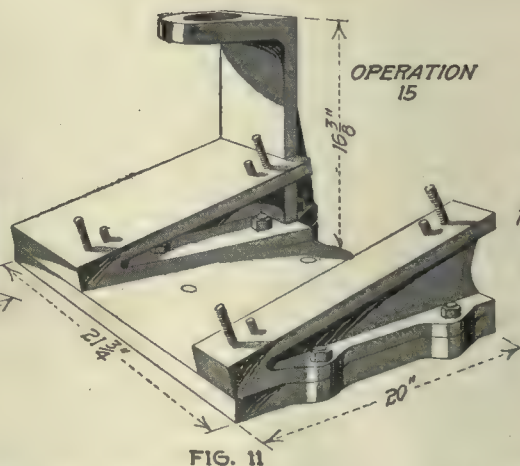


FIG. 11

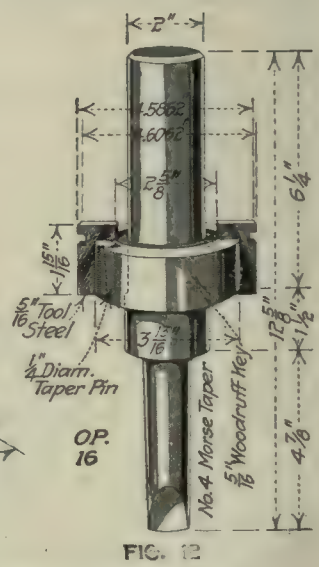


FIG. 12

FIGS. 3 TO 9, 11 AND 12. DETAILS OF TOOLS USED IN MACHINING A GAS-MOTOR CRANK CASE

Fig. 3—Jig for plunger guide hole. Fig. 4—Angle plate for side milling. Fig. 5—Jig for holes in bottom of crank case. Fig. 6—Jig for holes in top of crank case. Fig. 7—Boring bars and reamers for main camshaft and magneto shaft bearings. Fig. 8—Gear-case milling fixture. Fig. 9—Oil-filler milling fixture. Fig. 11—Crank-case oil-filler finishing fixture. Fig. 12—Boring tool for cylinder hole.

bushings in a jig of this nature are the cheapest to make and that you can run the machine faster with no danger of bars and bushings cutting from the kerosene oil in cutting lubricant, which gets into the bearings. We have



FIG. 10. BORING OIL-FILLER HOLE

way into cutter through bar, details being shown in Fig. 7. The magneto-shaft bore is drilled and reamed with hardened and ground slip bushings. All the tools are driven by knuckle joints. The case is located from plunger guide holes, 0.006 in. being left in all bearings for the line-reaming fixture. Time, 2 hr. per case. The same casting is used for the line-reaming fixture.

The sides of the crankshaft main bearings are faced on a horizontal boring mill with six properly spaced side milling cutters mounted on an arbor. The case is located from the plunger guide holes as before, and the same kind of a fixture is used as is shown in Fig. 4. This is operation 11. Time, 10 min. per case.

The gear-case cover end is then milled on a horizontal boring machine, this forming operation 12. The plate fixture shown in Fig. 8 is used, the case being strapped upside down on the cylinder face, and located from the plunger guide holes on two plugs A and B. The time is 20 min. The same fixture also answers for operation 13. This mills the back-cover face on the same horizontal machine. Time, 15 min.

Machining the oil filler comes next and forms operations 14 and 15. The milling is done with the angle fixture shown in Fig. 9. The work is located from the

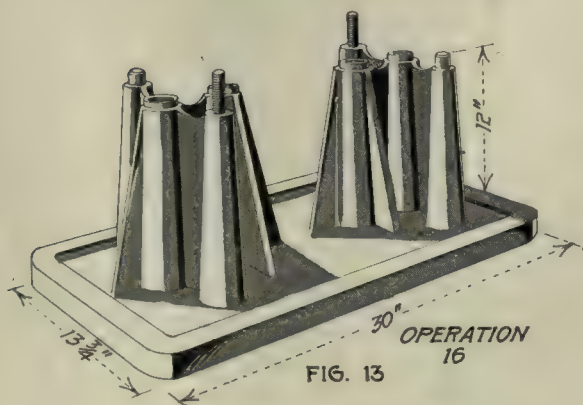


FIG. 13

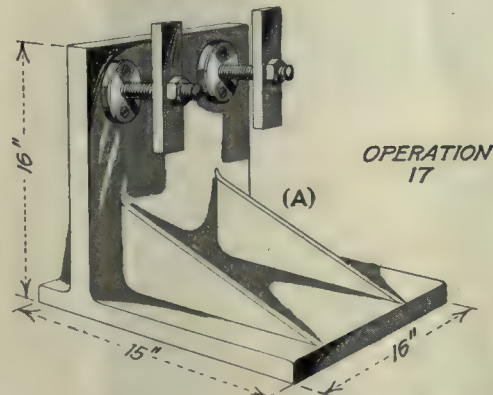


FIG. 15

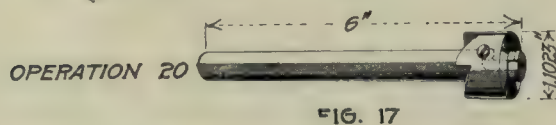
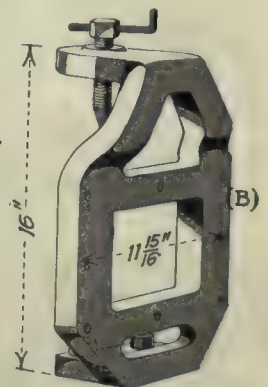


FIG. 17

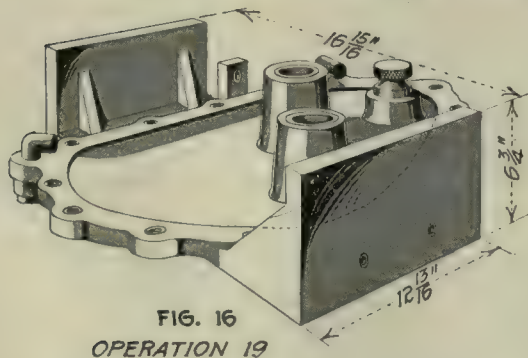


FIG. 16
OPERATION 19

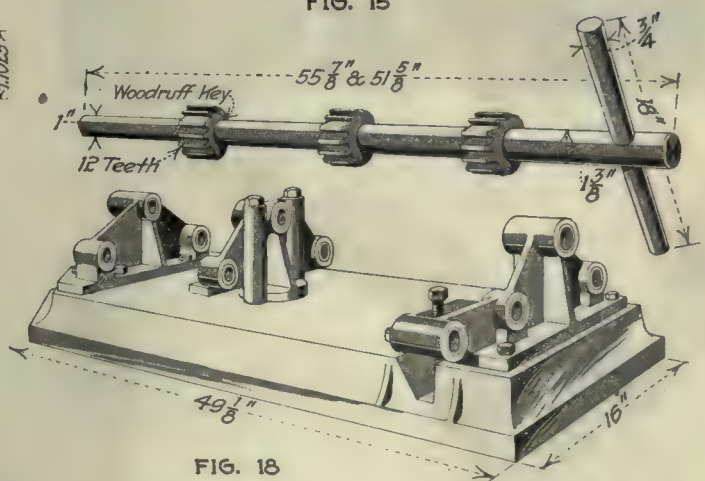


FIG. 18

FIGS. 13, 15 TO 18. DETAILS OF OTHER TOOLS USED IN MACHINING A GAS-MOTOR CRANK CASE

Fig. 13—Boring jig for crank case. Fig. 15—Fixture for drilling hand hole in crank case. Fig. 16—Jig for drilling gear case for cover. Fig. 17—Cylinder hold-down boss spot-face tool. Fig. 18—Hand line reamers for crank-case main bearings, camshaft and magneto shaft

bored 500 crank cases with a fixture of this type before replacing bushings.

The tools for bars are made from 1/2 in. in diameter drill rod No. 5, taper pin hole drilled and reamed half

oil-pan clamping holes and clamped by four slotted steel clamps as shown. The milling is done on a vertical machine in 6 min. The oil-filler hole is bored with an angle fixture, Fig. 11, under the radial drilling machine. The

case is located by taper plugs in the guide bushing. This locates the case from the cored hole in oil-filler holes. We at first located the case from the oil-pan clamp holes, but found there was too much variation in casting at this point. This bore is 4 in. in diameter and $\frac{1}{8}$ in. deep, undercut to an angle of 30 deg., this being done by an eccentric tool. Time, 15 min.

BORING CYLINDER HOLES IN BASE

The four cylinder holes are then bored in the top of the case with a double-bladed two-size cutter, operation 16. The first size is used as a rougher and the second as a finisher. Details of this are shown in Fig. 12. The case is located by two plugs from the plunger guide holes and is clamped by two studs through the plunger guide holes, as shown in Fig. 13. Time, 35 min.

All small holes on both sides of the crank case for hand-hole covers, magneto bracket, plunger-guide setscrew and name-plate holes are then drilled and tapped, operation 17. These holes are drilled on a high-speed radial drilling machine with an angle-plate fixture for holding the case, as in Fig. 14. The fixture shown in Fig. 15 locates

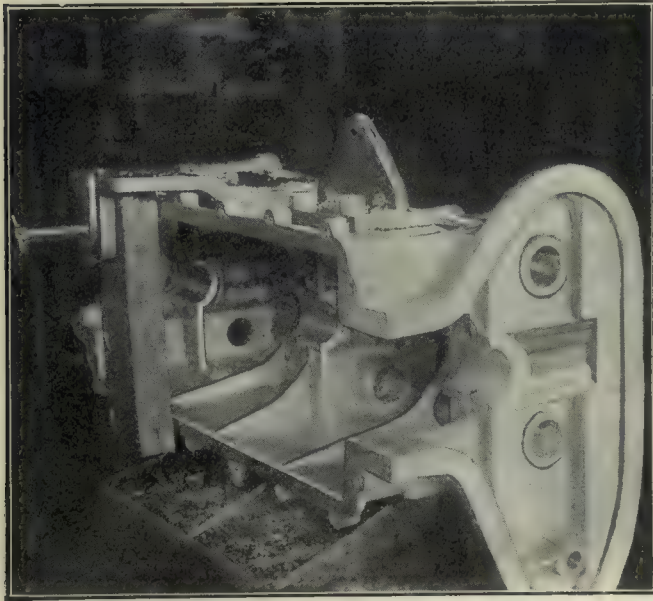


FIG. 14. DRILLING SIDE HOLES ON CRANK CASE

the case from the cylinder holes. The small, separate drill jigs *B* are located from the plunger guide holes. Time, 25 min.

The next is operation 18, which taps all holes on top of the crank case. Six of these holes are $\frac{5}{8}$ -in. Whitworth thread, left-hand thread. As we experienced some trouble in breaking taps, we took a tap to the grinding department and had half of the diameter of the threads ground away. Using this for the first tapping operation and a full-thread tap for the finishing operation ended our troubles. This requires 30 min. per case.

The next drilling operation, 19, requires a large fixture, as shown in Fig. 16. This drills the gear-case cover end. The case is strapped to a radial drilling-machine table with the jig locating into crankshaft and magneto-shaft bore. Time, 8 min.

Operation 20 spot-faces the oil-pan clamp holes and the gear-case cover-clamp holes with a special slip counter-bore from the underside of the boss. The tool, Fig. 17, shows how the cutter is held with a sort of bayonet

joint. By reversing the machine this cutter will drop off and you can pull shank from hole and be ready for the next hole. Time, per case, 15 min.

The last operation, 21, is the line-reaming of the main bearings and the cam and magneto shaft. For this reaming the case is located from the cylinder face and the plunger guide holes. This is a hand operation and is done in the assembly room after the case has been through the inspection department. Both the fixture and the reamers are shown in Fig. 18. After this it is ready for scraping the joints and is then assembled.

✱

Purchasing Machinery

By J. P. BROPHY*

An interesting part of the duties of the manager, superintendent or purchasing agent is the buying of the most suitable machinery for the work. It is doubtful whether sufficient importance is attached to this phase of purchasing to assure that the right kind and size of machine tool will be bought. I know of many mistakes having been made because of a tendency to adhere to past practice.

Engine lathes are often purchased for cylindrical work of a specific character, because lathes have in the past been used for all kinds of cylindrical work. The right idea, however, is to eliminate the lathe when another tool is more suitable. The lathe is a useful tool and always will be. But where is the sense in purchasing lathes when chucking machines, hand and automatic screw machines and boring mills are better adapted to the work? Still, many intelligent men buy lathes for work that can be done better and cheaper on some other type of machine.

The hand screw machine, on work within its scope, is far superior to the lathe. The same is true of boring mills and automatic screw machines on work for which they are fitted. In spite of this fact some of us follow the path of least resistance in making purchases and for a given product buy that equipment which we have always bought. This is all wrong. We should investigate, get prices and productions and inform ourselves as to which tool is the most suitable. Such investigation must be carefully conducted. The records of production of a certain machine on somewhat similar work give no positive assurance that similar results will be obtained on our work.

The miller has made phenomenal records in the production of flat surfaces at low cost, but there are flat surfaces that the miller cannot produce as cheaply as the planer or the shaper. The reverse of this is also true, and a manufacturing plant using planers and shapers on work better suited for the miller is negligent.

A common mistake in purchasing drilling machines is to get them too light for the work. Crowding a drill on a drilling machine that is too light will strain the machine. For this reason the ability to deliver quantities of accurate work should be considered in the purchase of drilling machines. This applies especially to radials. In buying radials an oversized machine is vastly superior to one that is just able to do the work.

Punch presses are machines that require cautious investigation before a decision is reached as to the best

*Vice-president, Cleveland Automatic Machine Co.

size to purchase. A press that is used for blanking, producing pieces to the capacity of the machine, may work with ease when the punches and dies are new and sharp. But what happens when the keen edge of the cutting tool is destroyed, after a few hundred pieces are produced? If the machine is not abundantly powerful, the working parts will be strained, and one must be constantly grinding punches and dies to avoid disaster to the machine.

And now comes the question of hand-operated as opposed to automatic machines. The hand screw machine is an exceptionally useful tool, and almost any piece of cylindrical form can be produced on it. But before buying these machines for a given line and quantity of work it would be well to make inquiries as to the results obtained on automatics.

Setting up a hand machine is somewhat similar to setting up an automatic, and vice versa. But the hand machine necessitates the constant attention of the operator, while the automatic does not. For turning out a great quantity of work at low cost the automatic is the really up-to-date machine tool. One man can operate from four to eight automatics, whereas one man can operate, in nearly all cases, only one hand machine. With large quantities of work, the saving of operating costs is greatly in favor of the automatic.

Considered merely from the viewpoint of output on large and small work, hand and automatic screw machines will be found about equal. In some cases the hand machines can do slightly more work than an automatic, and in other cases the automatic shows some gain over the hand machine. So it is just to rate them as equal producers.

In conjunction with automatics and hand machines the grinder plays an important part. The grinder is a wonderful machine when not crowded beyond its capacity; if it is, the results are very discouraging. One should be careful when ordering grinders and buy them large enough. Work produced on a grinder that is not heavy enough merely has the surface scratched. It is costly and unsatisfactory, whereas if the correct machine with proper wheels is used, the result is little short of marvelous.

All that has gone before means that when you give orders to your purchasing department to buy new machinery, do not do so too hastily. Do not make the mistake of ordering a 14-in. lathe for work that should be done on an 18-in. size. This applies to any kind of machine. An overcrowded machine costs more for cutting tools and vastly more for repairs and depreciation. One cannot confidently expect so good or so much work from a machine that is not suitable for the job.

Riveting and Shearing Machine

By WILLIAM SEELERT

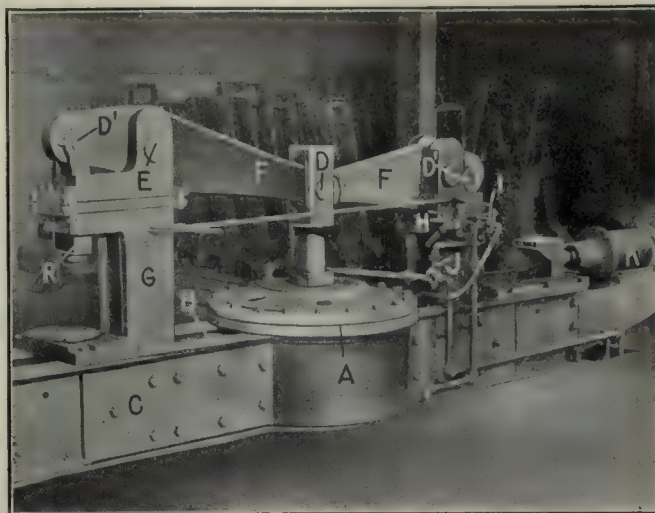
The machine described below has proved to be a great time saver on repairs. One end of the tool is designed for shearing off the heads of rivets on old coupler and draw pockets, the other end for riveting new ones together.

It will be observed that the machine is of heavy construction, which is necessary for this class of work.

This machine is composed of the stroke cylinder *A* (28 in. in diameter by 18 in.) with lugs *B* cast on both sides

onto which are fastened the 16-in. I-beams, these in turn being reinforced and supported by the plates *C* (1x15 in. by 8 ft.), which are bent around the sides of the air cylinder.

Underneath the air cylinder is mounted a stroke cylinder (10 in. in diameter by 24 in.) that is filled with kerosene. The cylinder is provided with a bypass and



PNEUMATIC RIVETING AND SHEARING MACHINE

acts as a cushion for the air piston. Without this cushioning effect the machine would soon jar itself to pieces.

The holes in the levers at *D* and *D'* are slightly oblong to allow for the radial movement of the levers. The ratio *D-E* to *E-D'* is 3 to 1, making a pressure of about 73 tons on the ram *R* at 80-lb. pressure in the cylinder *A*. The machine is operated by the three-way cock *H*. The cutout cock *I* operates the air cylinder *K* by means of which the couplers are pushed against a stop and held in place while the rivet heads are being sheared. The air cylinder *A* is single-acting, but in cold weather the piston is a little sticky. To counteract this the air pipe leading into the top head with the three-way cock *J* was applied, to force it down.

The levers *F* and the uprights *G* are forged from a good grade of iron.

Reducing Breakage on Small High-Speed Drills

By D. C. BENTON

We have three semi-automatic five-spindle drill presses for drilling cotter-pin holes $\frac{5}{64}$ in. and $\frac{3}{32}$ in. in diameter in cap screws and clevis pins.

Owing to the shortage of men, we had to employ boys to operate the machines. After our contract ran out on high-speed drills we found that we had to pay list plus 30 to 50 per cent. for drills. We checked our drill cost for a month and found that the broken drills represented more money than we got for the delivered product.

The next month the following plan was tried: Where the piece-work price was $5\frac{3}{4}$ c. per 100 holes we gave the boys a price of $6\frac{3}{4}$ c. per 100, provided they did not break more than four drills during a ten-hour day and 8 cents per 100 if they did not break more than two drills a day. This at once made a great change in our drill cost, and all the boys are showing an interest in their work, taking greater care and producing a larger output.

Jigs Used in Manufacturing Elements for Hosiery Machines

BY ROBERT MAWSON

SYNOPSIS—On this and the accompanying page are illustrated some jigs and fixtures for machinery elements used on hosiery machines. The tools are modern in design and construction, and interesting methods of locating and holding the parts are shown. The jig for the take-up head cover employs a swinging steel plate that fits into a slot previously milled as the locating medium. It is believed that the principles here described may be followed in many machine shops.

On pages 666 and 718 were shown tools used by the Jenckes Knitting Machine Co., Pawtucket, R. I., for

manufacturing parts for hosiery machines. The jigs and fixtures are of modern design and incorporate good holding and locating features. In this article the time required for machining is given, also the milling speed for the cutter. The data should prove of value to the general machine shop where problems occur in which jigs and fixtures are necessary.

In the textile-machinery practice covered in this article the work produced meets the requirements of both practical and economical conditions. In other classes of work, where a higher degree of accuracy than that covered is not required, it is believed that much of suggestive value can be obtained from the textile-machinery field in connection with good commercial machine-shop practice.

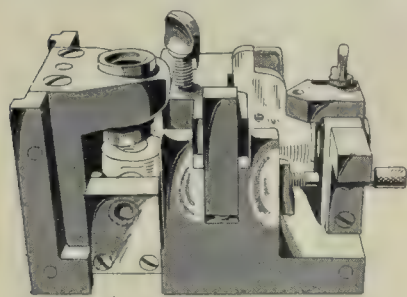


FIG. 2

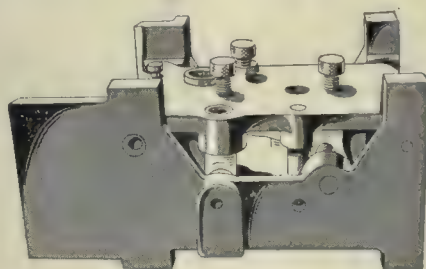


FIG. 4

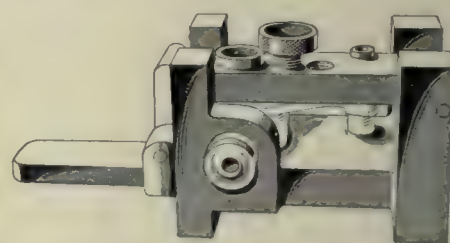


FIG. 6

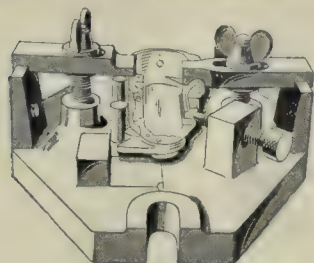


FIG. 8

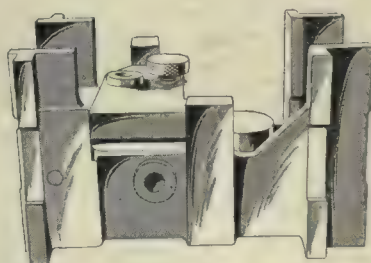


FIG. 9

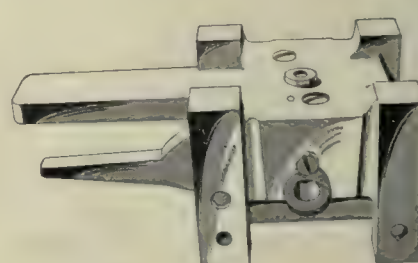


FIG. 11

JIGS AND FIXTURES USED IN MANUFACTURING HOSIERY-MACHINE ELEMENTS, WITH WORK SHOWN IN POSITION

FIGS. 2 AND 2-A

Operation—Drilling and reaming tension latch, Fig. 1. The rough casting is located in the jig in a V-block. The cover is then dropped down and a thumb-screw tightened on the piece. A strap at the end and a knurled head screw hold the casting securely.

Holes Machined—One hole $\frac{1}{2}$ -in. spot-drilled and reamed. One $\frac{1}{4}$ -in. and one $\frac{3}{8}$ -in. drilled.

FIGS. 4 AND 4-A

Operation—Drilling and reaming take-up head, Fig. 3. The casting is located by two pins placed in the form of a V. The other end of the part rests on a height pin. The cover is then dropped down, and by tightening the knurled head screws the casting is held in position.

Holes Machined—One $\frac{3}{8}$ -in. spot-drilled and reamed, one $\frac{1}{2}$ -in. drilled, two $\frac{1}{8}$ -in. spot-drilled and reamed, four No. 9 drilled, three No. 38 drilled and two holes drilled to suit No. 8-32 threads.

FIGS. 6 AND 6-A

Operation—Drilling reinforcer stop-lever bracket, Fig. 5. The rough casting is placed on a height pin and located against a stop surface. The cover is then swung down and a knurled head screw is tightened on the part to hold it in position.

Holes Machined—One $\frac{1}{2}$ -in. spot-drilled and reamed, one $\frac{1}{8}$ -in. drilled and one hole drilled to suit No. 10-24 threads.

FIGS. 8 AND 8-A

Operation—Milling take-up head cover, Fig. 7. The rough casting is placed on two height pins and forced against stop pins with knurled head screws. Two straps are then fastened down onto the casting with thumb nuts to hold the piece in position.

Surface Machined—Two notches, using a side cutter 1.096 in. in diameter and $\frac{1}{8}$ in. long operating at 506 r.p.m., the feed being controlled by hand.

FIGS. 9 AND 9-A

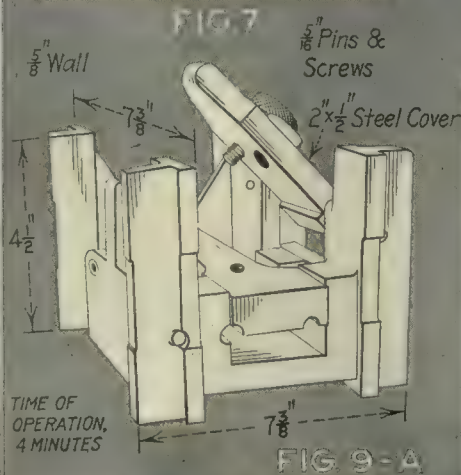
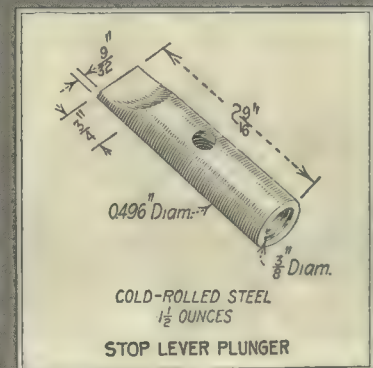
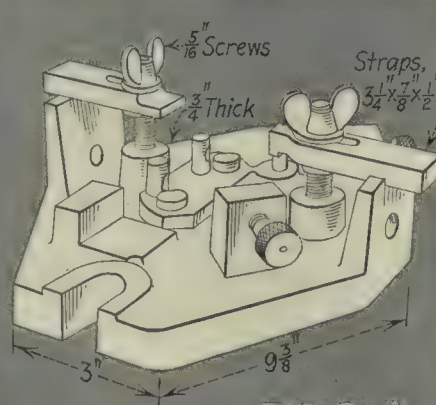
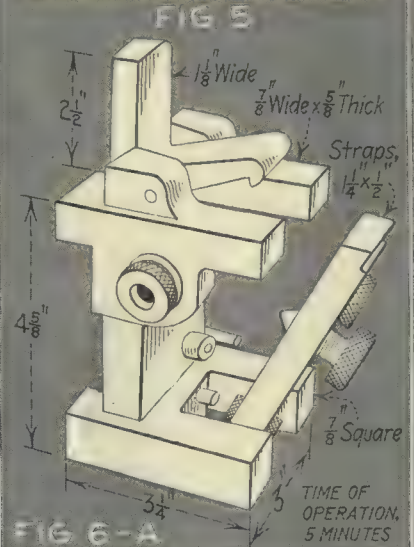
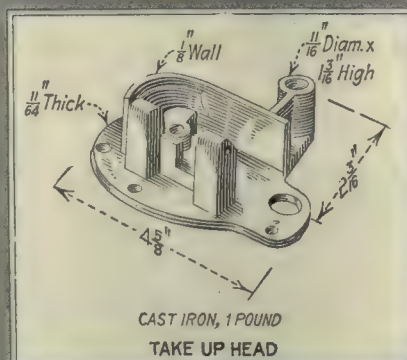
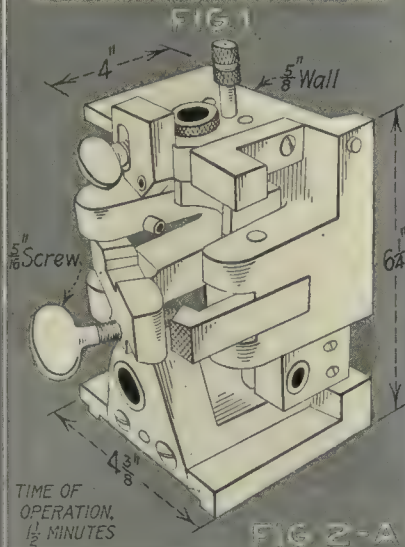
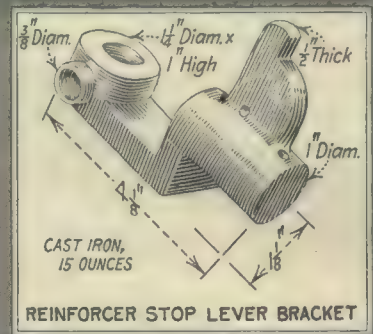
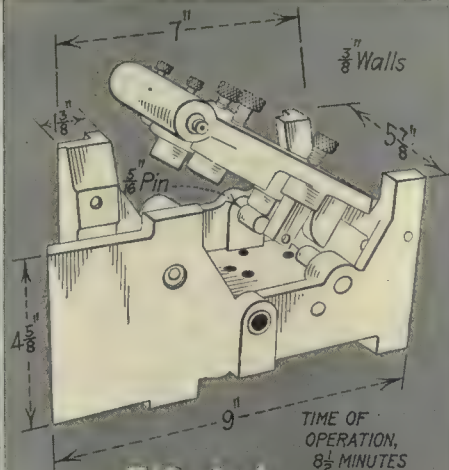
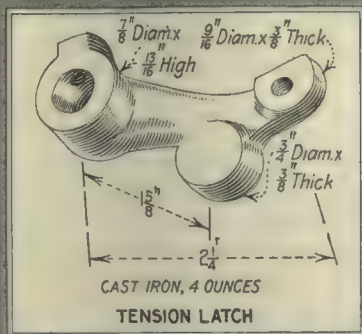
Operation—Drilling take-up head cover, Fig. 7. The milled casting is located by a steel plate that fits into the machined slot of the piece. The cover is then dropped down, a knurled screw holding the casting in position.

Holes Machined—One $\frac{7}{8}$ -in. drilled, two $\frac{1}{2}$ -in. drilled, one No. 53 drilled, one No. 38 drilled, one hole drilled to suit No. 8-32 threads, and two holes drilled to suit No. 6-32 threads.

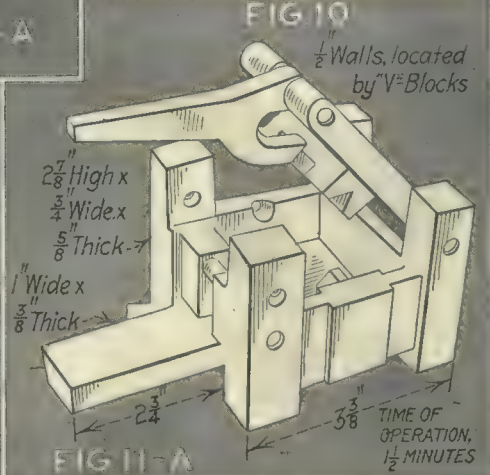
FIGS. 11 AND 11-A

Operation—Drilling stop-lever plunger, Fig. 10. The piece, which has been previously cut to length, is located in V-blocks in the jig. The cover is then dropped down, and as this is also fitted with a V-block, it assists in locating and holding the part to be drilled. The locating and holding action is rapid.

Holes Machined—One $\frac{3}{8}$ -in. drilled and one hole drilled to suit No. 12-24 threads.



NOTE
ALL BUSHINGS USED FOR
GUIDING TOOLS ARE BLACK-
ENED. ALL JIG AND FIXTURE
BODIES ARE CAST IRON,
STRAPS AND FASTENINGS,
MACHINEY STEEL; GUIDE
BUSHINGS ARE TOOL STEEL,
HARDENED AND GROUND



Stop and Slotting Bushing Holder for Automatics

BY C. N. UNDERWOOD

This arrangement was devised at the Remington Typewriter factory where a large number of screws like that shown in Fig. 1 was required. The limits allowed on this screw were as follows: In length 0.005 in., in thickness of head 0.005 in., and in thickness of thread body 0.002 in. They were made on a Brown & Sharpe No. 00 automatic screw machine equipped with a slotting at-

Special lead and slotting cams are required for the operation of this arm. Table 1 shows the layout of the lead cam for the screw shown in Fig. 1.

TABLE 2. LAYOUT FOR ROTATING CAM

Machine type—No. 00 Brown & Sharpe automatic screw machine.

Operation	Hdths.	From	To	Below Outside
Arm descends	7	81	88	
Dwell for feed	15	88	3	0.900
Arm descends	3	3	6	
Dwell for advance and c.o.	32	6	38	
Arm ascends	10	38	48	
Dwell for advance and slotting...	33	48	81	

In Table 2 is shown the layout for the rotating cam for the same screw, and Table 3 shows the layout for the slotting cam.

TABLE 3. LAYOUT FOR SLOTTING CAM

Machine type—No. 00 Brown & Sharpe automatic screw machine.

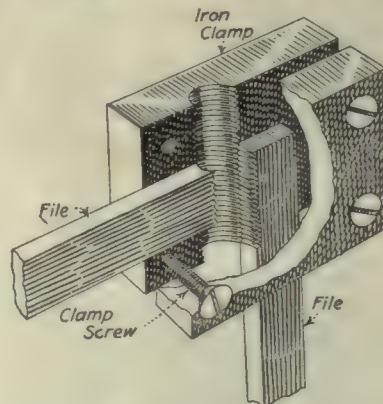
Operation	Hdths.	From	To	Throw	Below Outside
Arm advances	6	13	19		
Dwell for c.o. and ascend.	32	19	51		0.250
Slotting	29	51	80	0.070	
Arm recedes	1	80	81		
Dwell for descent and feed	32	81	13		

The machine spindle was run at 3,000 r.p.m. and oil cups placed on the journals. The time for making a screw was reduced to 4 sec. The average daily production of the machines jumped to 7,675. This gave an increase of 42 per cent. in the production, and the number of machines required was reduced from six to four. These machines have been running for two years under these conditions and have given absolutely no trouble. In fact they require less attention than they previously did when the stop was located in the turret.

Tapping the Thread on Chasers

BY GEORGE B. FAIRMAN

I needed a hand chaser in order to ease out a brass nut that was too tight. Not having one handy, I took



METHOD OF MAKING THE CHASERS

two files and after annealing them clamped them with spacers between two strips of iron, as shown. I then drilled a tap hole through the files and tapped them.

The Selection of a Foreman should be made from the shop force and from those who recommend themselves by being active, energetic, conservative, but progressive, with good moral character. We prefer selecting from the older men if their qualifications are satisfactory. In qualifications considerable knowledge of figures, reading and plain writing are essential, and being able to understand orders quickly. He must also possess mechanical skill and executive ability, be systematic and thorough in doing work and have the ability to impart information concerning the operations carried on in the shop. While being able to explain operations clearly, he must not incline to perform them.—"Railway and Locomotive Engineering."

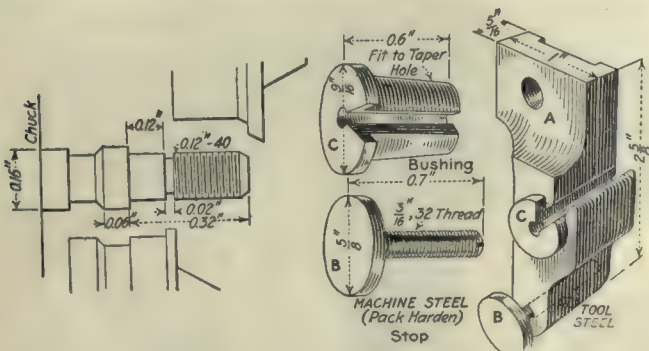


FIG. 1. THE SCREW REQUIRED

FIG. 2. COMBINATION STOP AND BUSHING HOLDER

tachment. The average production per machine per 10-hr. day was 5,417 screws, and six machines were required to produce the required number. By the use of this combination stop and bushing holder the time necessary for revolving the turret was saved.

This arrangement, shown in Fig. 2, consists of a holder A which replaces the regular bushing holder of the slotting attachment, the chief difference between the two being that it is extended to form a support for the stop B. The stop is screwed into the holder and held in place by a setscrew. The bushing C is made taper and fits into the holder as shown.

The operation of the machine is as follows: The turret advances and the die cuts the thread on the body already formed to size by the cutting-off tool, as shown in Fig. 1. The turret recedes and the slotting arm drops to a position in which the stop B is directly in front of the chuck. The machine then feeds the stock

TABLE 1. LAYOUT FOR FRONT AND BACK SLIDE AND LEAD CAMS

Machine type—No. 00 Brown & Sharpe automatic screw machine. Spindle speed—Forward 850, reverse 3,000. Seconds to make one—4. Gross in 10 hr.—9,000.

Operation	Hdths.	From	To	Throw	Rev.	Feed
Form	16	33	49	0.035	32	0.0011
Dwell	1	49	50		2	
Cutoff	32		32	0.070	64	0.0011
Cutoff	16	32	48	0.023	32	0.0007
Dwell	2	48	50		4	
Clear	8	50	58		16	
Die on	17	58	75	0.170 (10)	34	
Die off	5	75	80	0.170	10	
Clear	20	80	100		40	

out to the stop after which the slotting arm drops to its second position in which the bushing is directly in front of the chuck. The slotting arm then moves forward and the screw is taken into the bushing while the cutting-off tool separates the screw from the stock. The screw is then carried in the bushing to the slotting saw and slotted. The forming tool forms the head and neck of the screw at the same time that the cutting-off tool forms the thread body and cuts off the previously made screw.

Manufacturing a Top Plate for a Typewriter--II

By FRANK A. STANLEY

SYNOPSIS—One operation in this series consists of form-milling a V-surface in the top of a casting with the work located by a split parallel device and the cutter guided in a gage slot on top of the fixture. The most interesting operation is the automatic cutting of a series of radial slots where the indexing from cut to cut is accomplished by the miller mechanism so that the process is continuous from start to finish.

Fig. 7 illustrates a somewhat different type of milling operation from those described in the first section of this article, in that here is shown the process by which the accurate V-tip of the fan-shaped top plate of the typewriter frame is milled to exact dimensions, and the narrow flat

When set forward, the binder screw at the top is brought down lightly to hold the plug against the possibility of slipping back under the action of the form cutter when it feeds forward against the work.

POSITIONING THE WORK

The work itself is positioned in exact reference to the guide slot at the top of the fixture, which determines the position of the cutter by the same type of parallel locating device shown at *E*, Fig. 6, in connection with the milling fixture. This locating device is visible halfway down the vertical surface of the miller fixture in Fig. 7 and is more clearly seen in Fig. 8. In all cases where this type of locating device has been applied to fixtures the left-hand side is fixed with a dowel and is never changed. It is therefore always in exact relation to the

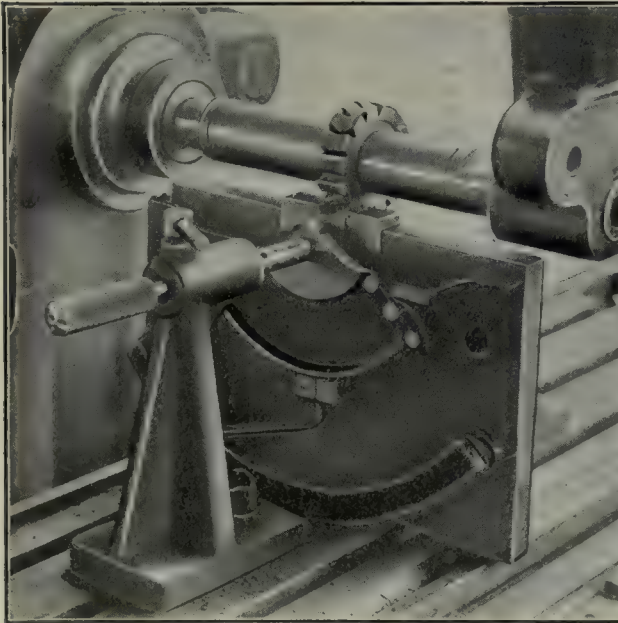


FIG. 7. MILLING THE SEAT FOR THE TYPE GUIDE

referred to in connection with Fig. 1 is produced to exact width—that is, to 0.080 in. This means that the sharp V-point is cut back a depth of 0.029 in. in preparing this V-surface to receive the hardened-steel guide block that serves as an accurate type guide at the point of printing on the typewriter when assembled.

FORM-MILLING THE FRONT OF THE CASTING

The holding fixture in this case is an angle iron with a vertical face, shown in Fig. 8, which is provided with suitable equalizing stop surfaces *A* to receive the top plate. This is placed against it in perpendicular position and held by simply pushing forward the knurled-head plunger carried in the housing at the left-hand end of the fixture, as shown in Fig. 7. This plunger is not pressed forward by spring action, but by simply sliding it in contact with the work with easy pressure of the fingers, thus making it impossible for any distortion to occur if reasonable care is used in moving the plug into contact with the work.



FIG. 9. DRILLING JIG FOR THE TOP PLATE

cutter guiding surfaces or any other portion of the fixture which must be relied upon to establish and maintain accurately any distance between surfaces or any important dimensions where the cut has to be taken. The right-hand half of the parallel locating device is the portion that admits expansion away from the center line, if expansion is at all possible. As a matter of fact, such devices are generally made a snug fit in the slot in the work that passes over them and constitute a gage for the accuracy of such work. Closed to their normal position, the work should just press over them lightly. When expanded even a small fraction of a thousandth of an inch, they should secure the work sufficiently for locating purposes.

If too great a degree of expansion is possible under the action of the opening rod, it is apparent that the preliminary milling operations have been indifferently done, although so long as one side and one side only is relied upon for the locating surface, all following cuts will be properly positioned in relation to that surface. It is,

however, the best practice to see that expansion devices of this kind never require to be opened more than a minimum amount to give the result looked for.

As will be inferred from what has gone before, the location of the cutter in relation to the work is established by the guide formed in the steel block *B* at the top of the fixture. This constitutes the setting gage by which the table of the machine may be accurately adjusted in and out until the cutter will just pass freely through the jaws of the gage block without improper contact at either side. The depth is also established just as accurately by using a feeler gage between the cutter teeth and the top of the guiding surface, and the point of the work

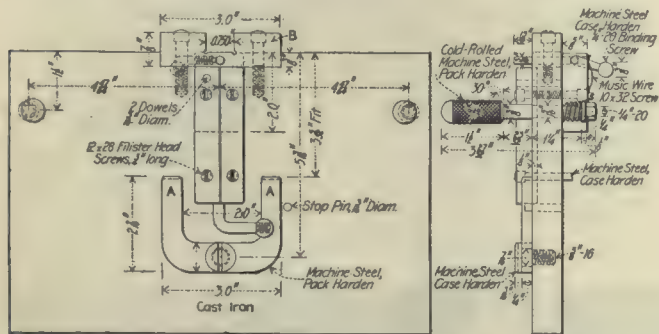


FIG. 8. MILLING FIXTURE FOR THE TYPE-GUIDE SEAT

thus finished may be relied upon to be dead right, both as to shape, because of the form of the cutter, and also as to depth from any given point by which the fixture is set.

Another fixture in which this same type of locating device is advantageously employed is illustrated in Figs. 9 and 10. The tool here shown is a drill jig, in which, under the gang drill shown, 14 holes are drilled simultaneously in the top plate for the clamping screws for retaining the toggle mechanism that operates the 28 floating type bars. One of the chief features of interest in connection with this jig is the locating device already referred to as used on other fixtures. Here again the top plate—that is, the work to be drilled—is located from the left-hand side of the slot milled in the first profiling operation. The locating apparatus holds the work perfectly square with the fixture and in the exact lateral position desired. The casting is pushed back prior to clamping, against the tool-steel stop pin shown at the rear end, this being milled away as indicated to leave one-quarter of the top surface intact, forming a V-stop and acting against the forward end of the V-shape surface milled on the work in the forming operation shown in Fig. 7.

This means that the 14 holes drilled in the fan-shaped casting around the quarter circle to a radius of 6.60 in., as called for in Fig. 1, will be at the exact radius desired in the casting, owing to the fact that the V-point of the top plug *A* in the jig, Fig. 10, is made to a radius of 0.029 in. Thus, the stop surface projects forward from the center point by that much, which compensates for the 0.029 in. that has been flattened off from the castings to be drilled, as shown in Fig. 1. This, then, assures the work being drilled to the true radius from the actual V-point, although that V-point has been removed in the form-milling operation previously described.

The work rests during this drilling process upon two hardened flat steel plates at either end of the jig. As the casting has been machined to a true plane prior to coming to this jig, there is no peculiarity in expecting

it to rest flat upon these strips. As a matter of fact, this type of flat support acts as a pretty good gage for testing the accuracy of the preliminary milling undertakings in that the slightest degree of distortion will be noticed at once by the tendency of the casting to rock when touched upon the corners, assuming it is not in a true plane. How-

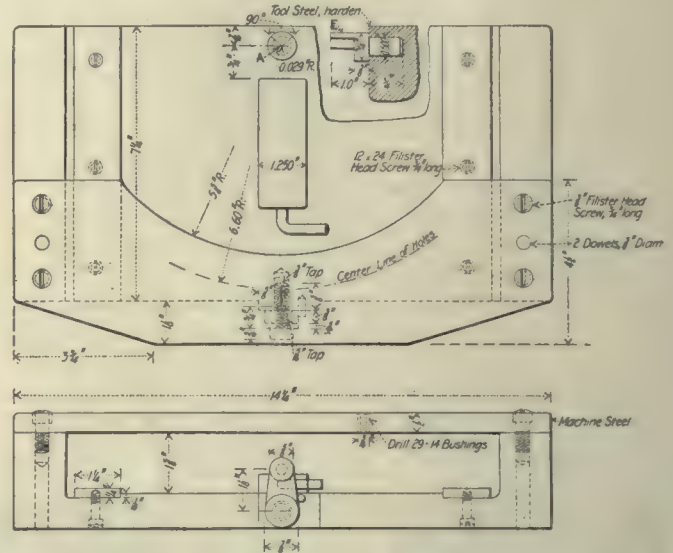


FIG. 10. DRILL JIG

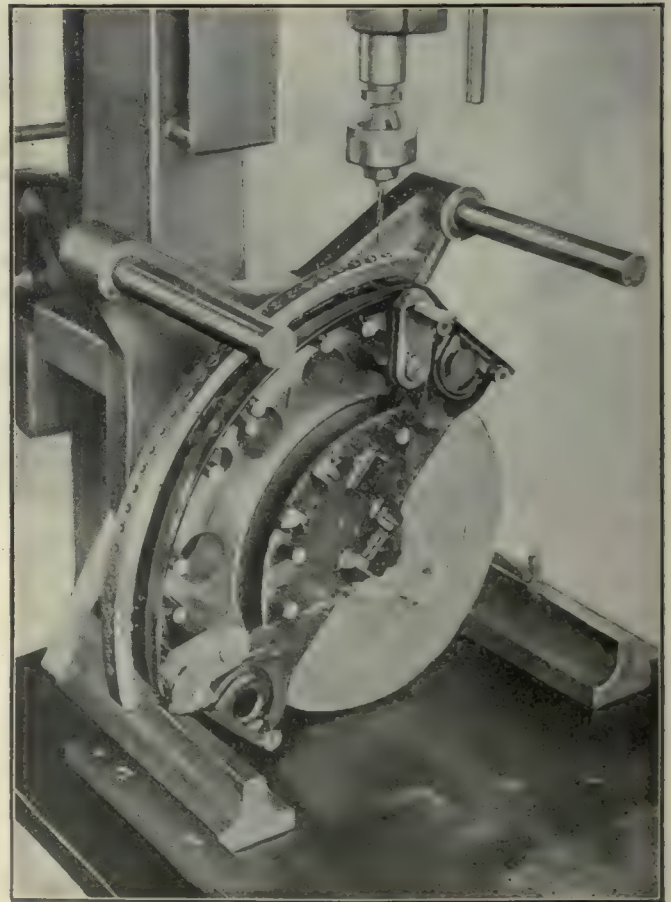


FIG. 11. AN INDEXING DRILL JIG

ever, the method of holding the work through all these milling operations, as well as in the jig-drilling operations, is such that there is no chance to spring the casting itself. As very little metal has to be removed in any of the cuts, there is just as little chance of distortion.

There are of course certain other drill jigs used on this casting and later on other classes of operations, but it is not necessary at this point to show them. It is the intention rather to pick out tools with some original locating feature or method of securing the work and show the more important phases in the general progress of the work through the shop.

In this connection a drill jig of quite unusual type is illustrated in Figs. 11 and 12. The construction of this interesting fixture will be obvious upon inspection, and it will not be necessary to go into any extended description, although a few words of explanation may be of service as pointing out some of its principal features of importance.

In this case the work is rotated bottom side to the front, so that the original locating guide slot cannot conveniently

by hand to bring one bushing after another under the sensitive drill spindle.

The holes drilled in the positions shown are 0.101 in. in diameter and are put in very rapidly, as it takes but a few seconds to swing the jig from one hole to another, pass the drill through, lift the spindle, swing the jig ahead to the next hole and so on. It will be noticed that the jig is provided with four feet, so that certain holes which are to be drilled from the flat side of the casting are put in by turning the jig down upon the V-seat, bringing the respective guide bushings into position to receive the drill.

One of the attachments of importance, and of interest as being out of the ordinary in the way of special equipment, is illustrated in Figs. 13, 14 and 15. This is applied to a plain miller and is designed for automatically index-

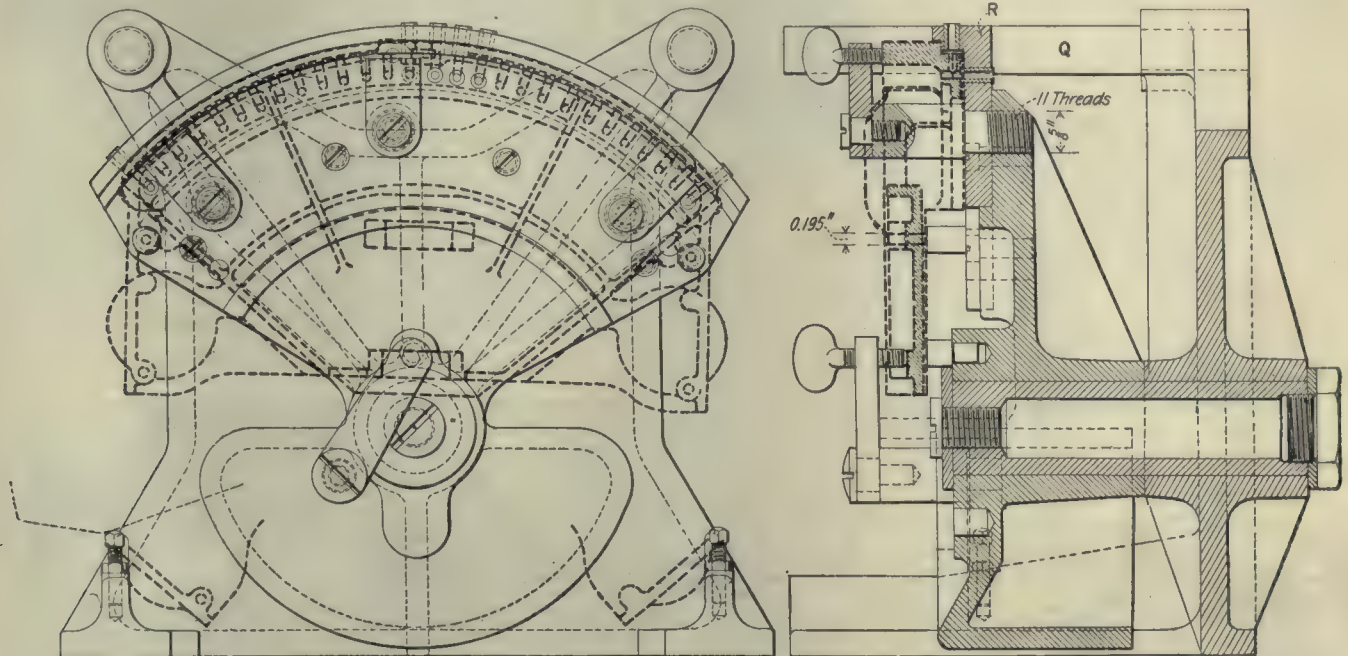


FIG. 12. DETAILS OF UNUSUAL FORM OF INDEXING DRILL JIG

be employed. As a matter of fact, as the holes to be drilled in this fixture are for the type-bar mechanism and clamp adjusting screws, an exact location in reference to the center of the casting within a fraction of a thousandth of an inch or for several thousandths is of no importance. The location of the work in the jig is therefore more a matter of convenience than anything else, although it has been arranged so that it is accurate in practice. For this purpose two holes 0.195 in. in diameter, drilled at the ends of the series in the arc of the circle, as located in Fig. 1, are here used to slip over pilot pins to secure the casting for position upon the faceplate of the indexing fixture.

The body of this jig is in the form of an angle plate, carrying a heavy stud and a central sleeve upon which is mounted the front portion, which is free to rotate to bring the holes in succession under the drill spindle. The work to be drilled, when put in place, is secured by two swinging clamps with small wing nuts which hold the casting in place without the possibility of distorting it. The inner machined surface of the casting rests against hardened stop pins in the face of the swiveling portion of the drill fixture. This swiveling faceplate is a snug turning fit, bearing on the sleeve, but may be readily moved

ing and cutting the 28 radial slots in the typewriter top plate for the series of type bars. The fixture proper is mounted upon a rotary table which is indexed to that part of the circle necessary to cover the number of degrees embraced in the arc on the casting. The entire action of the machine is automatic from the time the feed is thrown in for producing the first slot until the final slot is cut.

As originally designed, the fixture took care of two castings at the same time, one of these being somewhat smaller than the top plate and known at that time as a sublever segment, which is mounted upon the upper end of the fixture for the simultaneous sawing of the slots along with the milling of the slots in the larger top plate below. With the present model of typewriter this form of sublever segment is no longer used, and the upper portion of the fixture is therefore not required. It is the intention to remove the upper portion of this fixture in order to make it somewhat more convenient to place the work in position on the bottom plate. In this connection, however, it is interesting to mention that, although the upper half of the device is no longer of utility, an ingeniously devised method of operating two saws simultaneously was incorporated. This is well worth calling atten-

tion to as a suggestion for the handling of similar undertakings.

The method of operating the two saws will be apparent. The lower saw is of course carried upon the regular arbor of the miller. The upper saw, mounted upon a short spindle, is housed in a bracket slipped over the over-arm support and clamped thereto, while the spur gear carried upon the inner end of the short cutter spindle meshes with a similar gear near the shank of the main arbor of the miller. This arrangement, of course, does not provide any flexibility in the center distance taken horizontally between the two cutter spindles, but this was not required in the construction. If it had been, it could have been secured by the simple device of adopting one or more idler gears to connect the two spindles. What was obtained was this: In the process of sawing the radial slots in the lower plate, known as the top plate of the typewriter, the upper cutter simply sawed directly in toward the center of the sublever segments, one of which is shown in place in Fig. 13. The diameter of the cutter was made such that, after the lower cutter had sawed the slots to the rim of the casting, the upper cutter had gone to just the right depth in the upper casting; that is, the cutter diameters and the advance of the upper cutter over the lower one were figured out to provide for just the exact lead and distance apart required on the two jobs when carried through in unison. The feature just pointed out is of interest as showing how combinations of tools may be made to serve simultaneously two or more purposes without adding materially to the complication of the design and at the same time practically doubling the output per unit of time and labor. Reference to Fig. 15 will give a good idea of the method of mounting the top plate of the typewriter frame upon this indexing fixture. This illustration also shows the arrangement of the mechanism by which the indexing process is carried along without intervention of the operator. It will further be noticed in Figs. 13 and 14 that the action of the table feed is also automatic, being produced by a drum cam at the right-hand side of the knee. This cam engages with a roller, carried by a bracket, clamped to the dovetailed guiding surface on the under side of the table. This drum cam of course reciprocates the table at the requisite rate of speed, forward and back, for each successive cut. The action of this attachment is as follows:

When the work is put in place and the feed thrown in, which is done by lifting a lever at the front in the usual fashion, the casting passes under the cutter until the latter saws a slot clear through the ledge around

the rim of the work. The drum cam under the table then feeds the table to the right again to bring the work away from the cutter. As the table approaches the extreme end of its travel to the right, the bell crank at *A*, Fig. 15, comes in contact with the adjustable stop screw *B*, which, acting through the slotted arm *C*, causes the

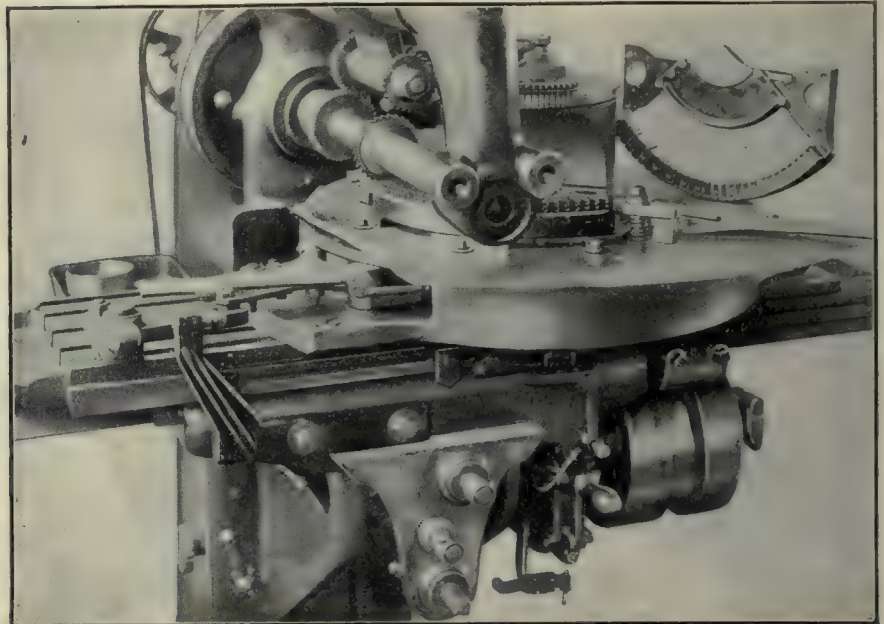


FIG. 13. AUTOMATIC SLOTTING FIXTURE FOR TYPEWRITER TOP PLATE

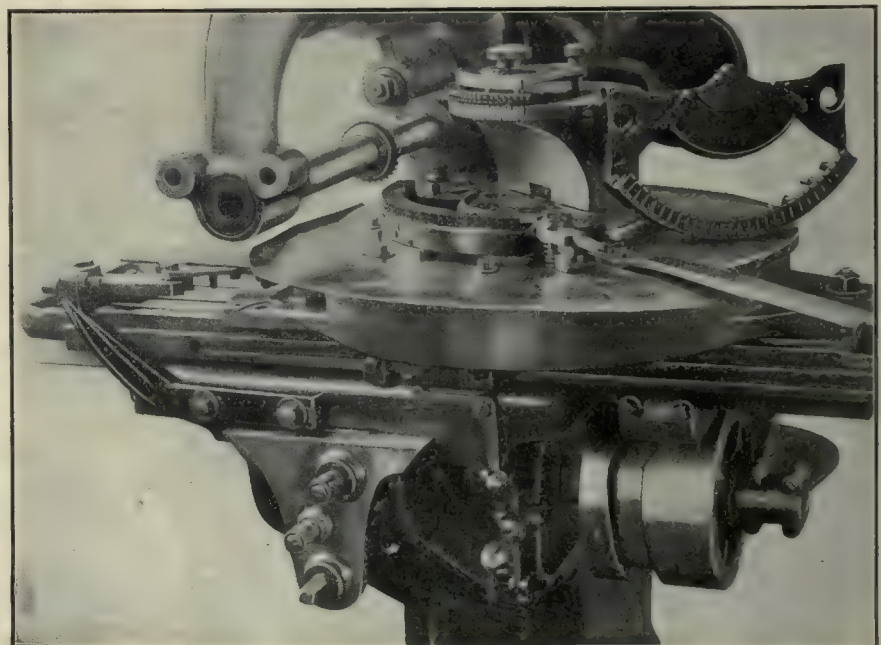


FIG. 14. AUTOMATIC SLOTTING FIXTURE AT POINT OF INDEXING

lever *D* to be swung outward or to the right, pulling the locking pin *E* out of position in its notch in the edge of the indexing plate and causing the pawl *F* to travel forward and index the notched plate and the work one step farther forward. The table, then having finished its backward stroke, is started forward and allows the rocker arm *C* to swing back to its original position. The lever *D* also assumes the position seen in Fig. 15, with its plunger *E* locked into the index notches in the plate. This cycle of operations is repeated for each forward and return stroke until the final cut has been taken. After that a

dog traveling around with the indexing table strikes the feed-locking device at the front of the knee and allows it to drop and throw out the feed automatically.

ARRANGEMENT OF MECHANISM

The arrangement of the spring control on the latches for holding them in place against accidental shifting and for swinging the various arms and levers back when the travel of the table releases them from contact with the stop screws is clearly shown in the drawing and will be understood upon inspection of the different views.

The method of holding the work in place will also be understood from examination of the illustrations. As indicated, the work drops over locating pins correctly positioned and is held by quick-action clamps drawn down at the forward end upon the work by means of cam

tact with the teeth of the ratchet, if it were not for this spring which just as constantly moves the ratchet point forward and against the wheel in all positions of the arc of the movement.

Saving Labor and Time in the Drafting Department

BY A. A. BOYD

Of late I have read a number of articles in regard to saving time and labor in the drafting rooms and on how to make that "nonproducing" department "efficient."

I read not long ago that someone had found that blue-prints could be made from soft-pencil drawings upon

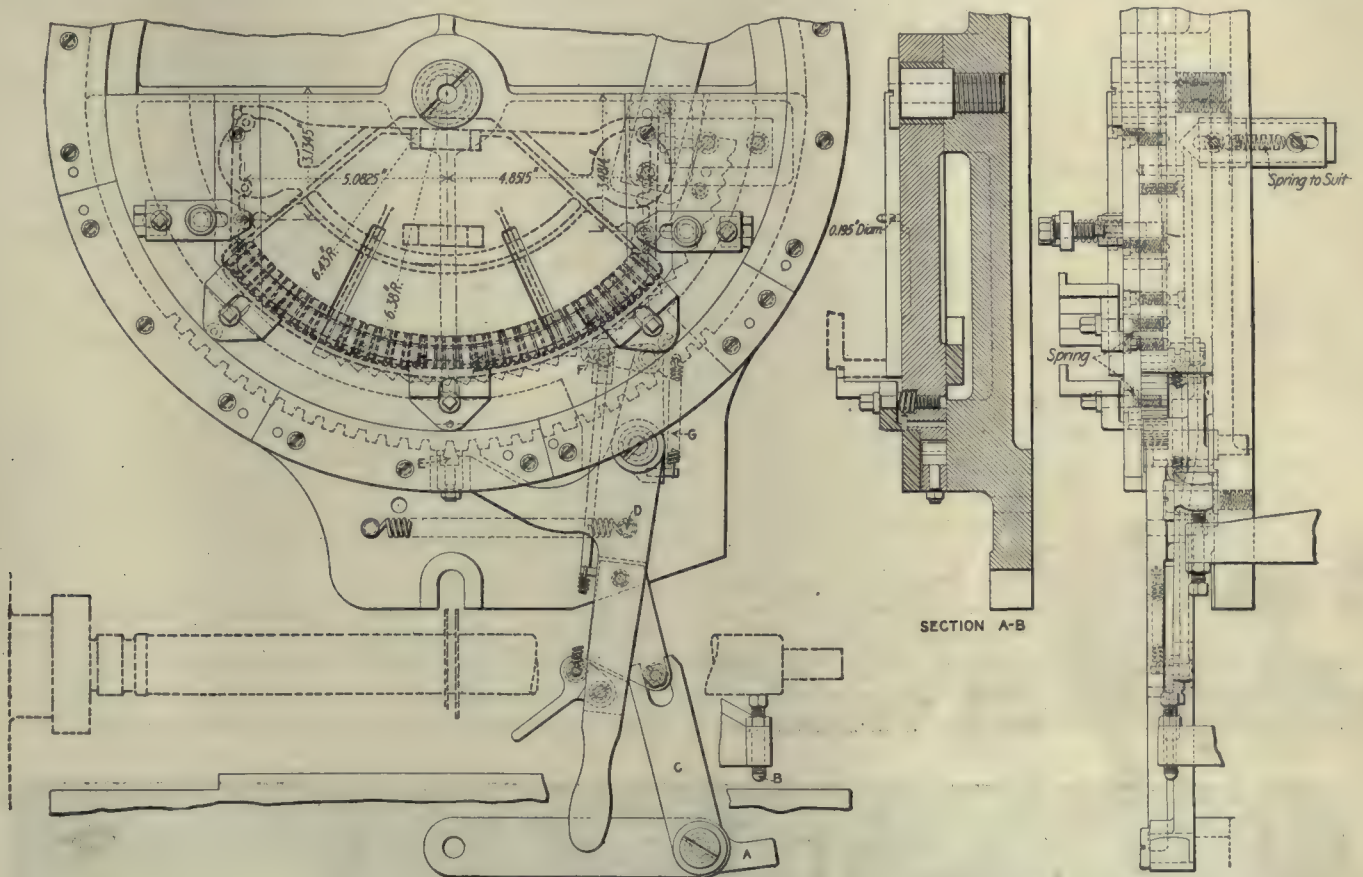


FIG. 15. MILLING FIXTURE FOR TYPE-BAR SLOTS

levers at the rear ends. The long handle shown projecting from the fixture in Figs. 13 and 14 is an attachment to enable the operator to swing the work around to any point by hand when setting up the job. This lever is brought into action by releasing the indexing plunger and pawl at the front by movement of the hand lever into neutral position.

The arrangement of the controlling springs on the lever and pawl apparatus will be of interest. One of these may be especially referred to—namely, the one at *G*, Fig. 15, which tends always to pull the pawl *F* down into contact with the ratchet wheel, no matter in what position the hand lever *D* may be placed. This lever *D*, being pivoted as it is at the periphery of the work table and not from the center of the ratchet wheel, would naturally have a tendency to swing the pawl out of con-

thin bond paper, thereby saving the time required to make a tracing as well as the value of a sheet of tracing cloth. Of course, the draftsman must leave out many of his construction lines, or they will show up on the blueprint, causing the machinist to wonder what so many lines are for. Bearing down hard to get black lines makes erasures difficult; also, there is far more chance of an unchecked drawing going into the shop by this method, because during the tracing many mistakes are made right. If the drawing is of a standard article, the lines will have to be done over now and then, because in handling they will become smudged unless sprayed with some sizing liquid, in which case it will be almost impossible to make a change upon the drawing. At best, it is a sticky, dirty job that is hard to file away—and all to save a piece of tracing cloth!

Tracing paper that is not durable is also objectionable. In a very short time it becomes cracked, torn and full of wrinkles, so why go to the expense of ink tracings on paper when tracing cloth will outlast it and is better in every way? Drawings on tracing cloth can be changed time and time again, as in the case of articles that are not to become standard, such as repair parts, from which not more than one print is likely to be required. But why make tracings or prints at all? With a cross-section blank and a piece of carbon paper a freehand sketch can be made that will give two or three copies and serve the purpose as well as a hurry-up blueprint from a pencil tracing. Blueprint paper and time are saved, and moreover the file is not filled with tracings that will probably never be used again. The original sketch may be placed in a small book made for the purpose, to be retained in the drawing room as a record, and the carbon copies may be sent to the shop. If the drawing will be needed frequently, it is best to make a durable tracing on cloth, which can be altered if necessary.

Not long ago I worked in a drawing room where little sheets of bond paper were given to the draftsmen to make drawings upon. Afterward the tracer would ink them in and clean off the useless lines, and then blueprints were made. Of course, now and then a mistake would occur, which would call for an erasure. After much handling these sheets looked like worn-out tallies for a card game. The spot left by the erasures would collect dust, even if it did not leave a hole. Rather than try to make a change of design over one of these dirty, worn-out drawings the draftsman would get a fresh sheet and do the drawing over, after which the tracer would trace it again. This company thought it was saving money on tracing cloth.

At another time I worked in a drawing room where I had to do all the designing and layout work on thin tracing paper. After several days' work on a new design, with change after change, one can imagine what this thin tracing paper looked like. The object was to enable the tracer to take this drawing and ink it in "direct," after which it was filed away to be used until worn out (which was not long). Often I have seen a draftsman take a

clean sheet of tracing paper, trace over his drawing and start new, rather than try to make another change upon an already much scrubbed drawing. I knew of one case where a designer saw that he could make a little improvement in his design, but did not, because the thin tracing paper was almost worn through. To erase again would have necessitated a new tracing, which the draftsman would not take time for, as the print was wanted in a hurry.

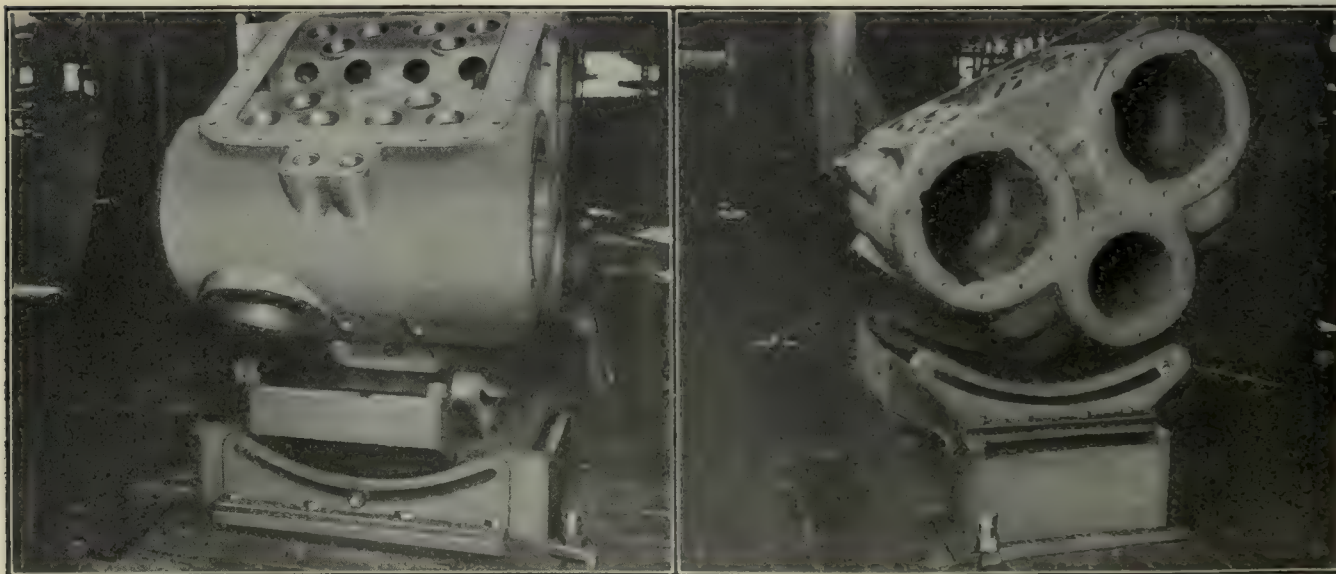
Many will think this last instance overdrawn and say that it is a poor designer who will let an imperfect design go through for such a cause. That is where human nature comes in, which many "efficiency" plans do not take into consideration. Give a man poor tools and unpleasant conditions to work under, and his work in time will get careless and he will lose interest in it. To buy a good grade of drawing paper for the designer will pay, because it is pleasant to work upon and change after change can be made upon it. The same can be said of tracing cloth. Nothing else helps a designer so much as good material. It means as much to him as do good tools to a machinist, or a good canvas to the artist. I think the best plan would be to leave the choice of material to the man who has to work with it all day instead of to someone who never did know, or has forgotten, what it means to spend day after day over a drawing board.

✱

A Universal Drilling Cradle

By A. TOWLER

The illustrations show a cradle that was designed to hold castings where the holes to be machined are in various planes. The base is made with circular slots at 90 deg. with each other on four sides of the fixture. The part to be machined is first fastened on the fixture, which may then be swung around by means of the slot to any position, so that the surface to be machined will be at right-angles with the drill, reamer or boring tool. After the cradle has been set at the desired angle it is held from moving by means of nuts on bolts that fit in the slots. The cradle is proving useful in manufacturing operations.



EFFECTIVE TYPE OF UNIVERSAL DRILLING CRADLE FOR CASTINGS IN WHICH HOLES TO BE DRILLED ARE IN DIFFERENT PLANES

BY A. J. SCHNEIDER

Fig. 4, the back of Final Cost Summary, gives a complete statement of all materials used and their cost. All parts marked R (raw) in the Raw or Fin. column, are those which were made on this order, all parts marked

FIG. 1. COST-DEPARTMENT SHEET FOR COMPANY COSTS OF DIFFERENT ORDERS

FIG. 2. A CONTINUATION OF FIG. 1. ON BACK OF SAME PAGEFIG. 3. FINAL COST SUMMARY OF A PLANER

1 MATERIAL COST 42" X 42" X 10" — Planer - 20 1/2" V - One Rail Head - Two Side Heads - Two Speed Countershaft																		L 170-1	
Quantity	Piece No.	Name of Piece or Group	Req.	Material	Weight	Rate of Fin.	Price Each	Amount	Quantity	Piece No.	Name of Piece or Group	Req.	Material	Weight	Rate of Fin.	Price Each	Amount		
1	3005	Bed	1	C.I.	9020	R			1	4310	Flushing screw	38 A	SS	30	R				
4	2009	Int Reg	1	C.I.		F			1	4319	shaft	34 A	CRS	31	R				
1	2008	Center Reg	1	C.I.		F			1	4340	shaft Rod	34 A	CRS	25	R				
1	2011		1	C.I.		F			2	41948	CRS 773		3.5	Assemb		F			
2	3007 1/2	End	1	C.I.		F			1	41806	C.P. 14	36 A	NA		F				
20	03396	screw	1			F													
2	1003	Rail Pocket Cover	1	C.I.		F			1	41928	C.P. 14 Clamp	37	NA		F				
2	02260	3/8" nut plug	1			F													
1	41787	Bed Bushings	2	NA		F			1	4284	A 14 screw	38	SS	33	R				
6	41788	Rolling Device	3	Assem		F			1	41807	Attach. C.P. 14	38	NA		F				
1	41789	Running Gear	4	NA		F			1	41808	C.P. 14 Countershaft	39	NA		F				
1	3191	Friction shaft	4	HC	134	R													
1	3201	Roller	4	HC	73	R			1	4174	Bracket	39	C.I.	7	R				
1	3210	Table	6	C.I.	5600	R			1	3338	Countershaft	39	C.I.	412	R				
1	41790	Table Back - Dogset	6	NA		F													
1	3024	C Housing	7	C.I.	3545	R			1	41809	C.P. 14 Feed Mech	40	NA		F				
1	3025	"	7	C.I.	3600	R			1	3298	Back shaft	40	CRS		F				
1	3039	Arch.	7	C.I.	340	R			2	01828	feed rack (all set)	40			F				
1	41791	Housing Arch det	7	NA		F			1	41810	C.P. 14 Head	42	NA		F				
									1	41739	" clamp	43	NA		F				
1	41792	Friction	8	Assem		F			1	41811	Attach. C.P. 14	44	NA		F				
									1	3284	A 14 screw	44	SS		F				
1	41793	Segment Gear Det	9	NA		F			1	41812	C.P. 14 Countershaft	45	NA (CRS 5330)		F				
									1	3338	Countershaft	45	C.I.	412	R				
2	4130	Rail Clamp	10	C.I.		F			1	41757	2 S.C.S.	47	NA		F				
4	0338	screw	10			F													
1	41795	Tumbler & Con.	11	NA		F													
1	41796	Shifting Mech	13	NA		F													
1	41797	" attach	14	NA		F													
1	41746	CRS 773	15	Assem		F													
1	41744	C Rail Head	17	NA		F													
1	41802	" Clamp	26	NA		F													
1	3047	Rail	27	C.I.	936	R													
2	3092	" screw	27	SS	78	R													
1	3102	" Feed Rod	27	CRS	25	R													
1	41803	Assembling Rail	27	NA		F													
3	41731	Trigger Gear	30	Assem		F													
1	41804	C.P. Device	33	NA		F													
1	41805	" attach	34 A	NA		F													

FIG. 4. TOTAL MATERIAL COST OF SAME PLANER, ON BACK OF PAGE

F (finished) are those which were taken from stock finished. Groups marked N.A. were assembled on this order. In other words, the group was taken from stock—finished details only, "not assembled."

This system commends itself chiefly by its simplicity, while at the same time it will be observed that the forms included permit a comprehensive account that can be examined and verified with facility.

Model of a Remarkable Gold Dredge

EDITORIAL CORRESPONDENCE

SYNOPSIS—The wresting of gold from Mother Earth has fascinated men since time immemorial. Instead of the older methods used by the early miner, this article describes a 2,000-ton machine that cost \$350,000, but which excavates at a cost of only two cents a ton.

One of the most striking features of the Panama-Pacific Exposition at San Francisco was the number of elaborate working models of heavy engineering equipment; and of these, none attracted greater interest or was more worthy of attention than the two models of the great gold dredge "Yuba No. 14," built by the Yuba Construction Co. These models were built on a scale of 1 to 20 as compared with the original dredge, one being exhibited in the College of Mines, the other in the California Building.

The dredge from which these smaller models were built for exhibition purposes is said to be the largest and best equipped all-steel gold dredge in the world, and yet only three men are required in the crew to control the entire

machinery equipment, which is capable of extracting gold from fully 15,000 tons of material in a day of 24 hours.

Travelers about the State of California now and then get a glimpse of a big gold dredge operating in some isolated section, possibly up a narrow river valley, sometimes in what appears to be a small lake or pond, almost landlocked, and they can hardly help wondering how such an enormous machine could ever find its way into so small a body of water. The secret, of course, is that the dredge makes its own pond; that is, it scoops into the river bank and drags the material, the sand, the boulders and gravel on board. It passes them through a screening process in so far as it is possible to screen this material, separates the gold and impels the collection of the dredge, so that as the machine eats its way inland it discharges the discarded earth and rock astern.

In its conventional surroundings the operation of a gigantic dredge presents many features of interest to the observer. The mere handling of such large quantities of rock and earth as is possible with a modern machine of this kind holds the attention of any one of an engi-

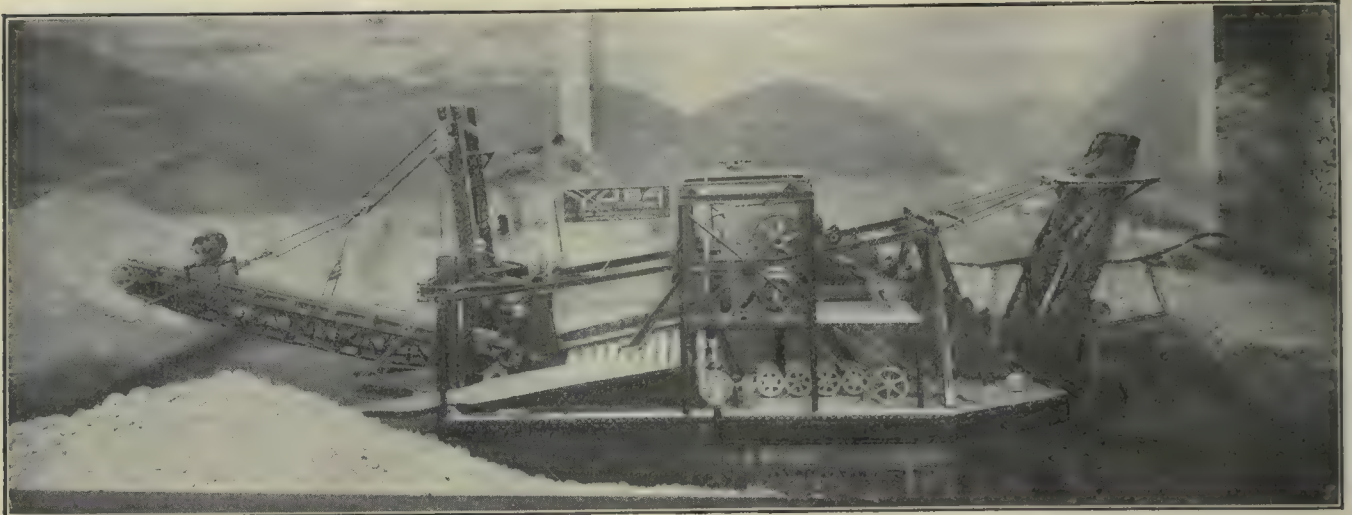


FIG. 1. MODEL OF LARGE YUBA RIVER GOLD DREDGE

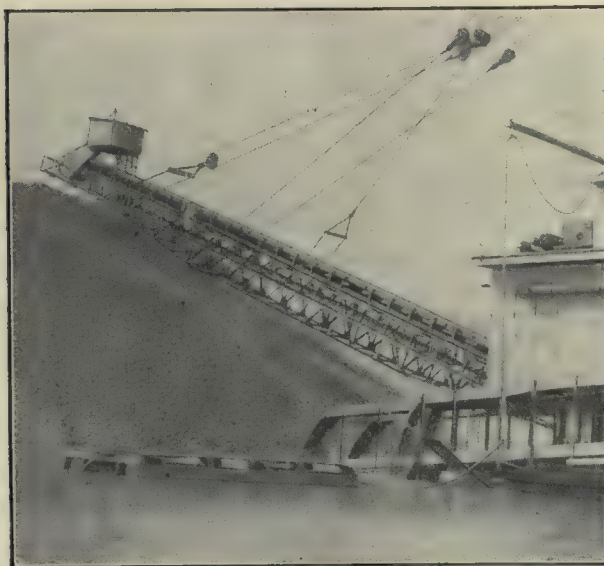


FIG. 2. DISCHARGING THE REFUSE



FIG. 3. THE DREDGE AT WORK

FIG. 4. AN OUTDOOR SCRAP-
ING JOBFIG. 5. THE SIZE OF THE MANGANESE
DREDGE BUCKETSFIG. 6. THE DREDGE FIELD SCRAP
HEAP

neering turn of mind. The gold dredge adds a degree of romance, and naturally being used in lesser numbers, is even less known.

According to authorities, there are forty-six such dredges in use in California for the reclamation of gold.

The largest and most powerful of these, weighing nearly 2,000 tons and costing over \$350,000, is the "Yuba No. 14," of which the model is here shown. This dredge started work at Hammonton on the Yuba River a little over two years ago, and with eighty-seven buckets of

16 cu.ft. capacity the dredge is enabled to handle 10,000 cu.yd. of material per day, the material having a total weight of 15,000 tons.

The buckets weigh about 4,600 lb. each and are made of manganese steel. The dredge spuds, the enormous steel posts on which the structure swings and by which it is held against the bank, weigh no less than 40 tons each. There is a 400-hp. motor that operates the line of buckets, and other motors aboard bring the total up to 957 hp.

It is a most important activity that this type of engineering equipment is now dealing with; namely, the recovery of placer gold, which is now said to be possible at a lower cost per ton than ever before. It is a matter of current statement in California that gravel is excavated from a depth fully 70 ft. below the water level, the gold recovered and the refuse shot out of the way at a cost of two cents per ton. It is obvious that the labor cost is insignificant considering the amount of material handled and the limited number of men employed on board such a dredge. Yet it is difficult to imagine the excavating of so much material, the screening and the recovery of the gold therefrom, and the passing out of the refuse, at such a remarkably low figure as one cent per thousand pounds.

The endless chain of buckets driven by the great overhead sprocket wheel is continually cutting into the bank in front of the dredge, carrying out stones and boulders, cutting up sand and plain gravel, and cleaning the surface of the bed rock with its gold particles. The full buckets as they pass up over the upper tumbler are dumped into a hopper, the material then passing to a screen. This revolves constantly and allows the sand and finer particles of gold to pass through the perforations on to the tables, where the gold is retained by mercury riffles and the waste sand run over tail sluices astern. Boulders and heavy gravel are passed from the low end of the screen onto an endless belt, and carried away behind the dredge, so that the operation continues in an endless cycle, the material coming in at one end and shooting out at the other, the dredge thus sometimes working its way a good many miles from the river whence it started.

The dredge itself is shown in operation on the Yuba River district, near Marysville, Calif. The complete dredge surrounded by its own body of water is shown in Fig. 3, while Fig. 2 shows the refuse or tailings. The rock piles up behind, while the sand and smaller particles run out the lower chutes with the water used in the washing process.

The next three views show some of the field work done in this dredging district. Fig. 4 is a pair of bearings that have been relined and are ready to be scraped to a bearing. They are laid on a huge sheet of sail cloth spread on the gravel, this forming a shop floor and work bench all in one.

A manganese dredge bucket ready to replace one that is worn beyond usefulness is shown in Fig. 5. This illustrates how the cutting edge is reinforced. The two-foot rule standing beside it shows it to be about four feet each way and gives some idea of the size of the ears and bearing pins. The view shown in Fig. 6 was taken to give some idea of the kind and size of scrap found about operations of this kind. It embraces all kinds of castings and sheet metal, much of it in large sizes, and would be of much greater value if it were not for the heavy cost of transporting it to a point where it can be utilized.

Inverted Drilling of Shell Blanks

BY A. F. MENZIES

Perhaps the most expensive operation in the manufacture of 18-lb. high-explosive shells is that of drilling the hole through the center of the billet. This hole is $8\frac{3}{4}$ in. deep and the maximum safe diameter is $1\frac{1}{8}$ in. The rising cost of high-speed twist drills has necessitated the development of the drilling method to be explained.

The generally accepted methods of drilling were literally turned upside down, for the drill was made to be stationary and point upward, while the billet was revolved and fed down, although some machines were arranged to feed the drill upward by means of a hydraulic ram.

In Fig. 1 is shown the idea applied to two drill presses of widely different types, that on the right being lettered for reference. The billet *A* is held in the chuck

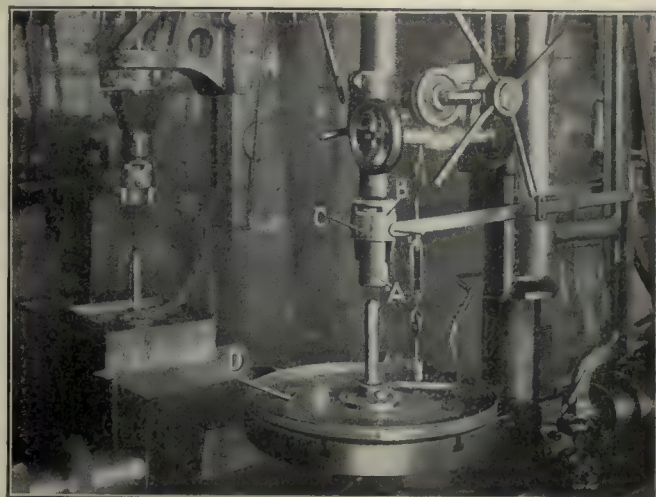


FIG. 1. THE BILLET CHUCK

B. This chuck, which was made from a piece of steel shaft, is also shown in Fig. 2. In order to avoid the necessity of lifting the drill spindle more than was absolutely required and to facilitate the placing of the billet in the chuck, part of the latter was cut away. The gap near the top of the chuck served two purposes: It enabled the operator to see if the billet was properly located, which was important as the base thickness had to be uniform, and it provided a means of forcing out an oversize billet when it stuck in the chuck.

In order to care for billets of varying diameter four hollow setscrews were provided, located as shown in Fig. 2. These screws with the locking setscrew *C* held the billet securely. As the billets of each heat number ran fairly uniform as to diameter, the four setscrews did not require adjustment very often.

The drill shank was made of tool steel turned $1\frac{1}{8}$ in. in diameter and two flutes were cut in it to allow the chips to drop out. Two smaller grooves were also made to accommodate the $\frac{1}{4}$ -in. copper tubes that carried the cutting compound to the point. When secured in the supporting flange the copper tubes were in connection with the supply pipe, which was tapped into the flange and provided with a handy cock for shutting off the compound when a hole was finished.

The upper end of the drill shank had a slot $\frac{1}{4}$ in. wide cut in it to accommodate the drill bits. The latter

were of high-speed steel machined to shape and had a $\frac{1}{4}$ -in. hole drilled through them. A pin driven through a corresponding hole in the shank served to hold the bits in a central position. While no accurate figures were kept, the cost of the bits certainly was not over 75c. each.

The operation was as follows: Let us assume that a hole has been drilled to depth, the feed automatically tripped, and the machine stopped. Then the locking setscrew *C* is slackened by a wrench, and the drilling machine head is raised to the highest point of its travel, leaving the drilled billet resting over the drill. The billet is then lifted off the drill and a fresh one put on the drill point. The table height is such that in this position the billet will just drop back into the chuck, allowing the latter to be lowered until the billet

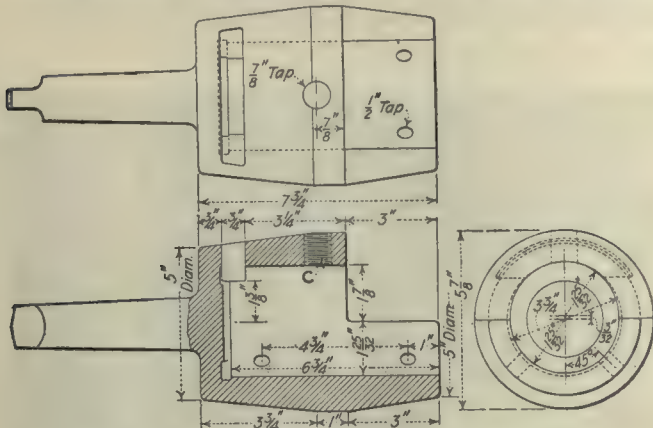


FIG. 2. INVERTED DRILLING OPERATION

comes to rest on the base of the chuck. The locking setscrew is then tightened and the machine started.

With practice the operators became expert at taking off and replacing billets and consumed little more time than was required when the drilling was performed in the ordinary way and the billet held in a vise.

Without allowing for the smaller delays, such as changing bits, etc., the production ran about $7\frac{1}{2}$ holes per hour per machine, which was as good as could have been obtained with twist drills. The quality of work was also good, while the power used was appreciably less. In drilling with twist drills the billets, after being drilled, were so hot that they had to be handled with tongs, while with the method just described the billets were just comfortably warm to the hand, the result of getting the cutting compound just where it was required.

❧

How Can I Improve Myself?

BY BURTON H. PRINCE

Having had occasion in the last ten years to meet a great many mechanics through the medium of the evening school, I am quite often asked by ambitious men how they can best improve their condition, what studies they should take up that would help them to future advancement; and while I cannot always answer as definitely as I would like, there are some general lines of study that will always be of benefit to any mechanic. It isn't always possible to advise either for the reason that one is not always cognizant of all the conditions, the man's previous education, his particular work and the field for which he is best adapted.

But the frequency of the request leads me to put a few of my ideas on this subject on paper, where they may come to the attention of some to whom they may prove of interest and value.

GENERAL DEFICIENCIES FOUND IN SHOP MEN

Generally, the men whom I meet are deficient in two essentials—the use of arithmetic and the ability to read a drawing—and to remedy this condition is one of the first steps along the line of advancement. I always recommend home study on these subjects from books obtained from the library, or the attendance at some evening school if one is within reach; or, failing these two, there is another source of information—the correspondence school.

Beyond this point, it is not so easy to advise. The mental capacity of the man may not be commensurate with his ambitions; his ability to handle men may be entirely disproportionate to the knowledge which he possesses of the trade; or you may meet with a man whose temperament and capabilities are such that he would be better off in some other position.

To repeat, then, it is not easy to advise definitely beyond the first few steps. However, generally speaking, the man who shows some signs of executive ability should be advised to take up such studies as would be of help to him five or ten years hence, when he has reached a higher position. It is a mistake to expect immediate results from any line of study, and it is a greater mistake to neglect study for that reason. The men who attain the higher positions are often only able to hold them through knowledge previously gained and only applied when the opportunity presented itself.

GETTING INTO THE RIGHT LINE

Occasionally, too, you run across a man who for physical reasons seems out of place in the shop, and if he has a natural taste for drawing and mathematics, I would advise such a man to take up the study of mechanics and machine design, and to continue along with his mathematics through algebra, geometry and trigonometry—and even farther if he is capable. He should also take up physics, chemistry, hydrostatics, etc. In this way he would fit himself for the drafting room, and when the chance offered he would be ready.

Some men take no interest in the technical side of their work, but have a great liking for the practical side—the best and quickest ways of doing a given piece of work; cutting speeds and feeds, rake and clearance on tools, lubrication and other phases of their daily shop work. Such a man should be encouraged to study along the lines of shop practice, shop management and kindred subjects. An ever-increasing knowledge along these lines, together with the right personality, should finally lead to a responsible shop position.

But beyond the essentials, a man cannot be advised to any great extent. He must choose for himself. He naturally should follow his own bent, but in any event he should take up some study and stay with it until he has mastered it.

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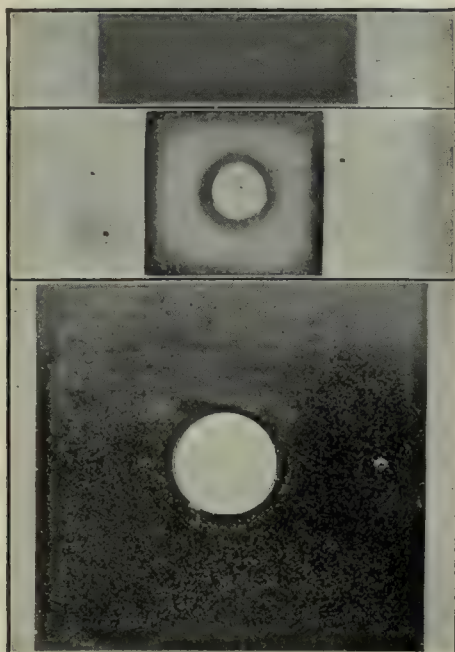
Babbitt Metal should not be used over and over again for the reason that every time it is melted some of the tin and antimony is burned out. The scum that appears on the top of the metal when it is heated is an oxide formed by the combination of the metal with oxygen from the air.

The Hardness Depth, Proportion and Finish in Dies*

BY EDWARD DEAN†

SYNOPSIS—To harden high-carbon steel dies successfully we must understand and follow the laws that control hardening and shrinking. The general law seems to be divided into three parts that control the hardness depth, or hardness penetration; the proportions of the die, with reference to the amount of heat that must be abstracted during quenching from the surfaces that later on will form cutting edges, and the effect of surface finish on the abstraction of heat. Each of these three subdivisions of the law is explained and illustrated by numerous test results. Their application is also pointed out in die design, making and hardening.

In one of my previous articles on this subject I mentioned that there are three great principles or factors in die design, making and hardening. These principles must



FIGS. 1 TO 3. SECTIONS OF SPECIMENS OF HARDENED DIE STEEL, SHOWING LAYERS OF DIFFERENT HARDNESS

Fig. 1—Hard shell and softer core of first specimen. Fig. 2—Softer core of greater area than hard shell. Fig. 3—Specimen has had same treatment as pieces in Figs. 1 and 2

be thoroughly understood and carefully followed if we are to be successful in making high-duty dies. Taken together it might be said that these three principles form the law that controls the handling and treatment of high-carbon die steel. For convenience in explaining and showing their applications, I will take up each subdivision separately, beginning with the principle of hardness penetration, following with the principle of die proportion and finally taking up die finish.

My purpose is to give the tool and die maker helpful information about the important art of finishing and hardening high-carbon tool steel, so that he can produce dies without undue risk of breakage and shrinkage; and, further, so that he can produce dies that will give the maximum amount of service before the tool is worn out or ground away to such an extent that its mechanical strength is impaired. Throughout this article I shall use only such terms as are readily understood by the skillful die maker. My laboratory has not been used to study the metallurgy of steel, but to search out the effect of various proportions and treatments upon those factors that either improve or lessen the service of steels when made into dies. Thus my work has been far different from that of the metallurgist.

I appreciate fully that nothing is infallible. I do know, however, that through the results of my own studies I have been able greatly to increase the service given by die steels and dies. The comparative tables printed in my first article on page 661 show the extent of the progress in my own shop. In presenting the results of some twenty years of research work I shall confine myself to plain statements of fact as I have been able to understand them, at the same time making free use of photographs to illustrate the points brought out.

All the work that will be referred to in this article was done on commercial die steels from 96 to 110 points carbon. It was bought from stock in various steel warehouses. All of the pieces were heated for hardening in a gas-fired furnace of standard make in which illuminating gas was used for fuel. All the work was quenched in clear water at a temperature of about 85 deg. F. In the earlier experiments the results from the specimens heated in the gas-fired furnace were checked by duplicate pieces heated in an electric furnace. As both methods produced approximately the same result, the use of the electric furnace was discontinued.

LAW OF HARDNESS PENETRATION

We are too apt to think that a piece of tool steel hardens all through. In fact, it is customary to give instructions to a hardener to treat such and such a piece so that it will harden "all through." It is, of course, true that a piece of hardened high-carbon tool steel is harder throughout its entire volume after hardening than when it was soft. It is equally true that such a piece of steel having a section thicker than, say perhaps $\frac{1}{8}$ or $\frac{1}{4}$ in. has several different degrees of hardness. In a manner it resembles a piece of hardened carbonized soft steel in that it has a very hard shell and gradually grows softer as the core is approached. Of course the differences in hardness between the various layers of a piece of hardened carbonized low-carbon steel are much greater than the similar differences in hardness between the layers of a piece of hardened high-carbon tool steel.

If we take a piece of high-carbon tool steel $\frac{3}{8}$ in. thick, 1 in. wide and 2 in. long and harden it, we will find that it has a soft core surrounded by a harder shell, and that the shell greatly predominates in bulk over the core.

*Two previous articles/articles on die making by Mr. Dean were published on pages 661 and 705.

†Superintendent, Century Electric Co.

Fig. 1, which is reproduced full-sized, shows both the hard shell and the softer core. The difference in hardness between the two areas is some 3 to 5 points on the scleroscope scale, the actual readings running from 92 to 96 for the shell and from 89 to 93 for the core. The specimen illustrated in Fig. 1 was prepared from a piece of 98-point carbon steel heated to 1,410 deg. F., quenched until cold in water at 85 deg. F., drawn in oil to a temperature of 440 deg. F., and then ground away $\frac{1}{4}$ in. on one edge. This ground surface was then polished with several grits of successively increasing fineness, the last one used being Turkish rouge. After the final polishing the surface was etched for about 40 sec. with a 7 per cent. solution of iodine. After careful washing in alcohol it was allowed to remain in the air for a few seconds until oxidation commenced. It was then at once coated with white vaseline as a preservative. This method of preparing and keeping the steel specimens for microscopic study is one that I regularly follow. The 7 per cent. solution of iodine can be bought at any drug store. The white vaseline I find is a better preservative than any of the oils, for the reason that it is free from acid. In the early days of my experimental work I ruined a lot of specimens by coating them with one of the

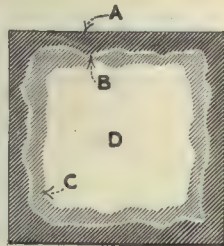


FIG. 4. AREAS OF DIFFERENT HARDNESS IN DIE STEEL



FIG. 5. DIAGRAM SHOWING DIFFERENT AREAS OF HARDNESS IN SPECIMEN OF DIE STEEL

much-advertised supposedly high-grade oils. To my cost I found that this oil contained an acid which destroyed the polished and etched surfaces of my specimens.

Fig. 2, which is also shown natural size, is of a block of steel 1 in. square, treated in the same manner as described for the piece shown in Fig. 1. It will be seen that the softer core greatly exceeds in area the hard shell. The difference in hardness of these two areas according to the scleroscope scale is about 3 to 5 points.

Fig. 3 shows another specimen 2 in. square that received the same treatment as the two described. Comparing it with Fig. 2, it will be seen that it shows a border of approximately even width clear around. Careful study of the original specimens has also brought out easily traceable differences in the hard shell and its softer core. It is, however, impossible to reproduce these in a halftone engraving. For this reason the drawing, Fig. 4, has been prepared to show with greater clearness the relationship

of the subdivisions of the shell and core. This cross-sectional diagram is typical of the polished and etched surfaces of the specimens shown in Figs. 2 and 3.

Turning now to Fig. 4, the hard outer shell is indicated by the dark border *A*. Directly inside of this border is a white line *B*. Inside of this white line *B* is a faint shadowy border *C*, approximately of the same width as the hard border *A*. Inside of this border *C* comes the softer center *D*.

I make no attempt to explain these borders and lines from a metallurgical standpoint, but I do recognize them as representing sections or areas having different degrees

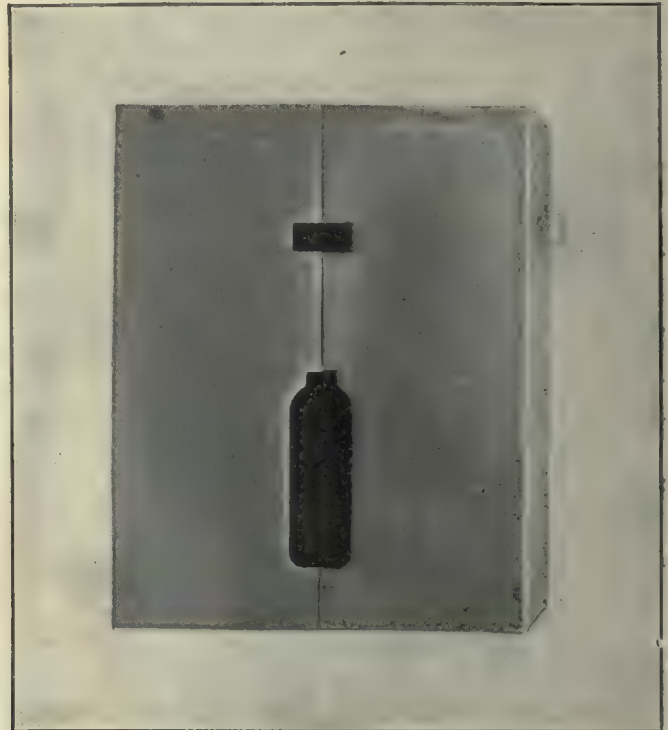


FIG. 6. NOTCHING DIE, SHOWING HARDNESS LINES ON SURFACE

of hardness. These hardnesses can be charted as shown by Fig. 5. The information plotted on this chart was taken from a specimen $1\frac{1}{8} \times 2\frac{1}{8}$ in. in size. The observations plotted were made before the specimen was polished, but after it had been ground down below the surface hardness on the side from which the grinding was done.

This chart (Fig. 5), which is only one of many that I have made, verifies the statement that the different shadowy lines and areas actually indicate different degrees of hardness or different densities of the metal.

In considering the structure of a die with an attempt to state the results that will come from using a die having these various areas of hardness, the following outline seems to be true: The best service will come from the hard border *A* of Fig. 4. This, in a properly hardened piece, is about $\frac{1}{16}$ in. wide up to the line *B*. Beginning with the line *B* and running inward toward the center *D*, the structure is such that grooving or rapid wear may take place if a part of the die having this structure is used as a cutting edge. In some unsuccessful dies I have found the white line *B* as close as 0.010 in. from the cutting edge and have even seen it run clear to the edge. It is evident that such a die was either improperly designed or improperly made and hardened to give maximum results.

To further illustrate this point Fig. 6 shows a die in natural size exhibiting all the lines of the specimen of Fig. 2 except that the white line corresponding to B of the diagram Fig. 4 is broken and the center color runs clear through the hard border to the cutting edge. When on test in the press this die only ran 1 hr. at a cutting speed of 480 strokes per minute, when it became dull and grooved at the points where the center color ran out to the edge.

On looking up the history of this die it was found to have been improperly hardened, having been dipped with the grooved face down instead of vertical and moved rapidly with an up-and-down motion. This allowed steam and vacuum pockets to form in the groove, preventing the

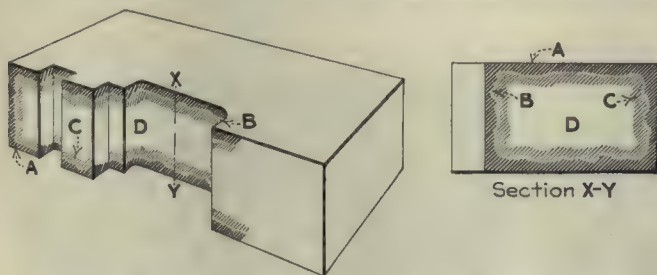


FIG. 7. DIAGRAMMATIC SECTIONS OF A SOLID DIE, SHOWING AREAS AND LINES OF HARDNESS

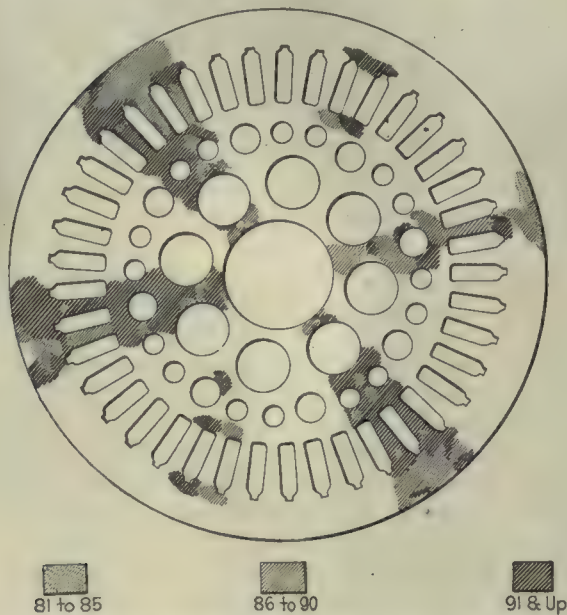


FIG. 8. DIFFERENCE IN HARDNESS OVER SURFACE OF A LARGE HARDENED DIE

cooling water from reaching the surface, creating the soft spots that later on scored when the die was put into use.

A companion of this die, made from the same steel at the same time and hardened in the same way, also ran only 1 hr. under test. It was then removed, annealed, refaced and properly hardened. The proper hardening consisted in dipping it with the grooved face vertical, and moving it in such a way and at such a rate that neither steam nor vacuum pockets could form in contact with the surfaces that later on were to furnish cutting edges. This die was then put to test and ran for 11 hr. at a speed of 480 strokes per minute. The first die only cut some 20,000 holes before grooving and dulling. The second die cut about 220,000 holes before dulling. These records show two things: First, the possibility of greatly in-

creasing the service of dies if they are properly made; and, second, the importance of obtaining the hard outer shell of hardened high-carbon tool steel on all surfaces that are to furnish cutting edges.

INFLUENCE OF PROPORTION ON DIE HARDENERS

After having made sure that the quality of steel I was using hardened uniformly if properly treated, and gave surfaces on small test specimens that were free from any soft spots, I began to search for other conditions that might produce softer areas in the surfaces that must supply the cutting edges of dies. My search brought out two factors that have a very decided influence upon the thickness and relationship of the various hardness layers outlined in the diagram of Fig. 4. As would be expected, one of the troublesome problems was the hardening of the inside of small holes and openings in the dies. If we are to make dies to give maximum service, permitting us to wear them down from 1 in. thick at the beginning to $\frac{1}{8}$ in. at the end, it is evident that the inside of all the openings for cutting edges must be uniformly hard from top to bottom. That this condition did not exist in many dies as ordinarily made had been proved to me over and over again. I have often seen a die start by giving excellent production records for the first few grindings; then I have seen these records begin to change, giving fewer and fewer blanks per grinding until perhaps only one-quarter or even one-tenth as many were being produced as at first. If the die was kept at work, these records would sometimes begin to improve after having reached a low point, and perhaps come back to an amount nearly, if not quite, equal to that produced at first.

My explanation of this action is best seen by referring to Fig. 7. The outer surfaces of the die from which the heat could be easily abstracted in quenching possessed the proper thickness of hard shell. But as we approach the middle of the original length of the hole the heat could not be abstracted rapidly enough in cooling and we find a place where the hard shell is comparatively thin and can not stand up to give maximum service. Actual differences in hardness over the surface of a die are plainly shown by Fig. 8.

From this condition we must conclude that there was too much heat per square inch of surface area in the holes to produce satisfactory hardening. It is probable that the length of time required for the heat to flow out has a very important effect upon the thickness and character of the hard layers. Thus, in designing our dies, it is important to proportion them so that an excessive amount of heat will not be compelled to flow through surfaces that later on are to form cutting edges.

This is the principle of proportion in die design. Once understood it is easily applied. Fig. 9 shows a group of dies, each of which has had a number of round holes drilled through it for the purpose of giving proper proportion. In fact, all the holes except the slots are for the purpose of obtaining proper proportion to control hardening. It will be seen that they are located so as to bring only a comparatively small mass of solid metal around each working slot. As a general rule it is well enough to say that the average amount of solid steel around a working hole in a die should not be greater than an average of $\frac{1}{8}$ to $\frac{1}{4}$ in. in thickness. That is, proportion holes must be drilled so that the heat from every section $\frac{1}{8}$ to $\frac{1}{4}$ in. thick must be able to flow in at least two

directions to quenching surfaces, provided one of these surfaces is that of a working hole or opening.

As a matter of fact this principle is more difficult to state than it is to apply. Any die draftsman or tool maker can easily determine where to drill proportion holes once he understands the principle and has applied it in a few cases.

It will be seen that the more or less common practice of plugging holes in dies in order to influence their hardening is about as bad as it can be. Holes should never be plugged while hardening. The common belief that fillets are necessary to prevent shrinkage and breakage is likewise wrong. I have made test pieces having six fingers that were identical with the exception that every other one was heavily filleted where the thin pro-

coating of scale forms on the surfaces. The thickness and nature of this scale and the ease or difficulty with which it is cast off when the steel is immersed in water have a decided influence upon the hardness. The ideal condition is one where the scale is very thin, is uniform all over the die, and is cast off as soon as the steel enters the quenching water.

It is easy to make a simple test showing this thin scale. Take a small, white porcelain dish, fill it with clear water, heat a piece of steel and then immerse it. The thin scale can be seen to float away from the surface of the steel. Microphotographs magnified to 1,200 diameters show openings or fissures through the scale, and also a multitude of tiny cables holding this scale to the surface of the steel. The intervening space was filled with

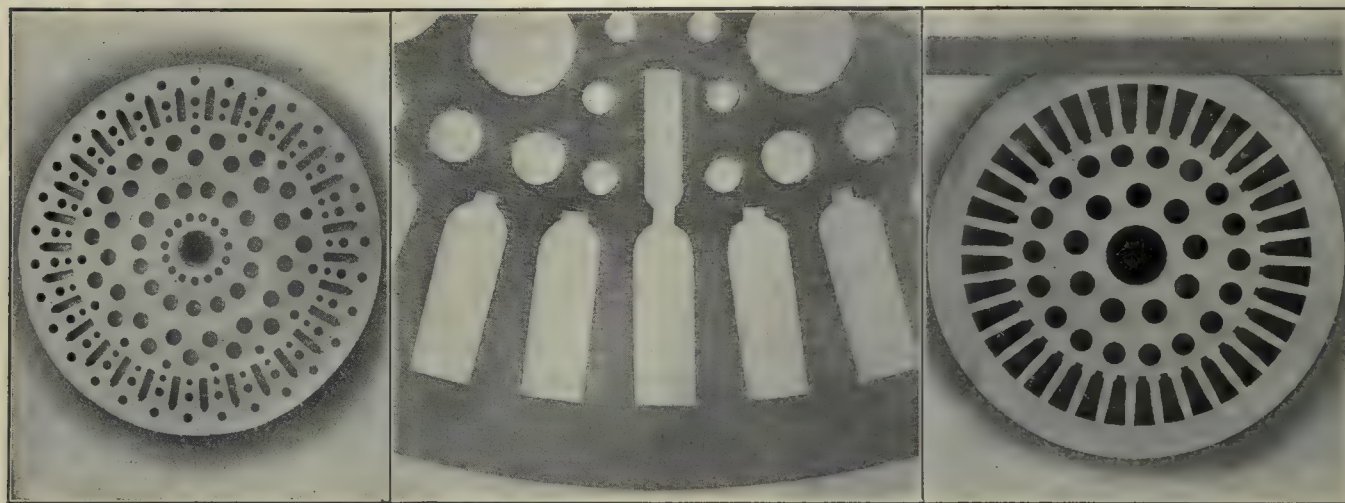


FIG. 9. GROUP OF DIES HAVING PROPORTION HOLES TO CONTROL HARDENING

jection extended from the larger body, and the others were made with square corners. All the filleting fingers were broken in hardening, the ones with sharp corners remaining intact.

Wherever a narrow projection extends from a larger body, drilling a hole near the base of the projection and at a distance away from the edge equal to $1\frac{1}{10}$ times the base thickness of the projection will insure hardening without breaking. Where the combined thickness of hard shells at any position in a die equals or exceeds the thickness of the adjacent soft core, the die will tend to expand in hardening. On the other hand at the points where the soft core predominates the die will tend to shrink in hardening.

By properly locating proportion holes not only do we get a harder and more uniform wearing surface, but we also get greater structural strength in the die, perhaps caused by the fact that we have a hard shell of uniform thickness extending all over the die surface.

INFLUENCE OF FINISH ON DIE HARDENING

The second factor which has a very marked influence upon die hardening and upon the thickness and uniformity of the outside hard shell is the surface finish. I have never seen this fact brought out in the technical literature dealing with the treatment of steels and the making of tools. However, for a number of years I have had standardized surface finishes that were required for all dies. Because of the decarbonization and oxidation that take place when heating a die, a thin, almost imperceptible

steam when the steel was hardened, thus preventing the free flow of heat and interfering with the hardening process.

The most detrimental finish to successful hardening seems to be a tearing cut with a fine feed and a dull tool, such as can be produced in the lathe, planer or shaper. I have a specimen that shows scratches made on two faces of a steel block 1 in. square. One side was finished smooth, the other so as to produce steam pockets. The block was hardened at 1,410 deg. F. and 0.002 in. was ground off each face after hardening. Each face was then scratched by a fine needle mounted in a steel ball; this needle was merely drawn across the ground faces without applying any pressure except that from the weight of the ball. The face that was finished with a surface suitable for hardening shows no scoring or scratching from the needle. On the other hand, the scratches on the other surface are very noticeable.

In order to obtain satisfactory commercial results in die hardening, I have standardized the finish on dies to one which is equal to that obtained from a No. 2 Swiss file on a flat surface. There is a difference of about one number between the grades of the imported Swiss files and the American Swiss. The No. 1 American is nearly equal to the No. 2 imported. Each leaves about the same grade of finish on the work.

A flat file will leave a smoother finish than a round or half-round file of the same number and cut. If you will look closely at a half-round file, you will see that it presents a series of small corners to the work instead of

a smooth cutting edge. If you wish to test the various kinds of finish, take a piece of tool steel $\frac{1}{2}$ in. thick and file it with a No. 2 Pillar file until the surface is straight and smooth. Then take a $\frac{1}{4}$ -in. No. 2 round file and file a half-circle about $\frac{1}{8}$ in. deep in the steel. The edge where the half-round groove meets the top flat surface will look like a saw when examined under the microscope. The other straight edges that have been filed will show smooth and even.

A No. 4 half-round file will leave approximately the same finish on a curved surface as a No. 2 flat file will leave on a straight surface. It is important to give a half-round file a slight rotating motion during the forward stroke of filing.

Too high a finish or polish on a die seems to have the effect of repelling the water when the piece is immersed for hardening. The quality of the finish should be neither too coarse nor too fine, though at all times a tool maker should be careful not to confuse smooth finish with flat finish. A piece of steel with a corrugated surface, or one cut with a coarse feed will harden successfully if the surface of the corrugations or feed marks is smooth; and, in fact, it will present more cooling surface to the water than a flat surface. At the same time, unless such a piece is moved in the water in such a way that the liquid flows lengthwise of the grooves, steam pockets are likely to form and unequal cooling take place.

Two other points need commenting upon before closing this article. A few weeks ago a correspondent of the *American Machinist* asked the reason for the decrease in size of circular ring punches while in use. I have met with this same condition of shrinking in ring punches, and explain the action in this way: From its shape the ring punch hardens all over, with a nearly uniform thickness of the hard shell. As this punch wears and is ground away on one of the flat faces this

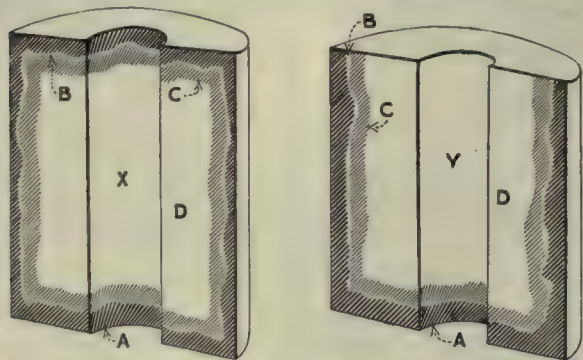


FIG. 10. DIAGRAMMATIC SECTION OF RING PUNCHES

hard shell is gradually removed, until we have a situation where the hard shell is on only one of the flat faces and on both of the circular faces. That is, it is something like the condition shown at Y of Fig. 10. Originally, it was like X of the same illustration.

When the condition as indicated at B is reached, the pulling or distorting effect of the hard shell tends to shrink the lower surface at B, for this surface is softer and less resisting than the hard shell on the other flat surface. The result of this readjustment of stress is to close the surface that has been ground away, making the punch somewhat smaller in diameter than when originally formed and ground.

In my own practice I overcome this difficulty by reversing the ring punch as soon as it gives trouble, thus

keeping the thickness of the hard shell on the flat surfaces approximately equal throughout the life of the punch.

Another point in the care of dies is grinding. It is easy to overheat a piece of tool steel during the grinding operation and impair the temper over small areas. A die that has been abused in this way will be as unsatisfactory as one that has been improperly proportioned and hardened. Not very long ago I had a striking example of the damaging effect of improper grinding. A die identical with the one shown in Fig. 11 was brought to me with a statement that it had

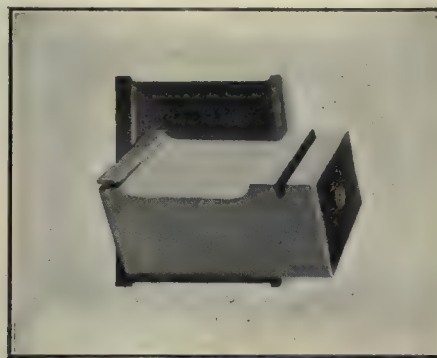


FIG. 11. DIE SPLIT BY IMPROPER GRINDING

cracked after being ground. I examined it carefully and started some experiments to see if I could not duplicate the conditions that had ruined this die. The experiment was made on a similar and companion piece, and the result is shown at the right in Fig. 11. The nature of the crack is the same in both cases, the only difference being in its location.

In order to split the second die I first loaded the grinding wheel with shellac and then scraped the wheel bushing on one side until it ran out of true 0.001 in. The overheating that resulted from the use of this wheel because it was in poor condition and was running out of true was sufficient to split the die as shown at the right in Fig. 11. This is an extreme example of the damaging effect of improper grinding.

Two Universal Drill Jigs

By B. AUSTIN

The United Printing Machinery Co., Woonsocket, R. I., has developed two interesting universal drill jigs for machining details used on presses.

In Fig. 1 is shown a jig used when machining flat bar parts such as connecting-rods. The piece is located at one end by a V-block A, and by a V-block B at the other end. The knurled-head screw C is adjusted to suit different widths of bars so that the hole drilled will be in the center. The V-block B is operated by a cam which is controlled with the lever D. Three plates E are provided to hold bushings so that holes may be drilled at each end and another anywhere between as desired, or the third hole may be omitted, as in the case shown.

A variety of bushings to suit the various holes machined are fitted to the jig plates. The plates slide in a slot, as may be observed by the detail, Fig. 2, so that the holes machined will be in alignment.

Another type of universal jig is shown in Fig. 3. It is used mostly on circular parts. The piece to be machined is placed in the two V-blocks A and slid over the support

B. This is made with a thread so that it may be adjusted for height to hold the part rigidly. The part is then pushed back against the stop *C*, which has been adjusted so that the hole will be machined centrally. The clamps *E*, when tightened with the thumb-screws shown, hold the part securely in place during the drilling operation.

The bushing plate *D*, which is provided with a tongue fitting in a slot of the jig, is then adjusted so that the drill will be guided as near to the work as desirable.

In this jig a set of slip bushings are also provided, to suit the various holes to be machined. In Fig. 4 is shown a detail drawing of this circular-work type of jig.

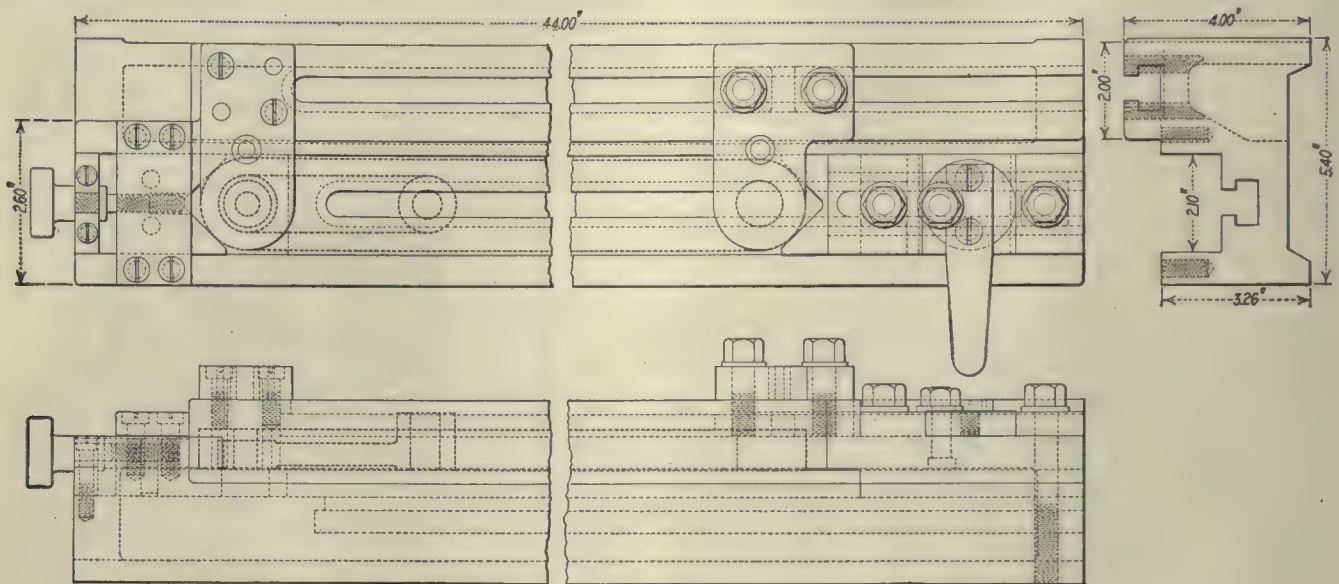
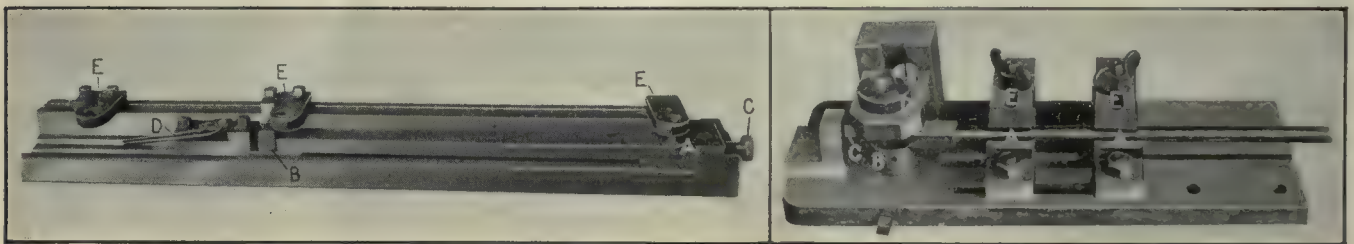


FIG. 2. DETAILS OF JIG SHOWN IN FIG. 1



FIGS. 1 AND 3. TWO UNIVERSAL DRILLING JIGS

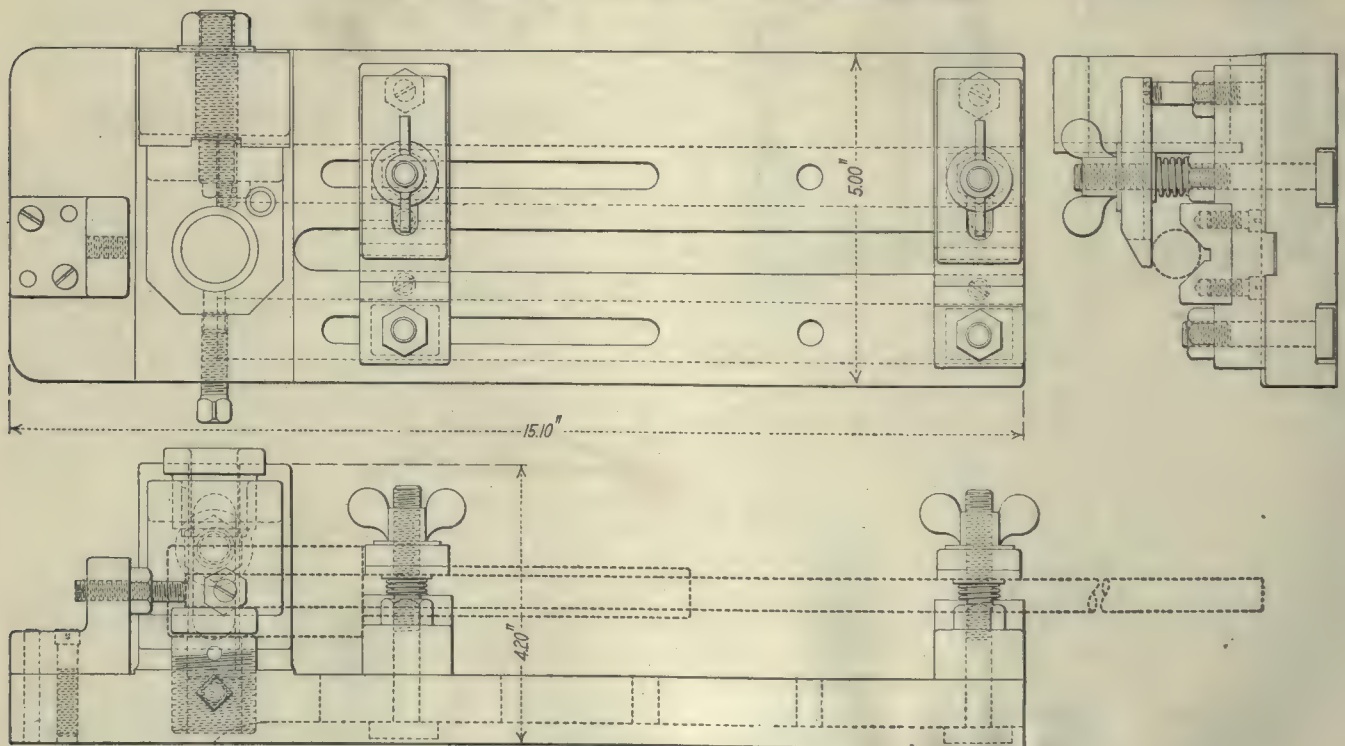


FIG. 4. DETAILS OF DRILLING JIG SHOWN IN FIG. 3

Whitworth Thread-Gage Making

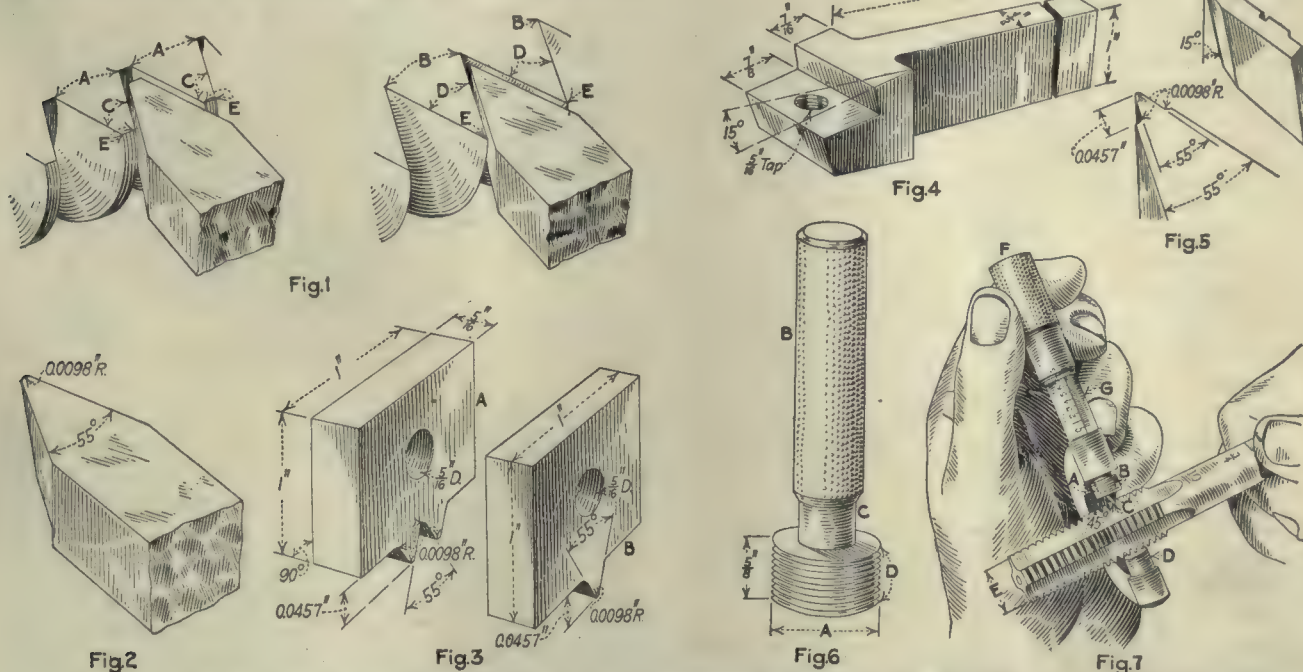
BY HUGO F. PUSEP

SYNOPSIS—The manufacture of commercial threads of the U.S. or V form is considerably less difficult than the production of similarly accurate threads of the Whitworth form. When the making of precision standards is considered, the conditions are reversed; and accurate Whitworth thread gages are more easily made than those with U.S. or V form of thread.

A great change has come over a class of tool makers known up to 18 months ago as thread-gage experts. Formerly a common sight to be met with in any toolroom of size and importance was a man diligently turning out taps,

have a tool maker who was willing to tackle the job. Now here is an instance where a jobbing tool shop had to turn down an order that would have meant in the neighborhood of \$1,000 clear profit in its pocket and perhaps several repeat orders afterward. The Whitworth "expert" turned out to be a fizzle, so the contract is probably going the rounds of other shops in search of a contractor willing to sign.

If this contract had been U.S. or V thread, there is not the slightest doubt that the order would have been filled long ago. What is the reason, then, that a good tool maker who is not afraid to tackle intricate tool and



FIGS. 1 TO 7. IMPORTANT TOOLS AND CONSIDERATIONS IN THREAD-GAGE MAKING

Fig. 1—Points of most wear on threading tools. Fig. 2—Shape of Whitworth tool. Fig. 3—Master form tools. Fig. 4—Form tool holder. Fig. 5—The Whitworth threading tool. Fig. 6—Whitworth male gage. Fig. 7—Micrometer rigged up for measuring

dies and thread gages with either U.S. or V threads. But since the advent of the Whitworth Standard to this country the tool makers who used to pride themselves on their skill in producing accurate threads have taken to some other line of work. There is also a goodly number of jobbing tool shops which could get large and profitable orders for Whitworth thread gages from big munition manufacturers, but have turned down these orders simply because the tool maker who has nerve enough to tackle such work is very scarce at present.

A few months ago a friend of mine, while working in a jobbing tool shop, was approached one day by his foreman and in exultant fashion told that the company had that morning hired a thread-gage expert who said he had actually made Whitworth thread gages. It subsequently developed that this particular company had in its office blueprints and specifications calling for the manufacture on contract of 300 Whitworth male gages for a big munitions manufacturer. This particular contract had not been signed simply because the company did not

gage work will approach the subject of Whitworth gages with fear and trembling? The reason for this aversion is the fact that the correct method of manufacturing Whitworth Standard gages is not well known in this country.

The purpose of this article is to show the methods used in Whitworth thread cutting, hardening and lapping. Before proceeding further it is well to dwell upon a few points in developing a practically perfect thread of any standard. Nothing is absolutely perfect, as all tool makers engaged on precision work know. The hardest thing of all is to lap a sharp corner. As an example, take the U.S. or V thread. No matter how carefully the tool is prepared and the cutting of the threads is done, there will appear slight radii at A and B, Fig. 1, for the simple reason that a threading tool wears first at the corners. The radii may be invisible to the naked eye, but a good magnifying glass will show them plainly.

In like manner the sides of threads, as at C and D, Fig. 1, on the completion of the job might appear very

smooth and highly polished to the naked eye, but a second look through the magnifying glass will show the imperfections in the form of minute ridges at intervals from the root of the thread to the outside diameter. It is impossible to eliminate these ridges altogether, even by lapping with the finest compound known, for the reason that the cutting action of a lap is due to thousands of tiny abrasive particles, themselves embedded in the lap, each one doing its share in removing metal from the hardened threads in a series of microscopic grooves and scratches. And in addition the corners, as at *E*, Fig. 1, which were to all appearance perfectly sharp after the threads were cut, will show small radii when the lap has done its work.

In view of these facts it would seem an easier matter to develop a more nearly perfect thread of Whitworth Standard than either the U.S. or the V thread. This has actually proved to be the case. The radii on the Whitworth thread go far toward eliminating the wear on a well-made and hardened threading tool, thereby transferring the exact form from the threading tool to the threads, provided that the threading tool is of the correct form. All specifications on thread gages prescribe a working limit, which takes care of small errors that will creep in, no matter how skilfully a threading job may be done. In the majority of cases the limit on all working surfaces of thread gages is 0.0002 in. Whitworth threads can easily be kept within this limit, if proper care is taken in preparing the various threading tools and laps.

For the sake of clearness in following the different stages of manufacture the methods, tools, laps, etc., are for Whitworth thread gages, both male and female, of 1-in. outside diameter 14 threads per inch. Any other diameter or pitch can easily be worked out by the help of tables given in the "American Machinist Handbook" or any other good handbook that may be available. All formulas will also be eliminated from this article, as they have already been worked out in various mechanical handbooks and can be referred to at any time.

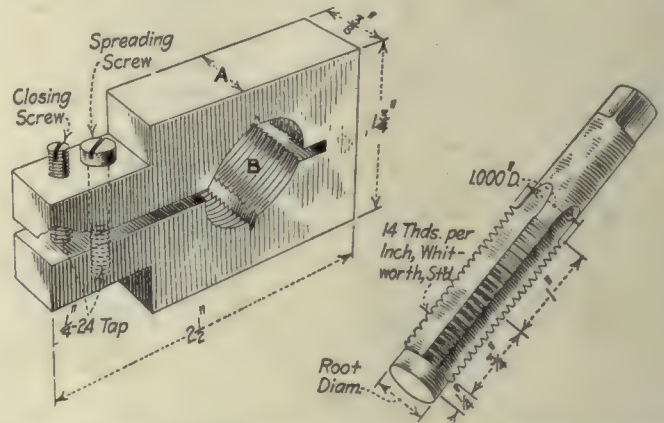
The first consideration is the selection of steel. When the specifications call for tool steel, it is best to choose the kind that will show the least change after hardening. Excessive expansion in hardening means just so much more lapping, which is a slow job at best, whereas any great amount of contraction might leave the threads with insufficient stock for lapping. Ketos steel has always proved its superiority in this class of work, and if hardened strictly according to the makers' instructions, will change very little if any, and then in certain directions—either expand or contract—so that the tool maker can always allow sufficient stock for lapping. Some manufacturers make their thread gages of soft steel, such as screw stock, machine steel, etc., rough-thread them to within $\frac{1}{32}$ in., afterward carbonizing them, finish-threading plus allowance for lapping, and then hardening. While much time can be saved in roughing out such gages, the time consumed in finishing the threads after carbonizing will counteract any such saving of time that was made in the first place.

Having selected our steel, we proceed to make the master tools. This work should be left to a competent tool maker and requires a lot of patience and time; but where quantity production is aimed at, the time spent in developing master tools will repay later on, when everything is clear sailing.

The first tool made is in the form of an ordinary forged lathe or shaper tool of convenient length, as far as the shank is concerned. The point of this tool is ground and lapped after hardening, as shown in Fig. 2.

This tool serves only for machining other master tools and should not be used for threading the gages themselves. It should be made as nearly perfect as possible. From this prepared tool the next two master form tools are made, *A*, *B*, Fig. 3. In Fig. 4 is shown the machine-steel shank to be used with the master form tools.

Next we come to our real threading tool, Fig. 5, the enlarged cutting point of which is shown. This tool is really a Pratt & Whitney threading tool and is used in a spring tool holder of the same make, which is to be



FIGS. 8 AND 9. LAP FOR MALE GAGE AND SIZING TAP FOR THE LAP

found in nearly every toolroom. Now it becomes clear why so much time was given to making the master form tools. The tool *A*, Fig. 3, is for finish-forming in a shaper the cutting point *A*, Fig. 5. The tool *B*, Fig. 3, is for preparing the circular lap; the lap revolves on the miller arbor, and the tool *B* is held in the miller vise by the shank, Fig. 4. Other laps necessary for finishing the master form tools *A*, *B*, Fig. 3, are machined with the tool seen in Fig. 2. Tools for roughing out the threads can be of any convenient shape, either forged lathe tools, resembling Fig. 2, or tools that can be used in a spring tool holder.

CUTTING AND MEASURING THE THREADS

Assuming our male thread gages to be of the form illustrated in Fig. 6, the stock is faced to length, centered and the knurled handle *B* and the neck *C* finished. The diameter *A* is left about $\frac{1}{64}$ in. oversize. Next, the threads are roughed out to within 0.010 in. or so, taking ordinary care that the roughing tool is somewhere near the right form, so as to leave enough stock for finishing. To determine the exact amount for the threads to be left oversize before hardening, we must resort to the cut-and-try method. One thing that it is well to bear in mind is that in no case should the threads be more than 0.001 oversize on various diameters after hardening. The result to be aimed at is to have precisely enough stock so that the threads will just clean up and no more.

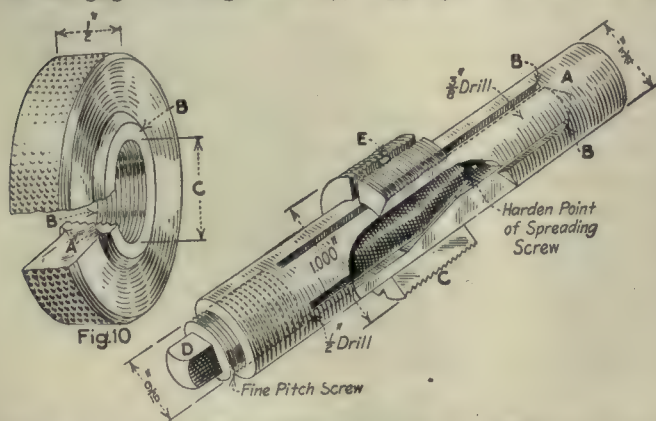
An ordinary outside micrometer is used for the outside diameter. The three-wire system or a regular Brown & Sharpe thread micrometer will serve for pitch diameter: incidentally, the latter is quicker than the three-wire system. For measuring the root diameter a 2-in. mi-

chrometer can be rigged up as shown in Fig. 7. The anvil *D* bears on the perimeter on one side, and the conical point *C* rests on the root on the opposite side. The setscrew *B* keeps *A* from shifting. Correct reading for *E* can be found by moving the thimble *F* till a 1-in. standard just slides between the anvil *D* and the conical point *C*. Now note the reading at *G*, subtract the single depth of the thread, and the result will be the correct reading at *E*.

HARDENING AND LAPPING

Hardening should be left to a practical man. When the thread gages are made of Ketos steel, the makers' instructions should be followed to the letter. Overheating a thread gage is fatal, and for that reason all heating furnaces should be equipped with pyrometers.

Now we have reached the most important stage of thread-gage making—namely, lapping. The success of



FIGS. 10 AND 11. RING TYPE OF FEMALE THREAD GAGE AND FORM OF LAP USED ON IT

this operation depends entirely on the laps used. The lap shown in Fig. 8 is the best form for gages similar to the one illustrated in Fig. 6.

Such laps are made of cold-rolled steel $\frac{3}{8} \times 1\frac{3}{4} \times 2\frac{1}{2}$ in. The thickness *A* depends on the length of the threaded portion of the gage; usually *A* should be about $\frac{1}{4}$ in. less than the gaging length of the threads, to prevent the corners *D*, Fig. 6, from being lapped undersize. As a number of laps will be worn out of form if the order is of any size, it is good practice to make a hand tap for sizing the laps, which will save a great deal of time and worry. The tap, Fig. 9, is made of Ketos steel with a pilot and tapered lead and is made to the finished size of the threads on all diameters.

It will pay to take extra care in making this tap, because if the tap is just right, then the laps will cut accurately. In making the laps, bore the hole *B*, Fig. 8, to the size of the root diameter; thread with an ordinary threading tool to within 0.003 in. or so undersize, and use the tap, Fig. 9, for sizing only. A plentiful supply of good lard oil should be used with this tap to prevent it from tearing the threads in the lap.

When a lap is worn, it will lap the outside diameter and the root diameter faster than it does the pitch diameter. When this takes place, the lap should be stamped with a letter *W*, denoting that it is worn, and a new lap should be procured to finish the threads. This practice does away with the possibility of mixing up worn laps with the good ones. The worn laps can be used to rough-lap the gages to very close limits, reserving the good ones for the finishing touches. The abrasive is the finest grade of

emery dust, used with a liberal amount of good lard oil. The reasons for selecting cold-rolled steel laps are that they keep their form longer than laps made of cast iron, charge easily and are easy to machine.

The most common form of female thread gage at the present time is the ring type, shown in Fig. 10. What has been said about male gages applies equally to female gages. The amount of stock to leave before hardening can be determined, as previously described, by the cut-and-try method. The internal threading tool is made with the master tools shown in Fig. 3. A few suggestions gained from actual experience will help the ring-gage maker considerably.

Leaving a collar projecting about the space of two threads on either side of *B*, Fig. 10, will prevent bell-mouthing, or rather, the bell-mouthing will all be in these collars, which are afterward ground off. Leaving good fillets, as at *A*, Fig. 10, will prevent the collars from cracking in hardening. Boring the hole *C*, Fig. 10, to finished root-diameter size and cutting the threads 0.0005 in. undersize before hardening will provide for sufficient shrinkage in hardening to allow the lap to clean the threads. This suggestion applies to gages made of Ketos steel only. To be on the safe side, it is always best to thread two or three gages, harden and lap them to finished size, keeping a record of sizes before hardening; if the test gages clean up, then the rest of the gages can be threaded accordingly. Knurling will set up stresses in the steel. Therefore the test gages should be knurled and otherwise machined to the same dimensions as the rest of the gages.

A good lap for female thread gages is shown in Fig. 11. The shank *A* is made of spring steel, the lap *C* of cold-rolled steel. There are three saw-cuts *B* in *A*, which will allow the lap *C* to expand when the spreading screw *D* is set up with a wrench. The lap *C* is split lengthwise, and a pin *E* is driven into the shank *A* to keep the lap from turning.

Only the most important points in thread-gage making have been described in this article, but it is my sincere belief that, if the foregoing instructions are faithfully carried out, there is no reason why a good tool maker and mechanic should not tackle a job of Whitworth gages and make a success of it—more especially if he has had practical experience with any thread-gage work before.

✽

Wanted--Information on Drills and Reamers

BY ALFRED J. SHIRLEY

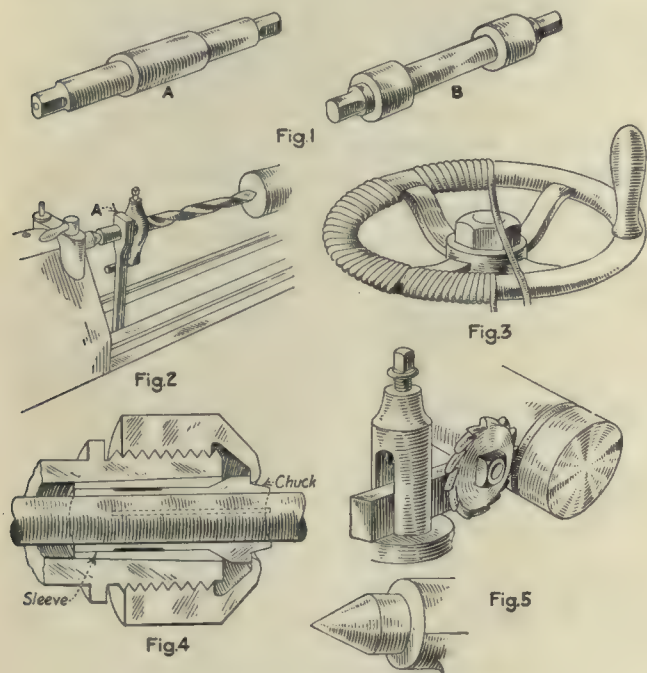
Some interesting points have cropped up lately, but I cannot get any authoritative information upon them and thought perhaps they might be of interest to your readers as well as myself. They are as follows: When you buy a $\frac{1}{2}$ - or $\frac{3}{4}$ -in. twist drill, what size should it be to the nearest $\frac{1}{10000}$ in.? This query applies to all standard-size drills. What size hole should it drill in, say tool steel or cast iron, if the drill is of the proper shape, etc.?

Also, what is a fair limit to allow for reaming a hole to a dead size after drilling with a standard drill so that you get a correct finish? I am training tool setters in theory and practical work for capstan and engine lathes and milling machines, and would like these questions answered.

Some Engine-Lathe Wrinkles

By GUSTAVE A. REMACLE

When it is desired to turn one or more pieces on a mandrel, and the hole in the piece or pieces is an odd size, it is sometimes better to utilize one of the hardened and ground mandrels at hand in such manner as is shown in Fig. 1, than to make a cheap, soft mandrel. Very often a piece of scrap can be found that already contains a hole to fit the mandrel. If such a piece cannot be found, another piece of scrap the proper length may be drilled and reamed to fit the mandrel, driven on, and then turned to fit the odd-size hole. If the job is not



SOME ENGINE-LATHE WRINKLES

long, a single piece should be used as in A, Fig. 1; whereas if it is long, two sleeves may be used as in B, Fig. 1. An excellent feature of B is that both sleeves can be turned to the same diameter, each being a drive fit to the hole. If a hardened and ground mandrel is several thousandths larger at one end than at the other, it will not fit a long, straight hole properly. When a mandrel is turned for a special size hole the centers are rarely hardened; therefore, the mandrel will not run upon these soft centers for any length of time without losing its truth.

In Fig. 2 is shown one method of drilling a hole in the engine lathe with the danger of breaking the drill eliminated. The piece of wood A is strong enough to stand up under the stress of drilling, but will break sooner than the drill if the drill is overstressed. The wood rests upon the drill and some other convenient part of the lathe, while the tail of the dog rests upon the wood.

If the lathe hand has a lot of drilling to do in the lathe, his hand will become tired and sore, owing to the grip he must use on the polished and slippery wheel on the tailstock. Relief may be had by winding twine around the rim as in Fig. 3, the twine of course running all the way around. The spokes of the wheel will keep the twine from slipping, and the twine will allow the operator to obtain a good grip.

It is frequently desired to machine standard-size rod in the engine lathe, and as the large chucks will not hold this small rod, various methods of chucking are resorted to. One good method was described by Mr. Davis on page 164. Another simple method (similar to that described on page 164), although not to be recommended for high-class work, consists of drilling and reaming a piece of cold-rolled steel to the proper size. Removing the steel from the lathe, a hole is drilled and tapped for a setscrew. With a piece of the stock which is to be turned screwed in position, the whole is adjusted in the chuck so that the stock runs true. Other pieces may then be placed in the holder and will run as true as the first. I have seen a number of different arrangements for adapting spring collets to engine lathes which were not built for the purpose. A very good method is shown in Fig. 4.

In Fig. 5 is shown how in an emergency, a milling cutter was used as a form tool in the engine lathe. It was necessary to make two rolls for rolling $\frac{1}{2}$ -in. tubes, and they were wanted in a hurry. A $\frac{1}{4}$ -in. radius forming cutter was bolted to a piece of steel and applied as shown, with satisfactory results.

It is possible to spoil some jobs by not having the tool set exactly at the center line. The mechanic in setting the tool for such a job usually gages the height by means of the head or tail center. If either of these cannot be reached with the tool, or he is too lazy to remove the piece from the centers, he guesses. If a line is marked off on the tailstock spindle as shown, it will be much used and result in better work with less effort.



Technical Writing

In writing in *Coal Age*, Alex Moscovitz offers the following suggestions, to all of which the editor says "amen" and adds "do it now!" Every man, whatever his occupation, trade or calling, is able to write if he is at all observant of his surroundings and does his own thinking.

The trouble with many practical men, whose ideas would benefit a host of others, is that they are either too busy to put their thoughts on paper, or think that they cannot write. Others who make the attempt use too many words. They seem to have an ambition to use high-flown language instead of simple, plain English to express their ideas. This is often the fault of beginners.

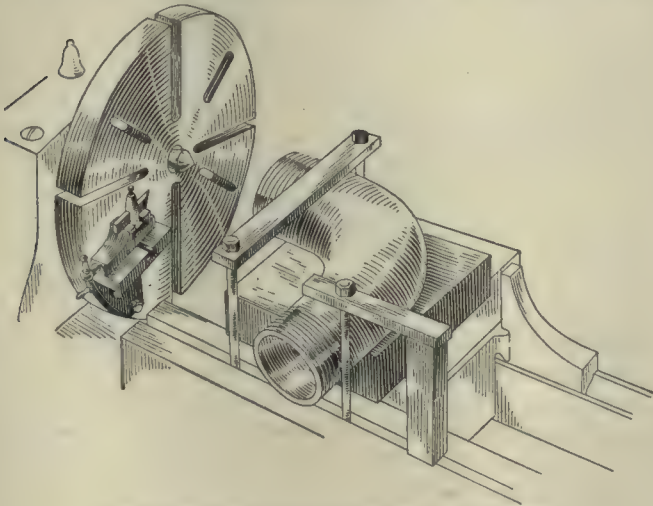
To all of these I want to say that there is no secret about writing. It is not necessary that you should be a born editor in order to write successfully for a trade paper or a technical journal. Write simply as you would talk—be natural. Before you start to write have the idea clearly in your mind, and tell it in as few and simple words as possible. Never attempt to write about a thing that is not clear to you, as you cannot expect to succeed then in making it clear to others.

In order to write interestingly one must have something to say and, as I stated before, any intelligent man can find something of interest and importance in his everyday work that others will be glad to know. Don't be afraid to express your thoughts, but when writing make your sentences short, remembering that a short sentence is always more easily understood by the one who reads. The points to be remembered are: Have something to write about; understand it clearly yourself, and then put your thoughts in as few and simple words as possible.

Letters from Practical Men

Threading Ends of Bent Pipes

We had to thread a number of pieces of 10-in. pipe with a right-angle bend in them close to the end. By putting an angle plate with a small compound rest on it on the faceplate, we were enabled to use a lathe for the



THE RIG FOR THREADING BENT PIPE

purpose. The pipe was fastened in blocks on the carriage, as shown in the illustration. By running the lathe backward it was possible to cut off, turn and chase the thread. We made good time and had no trouble. The illustration shows clearly what was done.

Memphis, Tenn.

H. J. SMITH.

✱

Feeding Roll for Spring Winding

Some time ago I converted an old lathe head into a machine for winding $\frac{3}{8}$ -in. round iron into coils like springs. The lead of the coils had to be kept uniform, but something simpler and faster than the carriage and lead screw had to be evolved for this purpose.

A roller, somewhat larger than the finished coils, was mounted parallel with and in front of the winding arbor. The roller was free to revolve, but only the least possible end play was allowed. It was scored from end to end with a half-round groove to fit the $\frac{3}{8}$ stock, the lead of the groove being the same as the lead of the spring. The root diameter of the roll was made the same as the diameter of the winding arbor.

In use, the stock is caught under a hook on the coiling arbor and dropped into the nearest groove on the grinding roll. When the machine is started, the friction of the stock causes the roll to revolve, the progressive movement of the helical groove establishing the lead of the coil. With some practice it becomes unnecessary to stop the machine at all; one can catch the stock, previously cut to length, under the driving hook at a high speed.

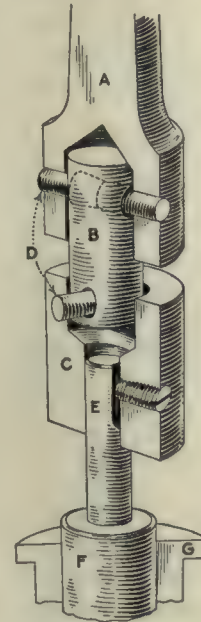
Poughkeepsie, N. Y.

H. W. JOHNSON.

Floating Reamer Holder

The accompanying illustration shows a floating reamer holder used with a reaming jig on a drill press. The holder is practically an easily and cheaply made universal joint of limited action with side play on the pins, and

permits the machine reamer *E* to be guided straight by the long bushing *F* running in the bushing *G*, which is integral with the jig. The bushing *F* is pressed on the shank of the reamer and ground in place, and of course is larger than the body of the reamer. The shank *A* can be straight if the size of the reamer employed permits the use of a drill chuck. As is evident, the spindle or chuck does not have to run true, neither does the jig require to be in very close alignment with the center of rotation of the spindle. As shown in the sketch the pins *D* are driven in *A* and *C* and pass through holes in *B* that are at right angles to each other. These holes are taper-reamed from each side so as to be slightly larger at the center, which is the smallest point, than pins *D*. The part *B* may be about $\frac{3}{32}$ in. less in diameter than the holes in *A* and *C*. For those classes of work in which the floating arrangement is effective the holder shown has much to commend it.



FLOATING REAMER HOLDER

Anderson, Ind.

LEROY M. CURRY.

✱

The Metric System

There have been so many articles in your columns and in other publications on the pros and cons of the metric system that it almost gets confusing to the ordinary reader. I have been trying to keep hold of a couple of ideas as anchors to prevent being swept away by all this flood of argument, and I wish the editor would give me advice as to whether these anchors are of good sound material and will stand the strain.

First, it seems to me that our present system of weights and measures is so firmly fixed in our past history and present work as to make it impossible that it should be supplanted by the metric system. If this is true, the introduction of the metric system would mean increase of complexity instead of simplicity. I remember looking at some German drawings of a steam turbine, and among the millimeter dimensions there were fractions such as $\frac{1}{2}$, $\frac{5}{8}$, $\frac{3}{4}$. I could not make out what they meant, but on inquiring found that they were sizes in inches of Whitworth studs. Take in comparison the United States Standard threads. Does not the fact that there have been millions of machines built with studs, screws and bolts having the United States Standard threads mean

that these standards must persist and that mechanics must continue to be familiar with inch measurements?

Does not all the land that has been surveyed to the present measurements (and practically all the land in the country has been surveyed) mean that the present measurements must persist and that everyone who is interested in the purchase or sale of land must be familiar with those measurements?

Do not all the books that have been written in these English-speaking countries, which use the names of the present measurements, mean that every one who wishes to read intelligently the books which have been written up to the present must be familiar with the present system of weights and measures? Does not the history of all the countries which have adopted the metric system confirm this impression that the old system of weights and measures must still persist and that the metric system does not supplant the old system?

The other point that I had in mind is this: Does not the selling of our manufactures in countries that use the metric system resolve itself almost entirely into a question of translation? In other words, when a catalog is translated into a foreign language, if the measurements in the present system are translated into measurements in the metric system does not that, in 99 cases out of 100, cover all that is necessary? When you have given the dimensions of a bolt of cloth or the weight of a barrel of flour in the metric system, have you not done all that is required? When you have given the bore and stroke of an automobile engine in millimeters (to the nearest millimeter), is not that all that is necessary? What difference could it make to the customer whether the engine was made to millimeter dimensions or not? The only exception I can see to this is in those machines or parts that are actually used for measuring purposes, such as the lead screw of a lathe and the various feed screws of a miller, but it is a comparatively simple matter to make these parts to metric dimensions for machines that are to be shipped to countries using the metric system.

In reference to this question of export business I have been amused to read the editorials in the *Valve World* for August. There are two paragraphs on the metric system, one of which is practically an answer to the arguments in the other. The first says in part:

Looking at the matter practically (and how else should it be viewed?), the whole question of general substitution of the international metric system of weights and measures for the present so-called English system resolves itself into this: Do we want our trade outside of the United States to grow? Do we want to confine our commerce practically to the bounds of our own borders; or do we want to deal, to the limit of our capacity and opportunities, with the world at large?

The other reads as follows:

While we are talking about the "cost" and the "confusion" likely to accompany the adoption of the metric system in this country, the system is being adopted here and there practically without the slightest confusion and at a cost so nominal that it is not to be considered. Orders from other lands for materials made to metric dimensions are being taken and filled almost daily by many of our leading industries. It appears to take us no longer to handle an order from France than one from England, the one in meters and the one in inches, the one to be paid for in francs and the other in pounds, shillings and pence. While some learned professor is telling us how "impossible" it would be for us to work in metrics without the utmost disturbance and at great expense, we are busily engaged in doing exactly that thing, without any appreciable disturbance and at an expense readily absorbed by the selling price. It is a condition that appeals strongly to our sense of humor, a state of mind not at all hopeful for the fearsome "professors."

If it is so easy to handle this export business at present with only those manufacturers who are exporting being affected, why should the metric system be imposed on the whole hundred million people in the United States?

The answer to this metric propaganda looks to me too easy. I am afraid I have missed something or that I do not understand what it is all about. Who is it that wants the metric system so badly, and why do they want it?

Sherbrooke, Que.

H. V. HAIGHT.

[Mr. Haight has hit the bullseye. Every argument for the metric system has behind it the assumption that the use of the system is to be exclusive—that the old units are to disappear. If the old units are to continue in use, as all experience shows they will, every argument for the system is inverted and becomes an argument against it. Instead of fewer units and ratios we have more of both; instead of better ratios we have worse (those between the English and the metric units); instead of simpler we have more complex calculations; instead of less work for school children we have more; and so on to the end. The metric enthusiast holds up to scorn and ridicule as examples of all that is bad, the ratios 12 in. make 1 ft. and 3 ft. make 1 yd., but he accepts the ratios 25.4 mm. make 1 in. and 3.28083 ft. make 1 m. as steps in the path of progress.

Members of the metric party contrast our tables of weights and measures and their numerous ratios with the metric tables and their uniform ratio of 10, but ignore the tables of metric equivalents with which every engineer's reference book is burdened and which, with the adoption of the system, would become an integral part of the real combined system to be used. If the reader will but turn to those tables and reflect that their equivalents are simply a set of ratios which the adoption of the system will add to those already in use, he will see how the adoption of the system will make matters complex instead of simple.

The universal persistence of old units in so-called metric countries—establishing the fact that the old systems never do die out—is the crux of this subject. The metric party dismisses the overwhelming evidence as of no importance when, as a matter of fact, it not only nullifies and inverts their case, but turns it to ridicule.

As to the men who want the metric system so badly, they seem to be scientists and pseudo-scientists who have use for units of measurement to put down the sizes of things that exist, but not for the dimensions of things to be made.—Editor.]

■

Parting with Tools Reversed

With regard to parting off work with the tool upside down, I remember a batch of connecting-rods we had to machine. They were forged solid with the caps on, from very tough steel. After turning, boring and drilling the bolt holes in the large end, the idea was to part off the large end cap, $\frac{1}{4}$ in. being allowed for the cut. There was no saw in the shop, so it was necessary to part off the connecting-rods in the lathe.

The trouble then began. What with the long thin parting tool and the intermittent cut, the cuttings could not get away. After having a lot of trouble and wasting plenty of time I decided to reverse the tool. The rods were then cut off with true faces in record time.

Sheffield, England.

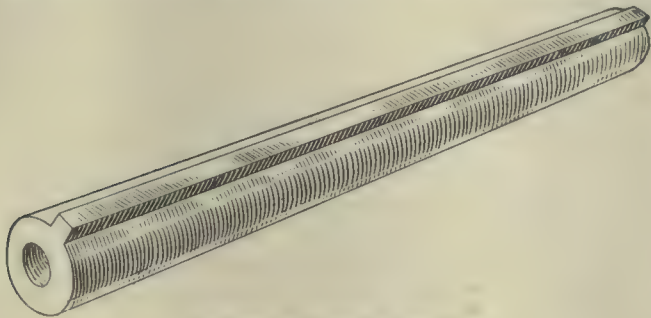
FRANK MCQUILLIN.

Discussion of Previous Question

Circular Shaping Attachment

Mr. Geersten's article on page 163 brings to mind a device that I have used for shaping pieces with integral key or feather, such as is shown in the illustration.

In shaping these pieces the work, instead of the tool, was revolved. The device consisted of a body containing two centers, a worm, a wormwheel and a divided disk,



WORK TO BE SHAPED

which answered in a small way the same purpose as the dividing head of the miller.

Referring to Mr. Geersten's device, it is invaluable for producing a concave radius if projections on any part of the radius being machined will not permit the use of a boring bar. This device does not possess the rigidity and other good qualities of the boring bar. If a miller is available, a boring bar may be used and a good radius obtained in a short time. A very old method of producing the radius in question, also a method which is still employed in most small shops, consists of strapping the job to the lathe carriage and using the boring bar. It must not be overlooked, if the job is of large dimensions, that the boring mill is especially suited to handle such work.

I will conclude by saying that unless projections of some sort, or other unthought of obstacles, prevent the use of the boring bar, this device should not be used.

Newark, N. J.

GUSTAVE A. REMACLE.

Progressive Dies for a Pressed-Steel Automobile Hub

I have read with interest Mr. Walter's description of his automatic hub dies, on page 411. I am surprised that he does not pierce the holes in the small end of the hub in the press, instead of drilling them. It seems hardly possible that a die which will enter the $\frac{3}{4}$ -in. hole will not be strong enough to stand up, even if three holes are punched at a time.

The die can be made at the end of a round piece, mounted in a heavy angle plate. It will be formed on the upper side to the radius of the inside of the hub, be horizontal, be recessed at the back for the edge of the hub to drop down and project just far enough so that the edge rests against the angle plate.

The punches will have a rather strong spring stripper, which will be shaped to fit the hub and will press it into place on the die.

The hub will, of course, be set on an angle so that the face to be punched will be horizontal with the outer edge resting in guides on the shoe. It will be indexed by the outer row of holes.

This arrangement will necessitate eight strokes for each piece. It is possible that more than three holes can be punched at once, but it seems to me that the angle will be too great. Even if only two are used it will still be many times faster than drilling—unless a special and complicated radial drilling machine is used.

This die will not be nearly so expensive to make as some of the others.

W. B. GREENLEAF.

Plymouth, Mich.

[It is difficult to see how, with the layout of holes in the small end of the hub, *three* holes can be punched at each indexing; also, spoke holes are usually required to be radial, and with a multiple punch only one hole could be radial unless a special radial punching fixture were used.

—Editor.]

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Electric Ovens and Furnaces

"The radically different method of heat introduction and application of an electrically heated japanning oven," as against a gas-heated japanning oven, does assure greater output and more uniform products from the former. However, some of the conclusions of W. Rockwood Conover in his article "Electric Ovens and Furnaces," page 316, I feel are misleading and open to question.

The article would indicate that the experience of its author had been confined to the comparison of electrically heated ovens and gas-heated ovens of a direct or open-burner type. In gas ovens of the indirect-heater style the products of combustion do not enter the chambers in which the articles to be japanned are placed, and in such cases no greater amount of ventilation is required than in the electrically heated oven.

All heat radiates from its source, regardless of the character of that source, and such heat is carried by convection currents. It is the heat radiated from its source and carried by the convection current which acts upon the japan.

I believe that the use of the direct-heated japanning oven should be discouraged because of the fire risk.

With two ovens of similar size, shape, etc., one heated by indirect gas, the other by electricity, with both ovens filled with the same kind of material, the same quantity and the same japan, the japanned coating would require the same amount of air, the same ventilation, to oxidize the japan, and the materials in the two ovens should bake at about the same temperature in the same time.

The operation of baking the japan would be the same in both ovens—namely, driving off the volatile matter and oxidation of the drying oils.

From a practical standpoint with electrically heated units, these units may be placed at whatever part of the oven desired and thereby give a uniform distribution of heat. With indirect gas heat this is impractical. Gas requires that the heat sources be placed under the bottom of the oven, or on the bottom at the side.

Electrically heated units can be so constructed that it would be impossible for the temperature at any point of the oven to go higher than 500 deg. F. The temperature of the flame of a Bunsen burner is over 1,500 deg. F. With such heat at the burner it is possible that the walls through which this heat radiates may be at a temperature of from 700 to 800 deg. F., with the result that there would be danger of overbaking if some of the parts to be japanned were placed too close to the walls of the oven.

It is this difference in temperature (an electrically heated oven baking at 475 deg. F. may be crowded to capacity, whereas an indirect gas-heated oven, baking at the same temperature, could be filled to only three-fourths its capacity) which is responsible for the greater output in electrically heated ovens.

As to the difference in appearance of the enamel, relative degrees of hardness, etc., there should be absolutely no difference in the results between an electrically heated oven and a properly constructed, properly used, indirect gas-heated oven.

With the author's conclusions regarding the location of electrically heated ovens, installation and possibilities of the future, we concur; the possibilities, no doubt, are far greater than the accomplishment of the past two years.

Brooklyn, N. Y.

CARL J. SCHUMANN.

✂

Limiting the Value of Inspection

The article by P. G. Little, page 533, describes systems of inspection as carried on in the big plants. From his remarks some of the readers might form the idea that inspection of finished and raw products is of advantage only to the concerns employing several thousands of men. This article is written to show how a comparatively small shop can have an efficient method of inspection.

For many a blunder made in the shop the drafting room is just as much to blame. For example, a drawing was made of a part with six holes in a straight row; two of the holes were to be $\frac{1}{2}$ in. in diameter, while the other four must be $\frac{3}{8}$ in. in diameter. The circles representing the holes, however, were all drawn the same size, so it happened that the workman drilled all the holes the same in spite of the fact that the two different dimensions were given. In a case of this kind the draftsman should have drawn the smaller circle even a little less than $\frac{3}{8}$ in., just to show that different sizes of drills were to be used.

Another frequent cause of error is the fact that the same dimension of a part appears in different views, and the chance for writing it down wrong in one place or another is multiplied. We had a case of this kind the other day. The plan on a drawing showed a hole $4\frac{1}{2}$ in. from the end; the elevation showed it to be $4\frac{1}{4}$ in. from the same end. Two men were doing the drilling. One man worked to the dimension given on the plan, whereas the other man had read the size on the elevation and he worked according to that.

Mistakes are also made by having the wrong size of drill handed to workmen by the storekeeper. The latter should have orders not to hand out drills or reamers without first trying them in a gage to make sure that they are the size asked for. Of course, the greatest number of blunders are made by the machinist himself in doing the work. He may finish a part just a little too small, ream a hole a trifle too large or make various other mistakes. As long as we can only hope to reduce the number of spoiled pieces—not entirely eliminate them—we must do our best to catch the spoiled work before the customer gets it. All the errors mentioned are made in small as well as large shops, and this fact shows the necessity of an inspection system in the small places also.

If the shop is not turning out work enough to keep the men busy inspecting all the time, they can be employed to good advantage in the drafting room. They will in this way become thoroughly acquainted with all the details and should be able to use good judgment in deciding what minor discrepancies can be passed. Inspectors as a rule do not go near the pattern shop, but I would suggest that the inspectors be sent there to check the patterns before the castings are made. Many a mistake on the drawing, which would otherwise escape notice, will in this way be discovered and corrected before the machinists begin work on the castings.

The inspectors should be directly responsible to the chief draftsman. Someone may say that this man is likely to shield his department. How can he? If a mistake has been made on the drawing, it will surely be found out when the machine is being assembled in the shop or erected in the field. The parts made wrong will not fit as they should. The inspector will have to condemn the parts, report the reason for this action and also which department is responsible for the blunder. The chief draftsman in turn has to give a detailed report to the manager, and an order for the new parts can be issued by him only. In case it is not noticed in the shop that there is something wrong, the erector in the field will discover it and will send an exhaustive report to the manager direct. The draftsman should be provided with tags to attach to all assembled work after it is passed, and all repair parts should also be tagged in the same manner. The shipping clerk must be instructed to look for this O. K. tag and not permit the apparatus to leave his possession without one.

The large shops usually make a standard line of machines in large quantities. Consequently, the same inspectors are kept busy all the time looking over practically the same parts. It is therefore not absolutely necessary that these men should be thoroughly versed in reading drawings and making sketches themselves. In the small shop, however, the inspector must be able to do these things, because there is generally a variety of machines built according to customers' specifications and drawings. Quite frequently the inspector is called upon by foremen in the different departments to explain details on the blueprints, and there is no other way in which he can make himself so clear as by making a sketch, even if it is only a rough one. It is perhaps needless to say that an inspector should not be a conceited man. One who was in former years a machinist should be a good man for the job, because he has already the necessary training in handling the different measuring tools, which is of course important.

It is understood that the tools and gages placed at the disposal of the inspector must be of the best. Small trucks, with standard interchangeable trays, can be used to good advantage for bringing the parts to the inspector's bench. Particular attention should be paid to the erecting floor; that is, it should be as nearly level as possible, especially for large work. Inspection must not only be made of the different parts, but also of the finished product. To obtain the best results, the apparatus must be properly lined up and all the parts put in their respective places. If this is not possible, one cannot hope to attain perfection.

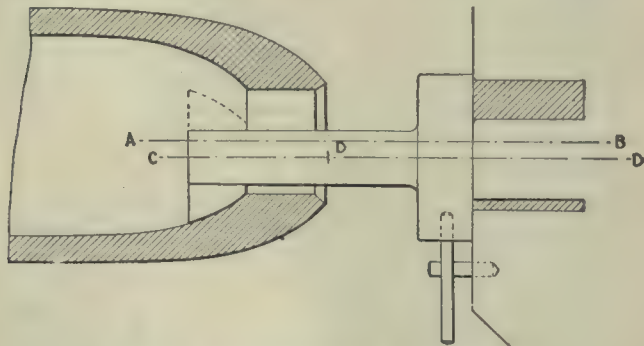
I remember one case where it was not thought worth while to cart big clumsy bearings to the fan housing. The result was that, although the holes in the bearing base and the corresponding holes in the supports on the side of the fan were carefully checked, the shaft, when put in place in the field, would never revolve freely. It was always binding, and caused the erectors much extra work. When it was finally decided to line things up properly in the shop, the fact was overlooked that the heavy fan was erected on an old wooden floor that sagged more or less. As a result, the apparatus, after it reached its destination and was set upon its permanent foundation, was not as level as it should have been.

Shelton, Conn.

J. LIMBRUNNER.

Inside Forming Tool for Shells

Replying to the request of H. E. Bilger, published on page 167, for further information on the forming tool that was described on page 1131, Vol. 44, I think he has not quite grasped the idea of this tool. He suggests that if the eccentric bushing revolved, it would give the same



INSIDE FORMING TOOL FOR SHELLS

results as revolving the tool itself. It would be much more difficult to make that way, and would not achieve the desired purpose any more efficiently.

The accompanying sketch and instructions will, I hope, make the idea clearer. The sketch shows the tool in position in a shell, the cutter, as shown in full lines, being in the cutting position. When revolved backward 180 deg. the cutter will be as shown in dotted lines, in which position it can be withdrawn from the shell or put in, as the case may be. *AB* is the center line of the lathe and *CD* the center line of the cutter holder and of the hole in the eccentric bushing.

The hook on the bolt shown in the original drawing is to take the pull of the cut when the turret is pulled back and the tool is cutting.

The idea is that the tool is set in the position shown by the dotted lines, then run into the shell. Now turn the tool over 180 deg. and we have the cutter in the position shown in full lines, and the bar which turns the tool rests in the hook of the bolt. By hauling back the turret until the mark *D* on holder comes flush with end of shell, the form tool will machine the inside of the shell to shape and remove the excess length of thread in the nose, the hook on the bolt preventing the tool holder from pulling out of the turret. Throwing the cutter holder back 180 deg. will allow it to be withdrawn from the shell.

Nova Scotia, Canada.

JOHN S. WATTS.

Where Are the Good Mechanics?

The article on page 604, about the excellent all-round mechanic who sent out a form letter and only received three answers, has interested and at the same time puzzled me a good deal.

Just why he didn't receive many high-grade offers I couldn't at first see, and, I'm free to admit, I may still be floundering. However, I think I see light.

On reading his letter as a whole you reach conclusions something like these: A thoroughly able and experienced machine-shop executive, right in the prime of life, interested in the advancement and betterment of the trade, and ambitious. Certainly all worthy and commendable attributes, and qualities that should be attractive to many firms who are sorely in need of such a man. Yet he receives only three answers. Why? Re-read the form letter and analyze the various items.

The very first paragraph arouses unfavorable attention. It sounds conceited. Quite likely his way of advertising was unique, but he should have let its uniqueness proclaim itself; he should not have labeled it.

Secondly, although his having patented several devices and written articles should prove him able, and interested in the advancement of the trade, still a feeling of distrust is aroused; and you try to imagine why he wasn't developing his own ideas and patents. Were they not successful? Is he a poor business man? Does he lack the tenacity and nerve to hang on?

He has been an executive in one shop for nine years, and now wants a permanent job at a larger salary. You at once question his loyalty and discount any desire for a permanent position, and arrive at the conclusion that the idea of rendering service is entirely subordinated to his desire for money.

In other words, his whole letter bears the taint of self-interest and the corruption of self-seeking. He would never be able to lose himself in any work.

Springfield, Mass.

CHARLES F. ROGERS.

Building a Large Marine Engine Crankshaft

In reference to the article by R. M. Sherman on page 59, it may be of interest to state that back in the early eighties there was built at the works of Sir Joseph Whitworth a crankshaft which weighed when completed over 141,000 lb.

The crankpins, which were 26 in. in diameter, were forged hollow, turned, bored, hardened and ground by means of emery wheels on the lathe. The steel slabs from which the webs were made were punched and forged round

the holes on a mandrel. The metal was thus compressed about these parts, and the fibers of the material were induced to lie in unsevered lines around the holes. The webs, which like the crankpins were finished complete before shrinking, were keyed as well as shrunk onto the shaft, two keys being used at an angle of 45 deg.

The shrinkage allowance was 0.001 in. per inch of diameter, which allowance was actually predetermined by pressing specimen pieces on and off and noting the pressures required. After the shaft was assembled there remained about $\frac{1}{20}$ in. on its diameter for turning and polishing to a finish. The shaft was a splendid example of what could be executed by the skilled craftsman of thirty years ago.

B. O. REILLY.

Sheffield, England.



Errors in Grinding Due to No Fault of the Operator

I heartily concur with Mr. Wickstrom in his statement on page 571, that work sent to the grinder should be of uniform length, with center holes of equal depth.

Short pieces especially should be recentered to a uniform depth whenever possible before they go to the operator. This should be made a shop rule. A machine will not grind a perfect cylinder if the center holes are out of round or scored through abuse during a previous operation. It is galling to a piece worker to measure a piece of work and find it undersize on one diameter, oversize on another diameter and exactly standard on a third diameter. It takes much of his time to potter with such work—and time is money today. It is still more galling to go down on the shop's record as having spoiled a considerable number of pieces, when it is evident to the operator, though to no one else, that the inspector's micrometer happened to hit many pieces of work on the small diameter.

It is next to impossible to see with the eye that a center hole is out of round two or three thousandths of an inch, and the only certain way to guarantee the machine operator a square deal is to recenter before sending the work to him. Any protest by him regarding the false record against his ground pieces would be met with the statement that he did not clean his center holes properly. I know this to be true from experience. A statement from an operator endeavoring to shift responsibility would take more time to prove when the flaw is not openly apparent than an inspector cares to give. The misshapen center-hole tale makes poor jury evidence.

It is an easy matter to center the work to a uniform depth. All good centering machines are provided with facilities for doing so. An adjustable collar on the combination centering reamer is a simple device worth trying. The argument that recentering after turning is liable to throw the work out of concentricity is being met with in several shops by an inspection of the centering machines each morning and afternoon. Each machine must be within an 0.002-in. error limit at all times.

If an operator is grinding tapers to a gage, and the length limit on the tapered part is close, he can draw the grinding wheel in to the crossfeed stops every time with positive assurance that he is not going to overstep his limit only when he knows for certain that his pieces are all centered to the same depth, and are of uniform

length. Taper grinding then becomes an elementary operation.

But suppose he is grinding work having a No. 3 Morse taper and the center holes are at a random depth. Then he must first grind the piece to within several thousandths oversize of what he imagines the final diameter will be, insert the piece in the gage, measure the remaining length to find the distance the piece still has to go, allow 0.0015 in. for every $\frac{1}{2}$ in. remaining, put the piece back in the machine and proceed to grind. Errors in calculation, being mental, of course will happen, but the basic error rests in the routing of the operations that did not include recentering before grinding.

Other things, such as unlapped center holes in hardened work, egg-shaped holes in bushings, which conform to the arbor while grinding the outside diameter only to spring back to their original form after removal from the arbor, lead from the leadpots in the center holes, and the requested cleaning out of shoulders in grinding, thus destroying evidence that the lathe hand was in error, all tend to discredit the operator.

Finish-grinding is usually the last operation on all work, and to the operator come the accumulated errors of the other departments, including abuses in transmission, and he is charged with many an error due to no fault of his own.

ROBIN DUFF.

Worcester, Mass.



Metric System and Its Critics

My few remarks on page 78 on the metric system seem to have been most annoying to Mr. Tessitore, page 256. What would have happened had I really let myself go, I scarcely dare to think.

My little argument of the crowbar seems to have missed its point so far as Mr. Tessitore is concerned. It is a most elementary illustration I admit, but its meaning is deep. It has wrecked metric men by the score, and it might interest Mr. Tessitore to know that I have been using it for twenty-five years and have always found it either shuts off argument entirely or calls forth a tirade of abuse.

It is hardly necessary for anyone to tell us of the clumsiness of our present system. British and American manufacturers are always ready to admit it. As Stephenson admitted his locomotive was bad for the "coo," so is our system clumsy and awkward for the metric "man."

Mr. Tessitore's statement that everything bought or sold in Argentina is in kilograms, meters or liters, requires some emphasis on the *in*. It is also a fact that the greater part of the selling *to* is done by the English-speaking manufacturer, and will so continue despite our clumsiness. While the buyer puts quality first we are always ready to give him what he wants. The business men in Argentina are clever enough to know that an automatic is not any better because it is made in meters nor a crowbar any lighter when weighed in kilograms.

The argument "that the metric system is bound to come" is one of our oldest "relics." It was an antique twenty-five years ago in Great Britain. In fact it was to be adopted at any time, but now is as dead as a door nail. To mention it might mean "a firing party at dawn," and I can assure Mr. Tessitore that it is not a relic we are proud of.

F. P. TERRY.

Belfast, Ireland.

Editorials

Prevention of Illness

The first address by an outside speaker, Frank F. Dresser, at the convention of the National Machine Tool Builders Association held Oct. 24 and 25, 1916, dealt with "Health Compensation." In it were first reviewed the underlying principles of the laws of Great Britain, Germany and Austria, and then the discussion turned to the proposed legislation that has been brought forward in several states of the United States.

Mr. Dresser's important constructive suggestion to the machine-tool builders was that they should take an active interest in this subject and a part in the working out of the coming legislation, else the movement might progress in a way far from their liking and in a manner that would not be to the best interests of either employer or employee. That the convention appreciated the soundness of this admonition is shown by the fact that a resolution was passed calling for the appointment of a special committee to make a study of health conditions in the plants of the association's members.

It is natural to turn to the work already done for accident prevention and compensation when we search for a parallel to the work that might be done for health compensation, but at the outset a difference of principle is forcibly presented. The trend of all accident work is toward prevention. Mechanical safeguards, instruction, education, the best interest of employees and employers alike are all aimed toward the elimination of accidents. Thus the very operation of the compensation legislation and the carrying out of its provisions in shops tend toward a lessening of industrial accidents, because the work is of a preventative nature.

Furthermore, the time when there is the greatest liability to accidents—that is, when business is rushing—is the time when shops are filled with work and earnings high. The rise in the number of accidents peaks with the rise in business.

Turning now to health compensation, we meet with a different set of conditions. But little can be done in factory buildings to safeguard health beyond what is now done in the better class of shops. (Fortunately, occupational diseases are not found in machine shops.) A man's condition due to an accident is known at the time the accident occurs, and the cause of his injury is evident. The nature of sickness is not so easily diagnosed, nor is its cause so readily determined. There is far less opportunity to reduce sickness through preventative measures in a plant than there is to lessen the number of industrial accidents through safeguarding.

The fact that compensation may be paid for sickness has been found to be a stimulus for real or feigned illness. Malingering has been found to be common in the European countries where some form of health compensation has been in operation for a sufficient period to draw conclusions as to its results. It has been discovered that in some industries where the work is seasonal there has come an increase in sickness during the period

when the business is normally slack. This points to the conclusion that the expense of health compensation, instead of peaking with the trend of business, is apt to be opposed to that trend; that is, requests for payment for illness might be expected to increase at the time when business was slack and dull. This is in direct contrast to the situation that prevails in regard to accident compensation.

A few firms have done splendid work in regard to illness prevention among their employees. Perhaps it is impossible to declare that this work has paid for itself in money in the plants where it has been undertaken. A similar statement is frequently made in regard to accident prevention. However, the work of safeguarding employees' health has important economic advantages—even although it may not be possible to measure them exactly in dollars and cents.

Turning back to Mr. Dresser's suggestions, it seems as if two things should be promoted among the machine shops of the United States. These are:

1. The establishing of work to prevent illness among employees in each one of the larger plants.
2. The working out of some coöperative scheme whereby a group of smaller plants in a given locality can combine and obtain for each one of the members the same advantages that each larger firm can have within its own organization.

Name, Size or Proportion

It is easy to lose a sense of proportion. It is easy to grasp a shell—much harder to reach the kernel. It is easy to bring about minor changes and innovations, but it is much more difficult to put into force improvements that will be permanent. So, then, which is most important in regard to a machine part, its name, its size or its proportions?

Names of things have had more or less study (often less). A recent act of the Society of Automobile Engineers shows that it has given very careful consideration to the names of automobile parts. But this is an exception. Names cannot be brushed away as trivial, but other things loom larger when one asks, "How much?"

No one will attempt to deny that sizes are unimportant. Volume after volume has been published devoted to the design of machine parts. These show the importance of this portion of the discussion. But after all, fits can be made to any sizes and in any system of measurement.

Is not the acme of all these matters that of proportion? Here is where the great work of standardizing machine elements comes into play. Earnest attempts have been and are being made to bring about uniformity of many machine parts in various industries in the United States. A little has also been done in regard to international proportioning. But here only a beginning has been effected.

All this has a direct bearing on the metric controversy. What difference does it make whether a certain part is

called a screw or *vis* or *Schraube*; or a machine referred to as a lathe or *tour* or *Drehbank*? What real difference does it make whether the dimensions of a screw are expressed in inches or millimeters? How much more important it would be to know that a No. 1 screw and a *vis* No. 1 and a *Num.* 1 *Schraube* would enter the same tapped hole.

It may seem revolutionary, but it is not an idea impossible of fulfillment to suggest the universal international standardization of essential machine parts. Standardization as it is known in this country is a purely American idea. How much more important it will be to work for the standardization of machine parts rather than to attempt to bring about a uniformity in mere names and designations of dimensions.



Usable Mathematics

Occasionally a contributor sends in a manuscript filled with mathematics. Sometimes there is page after page devoted to the derivation of formulas, perhaps involving much of the so-called higher mathematics. Invariably such a contribution is returned with a letter stating that it is unavailable for publication, or suggesting that the mathematics be taken out, and only the foundation work for the mathematical study and its workable conclusions be allowed to remain.

The reason for this course is found in the desire to make whatever is published in the *American Machinist* of use to the readers and to present it in the most usable form. The designer does not employ the derivation of a formula in his calculations, but the formula itself. If he believes it is true, that it comes from an authoritative source, or if he has used it before in his own work, he turns to it with confidence. It is reliable. He does not need to wade through page after page of the derivation which led to the putting of the formula in form for instant application.

If nothing but reliable, helpful, designing material is presented, it is obvious that the work of derivation is only of interest to the man who wishes to go through all the steps of reasoning which lead to the final conclusion. Such a man is the exception. The average designer desires to have his designing information in a handy, acceptable shape. Just recall the thousands of handbooks that have been sold. In the shop a man does not care about the various steps and processes which led to the manufacture of the tool which he is using. But he does want to have that tool accurate and adapted for the work that he has to do. This "shoppy" parallel can be applied to designing formulas. The man who uses them does not care how they are made, but he does want to have them correct and applicable to his needs.

Along with this policy of excluding derivative matter from the *American Machinist*, two other standards of exclusion have been set up. The first bars practically all mathematics higher than algebra and trigonometry. Seldom is it found necessary to introduce calculus into the *American Machinist*. The second exclusion is the use of Greek letters in formulas. Seldom are these used, with the exception of the Greek letter π , which has a definite meaning. Others which are so commonly used for reference letters are practically never employed. As long as the English alphabet is available for such purposes there seems to be no good reason to turn to Greek.

What is Industrial Engineering?

In a recent bulletin of the "Society for the Promotion of Engineering Education" Dean Walker, of the University of Kansas, answers the question asked in the above title. With truth he points out that an unfortunate tendency of the present is to confuse the broad subject of industrial engineering with one of its topics—the science of management. Many authors and speakers use the two terms as synonyms. He also points out that because of the increasing attention given to industrial matters it is becoming increasingly important to give the term "Industrial Engineering" its full significance. Scientific management, or industrial management, is but one of the elements entering into the composite structure of this branch of engineering.

With this viewpoint the *American Machinist* is in complete sympathy. The industrial manager needs to know many things that cannot from any proper reason be included under the head of management, never mind how this word may be modified. On the other hand industrial engineering cannot be considered as one of the main branches of engineering like mechanical, civil, electrical and mining. For each of these special training must be given. Rather is it better to consider industrial engineering as one of that group of activities in which most engineers practicing in the main branches need instruction and training.

From the viewpoint of engineering education Professor Walker adopts this interpretation and gives a list of topics which in his opinion should be included in a course in industrial engineering intended primarily for mechanical engineers who are to work in the manufacturing industries. These topics are grouped under two heads, (a) elements in the profession, (b) considerations involved in education. The topics in the first group are: The prospective establishment; location for the enterprise; industrial processes; financing the enterprise; organized form of company; plant design; company organization; management methods; accounting practice. The topics in the second group are: Fundamentals in economics; economics of business; industrial development; statistical studies; manufacturing processes; economics of power and power application; business organization and methods with contract law; management methods; accounting and valuation of properties.



Man is a Tool-using Animal. Weak in himself, and of small stature, he stands on a basis, at most for the fattest-soled of some half-square foot, insecurely enough; has to straddle out his legs, lest the very wind supplant him. Feeblest of bipeds! Three quintals are a crushing load for him; the steer of the meadow tosses him aloft, like a waste rag. Nevertheless he can use Tools, can devise Tools: with these the granite mountain melts into light dust before him; seas are his smooth highway, winds and fire his unwearying steeds. Nowhere do you find him without Tools; without Tools he is nothing, with Tools he is all.—Carlyle, "Sartor Resartus," Chapter IV.



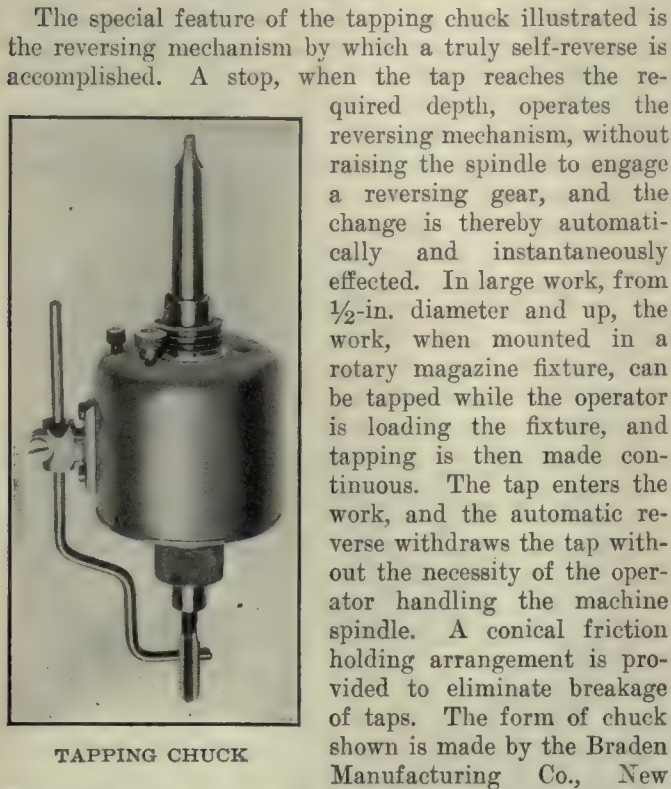
Here are two definitions of an automobile from widely different points of view.

The lady's definition: A carriage with something under it to make it go.

The engineer's definition: A small locomotive with seats on top.

Shop Equipment News

Tapping Chuck



TAPPING CHUCK

The special feature of the tapping chuck illustrated is the reversing mechanism by which a truly self-reverse is accomplished. A stop, when the tap reaches the required depth, operates the reversing mechanism, without raising the spindle to engage a reversing gear, and the change is thereby automatically and instantaneously effected. In large work, from 1/2-in. diameter and up, the work, when mounted in a rotary magazine fixture, can be tapped while the operator is loading the fixture, and tapping is then made continuous. The tap enters the work, and the automatic reverse withdraws the tap without the necessity of the operator handling the machine spindle. A conical friction holding arrangement is provided to eliminate breakage of taps. The form of chuck shown is made by the Braden Manufacturing Co., New York City, in various sizes with capacities from 0 to 7/8 in. The largest size is made to suit any diameter required.

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Vertical Internal Cylinder Grinders

While primarily developed for grinding out automobile cylinders, the machine shown is designed to be adapted for various other classes of internal grinding.

A vertical motor, shown, revolves the grinding wheel, while the horizontal motor set up on the bracket operates the up and down movement of the wheel. The emery dust may be either sucked out through the exhaust port of the cylinder, by connecting to an exhaust fan, or blown out by connecting a compressed-air line to an attachment furnished with the grinder.

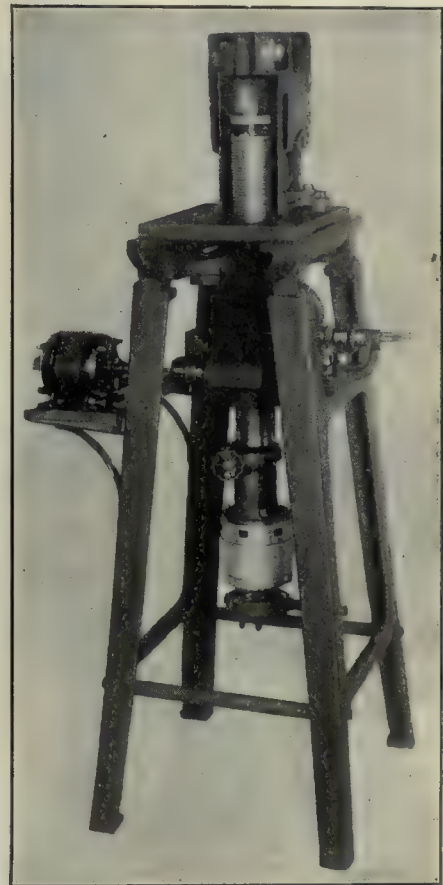
The grinder consists of a vertical bar with a circular rack that is rotated and fed down through a chain of gearing driven by the horizontal motor. Inside of this main bar is a sleeve that carries the grinding spindle. The sleeve is eccentric to the main bar, so that the grinding of different-sized cylinders can be readily accomplished.

Flexibly coupled to the grinding spindle is a vertical motor that revolves the grinding wheel at high speed.

The handwheel shown is for increasing or decreasing the throw of the grinding wheel for various-sized bores

and for regulating the depth of cut to be made. Raising or lowering the main bar can be done by hand, and a shifting rod can be thrown in or out for automatically feeding the main bar up or down. Hand adjustment for revolving the main bar is provided, and adjusting screws tilt the faceplate so that the cylinder can be placed in the proper angle for grinding.

The cylinder is placed on the faceplate; but before clamping down, a steel disk is substituted for the grinding wheel, and the main bar is slowly revolved, the throw of the wheel being regulated by the handwheel until the cylinder centers itself. The faceplate is then



INTERNAL CYLINDER GRINDER

Capacity, cylinders, 3 1/4 to 5 1/2 in. diam., with cut 10 1/4 in. long; bed, 20x12 in.; faceplate, 15x12 in.; floor space, 2 sq.ft.; weight, 400 lb.

clamped tight to the bed and the cylinder clamped tight to the faceplate.

The steel disk is then replaced by the emery wheel, the vertical and horizontal motors are started by throwing the two switches placed on the machine, and the depth of the grind is regulated by a handwheel. The shifting rod is then thrown in, which automatically feeds the grinding wheel up through the cylinder in the way clearly shown in the illustration.

The machine is a recent product of the Reno-Kaetker Electric Co., Cincinnati, Ohio.

Fuse-Graduating Machine

The work of graduating fuse rings and bodies requires extreme accuracy and to provide a graduating machine to be especially adapted for fuse work the American Am-

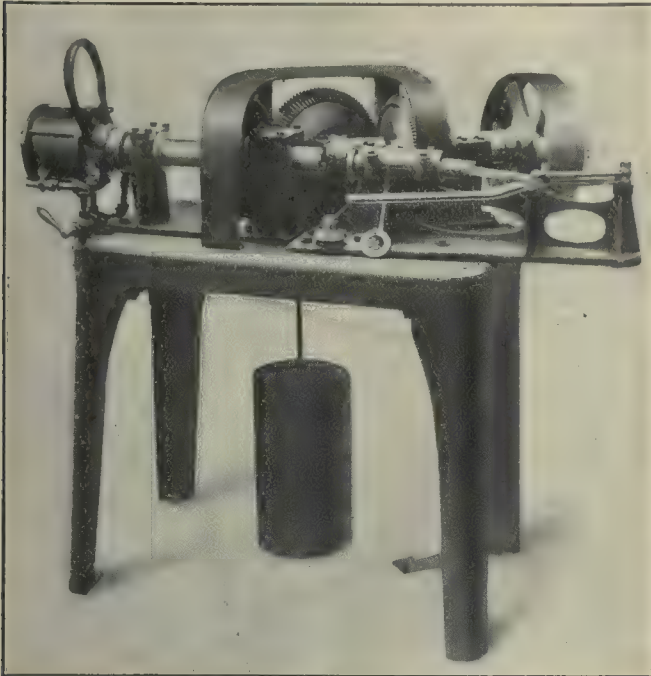


FIG. 1. FUSE-GRADUATING MACHINE



FIG. 2. REAR VIEW OF FUSE-GRADUATING MACHINE

munition Co., Bordentown, N. J., has developed the machine shown.

In this machine the fuse is held in a draw-in collet that is operated by an air chuck. On the bodies of the No. 80 fuse the pressure on the angular part is so great that it has been found necessary to bring a plunger up behind the fuse body to prevent its working out of the chuck.

The chuck shaft is pivoted on its rear bearing and has a sliding box for the front bearing, although this only slides about $\frac{1}{2}$ in.

The machine is driven by a regular punch-press releasing gear and makes one revolution to each pressure on the foot treadle. As there is a blank space on practically all these dies, the graduating dies are set to their full depth; the machine is started and stopped at this blank place, so that the body or ring can be slipped in without moving back the graduating die. The machine then makes one revolution; or if the body happens to be hard, as is often the case, a second or third revolution can be made.

The gears are about four times the diameter of the part to be graduated, and provision for their adjustment is such that practically all backlash can be eliminated with the resultant increased accuracy.

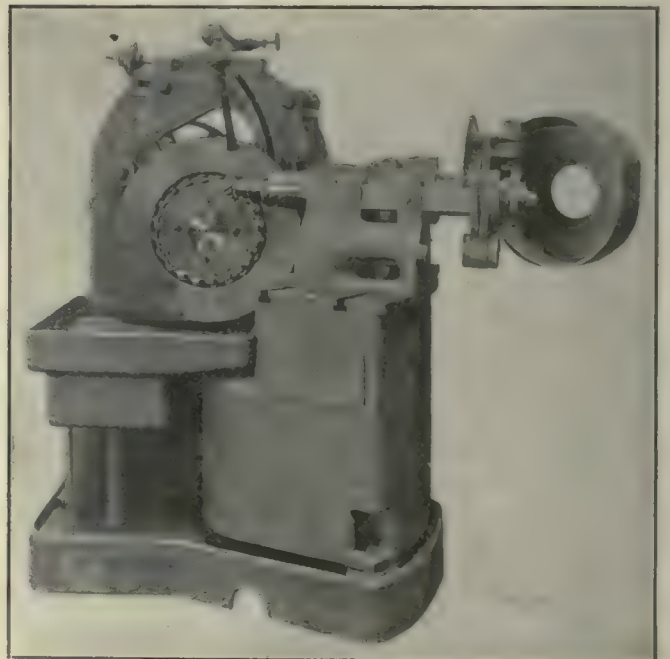
The graduating roll is brought into contact with the body by means of a number of weights, working on a bell crank. As the dies become dull, it is only necessary to add another weight occasionally to the machine until the die is beyond use.

The general design and construction of the machine will be made clear by the illustrations.

Spiral-Type Bevel-Pinion Roughing Machine

The demand for a rapid and economical machine for roughing out pinions prior to finishing on its standard spiral-type bevel-gear generator prompted the Gleason Works, Rochester, N. Y., to develop the machine shown.

The machine is universal, roughing either right- or left-hand spiral, and is fully automatic. The construc-



SPIRAL-PINION ROUGHER

Longest cone distance of any gear that can be cut, 7½ in.; extreme ratio of any bevel pinion, 8 to 1; greatest pitch angle, degrees and minutes, 26-34; least pitch angle, degrees and minutes, 7-7; greatest pitch diameter of 8 to 1 ratio, 1½ in.; greatest pitch diameter of 2 to 1 ratio, 6½ in.; largest pitch (D.P.), 2½; longest face, ¼ cone distance; greatest distance from center of machine to nose of spindle, 12½ in.; cutter speed, 130 ft. per min.; diameter of drive pulley, 16 in.; width of drive belt, 4 in.; diameter of tight and loose pulleys, 12 in.; horsepower required, 5; weight, 5,000 lb.; floor space, 53x58 in.; height, 60½ in.

tion is such as to permit easy oiling and adjustment of all parts. The positive index is actuated by the generating roll of the work spindle. For spacing teeth a notched dial with the required number of divisions is used. A cam mounted directly on the cutter sleeve drives the positive feed.

The drive to the cutter is through one pair of internal gears, the drive pinion being integral with the pulley shaft. All bearings are provided with oiling facilities, and all gears are guarded.

The cutters are of the same type as those on the finishing machine and are interchangeable. Adjustments for setting to the spiral angle can be easily and quickly made. The cutter is set permanently to the root angle and requires to be adjusted only as the cutter wears or a new cutter is needed. The same mandrels are used as for the spiral-type finishing machine, and they are also interchangeable.

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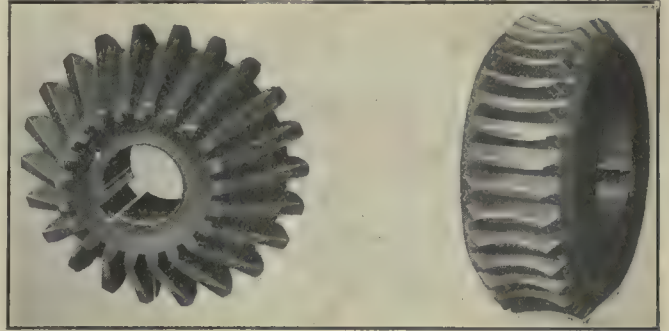
Bakelite-Micarta Gears and Pinions

A nonmetallic gear material which is claimed to successfully meet all practical requirements has recently been placed on the market by the Westinghouse Electric and Manufacturing Co., East Pittsburgh, Penn., under the name of Bakelite Micarta-D. Strength and the elimination of noise in operation are the two principal qualities.

The material is a product of heavy duock bonded together with Bakelite by heating while under an enormous pressure. It is claimed to be as strong as cast iron, unaffected by atmospheric changes, vermin proof, and can be stored indefinitely without shrinking or other deterioration. It can be used for gears that have to operate in oil, without any signs of swelling. In most cases neither bushings nor shrouds are required, as the material is self-supporting. Where, however, the requirements are unusually severe or where the diameter of the gear is several times the width of the face, end plates may be advisable; but even in such cases the teeth need not be shrouded, and the width of the gear is determined only by the power to be transmitted.

In nonmetallic gears in which the teeth are shrouded, the width of the face of the nonmetallic material is usually made equal to the width of the face of the mating gear plus the aggregate end play of both shafts; otherwise the shrouds would mesh and the gear would be noisy. In order to fulfill this condition it was necessary to specify a greater width than would be necessary to transmit the required power. This is claimed to be unnecessary with Bakelite-Micarta gears. Further, it is advised that the width of the face of these gears be made the same or less than the mating gears in order to insure uniform pressure over the entire tooth. This material readily takes a polish, machining best at high speed and with plenty of rake to the tool. It can be machined in any direction and drills and taps readily. The same tools are used as for steel when cutting teeth, but an increase in cutting speed of 25 per cent. and an increase of feed of 50 per cent. may be used.

The depth of material from the root of the tooth to the bore should never be less than the depth of the tooth. In other words, from bore to root of tooth should equal or exceed the distance from root of tooth to face of gear. And, if rivets are used, the diameter of the hole must be subtracted from the distance from bore to root of tooth. At present this material is not made in thick-



BAKELITE MICARTA-D GEARS

Tensile strength, parallel to laminations, 10,000 lb. per sq.in.; compressed strength, 30,000 lb. per sq.in. perpendicular to laminations and 17,000 lb. per sq.in. parallel to laminations; transverse strength, 17,000; coefficient of expansion, per inch per degree Centigrade, 0.00002 in. in the direction parallel to laminations and 0.000085 in. in the direction perpendicular to laminations; specific gravity, 1.4; weight, 0.05 lb. per cu.in.; water absorption, 0.25 to 2 per cent. by weight; shrinkage and oil absorption, zero

nesses over 2 in. Hence, when gears having a face of more than 2 in. are required, two or more plates of Bakelite Micarta-D must be riveted together, using metal end or standard washers under the rivet heads.

The illustration represents two types of gears to which the material has been applied. The forms and applications possible are of wide variety.

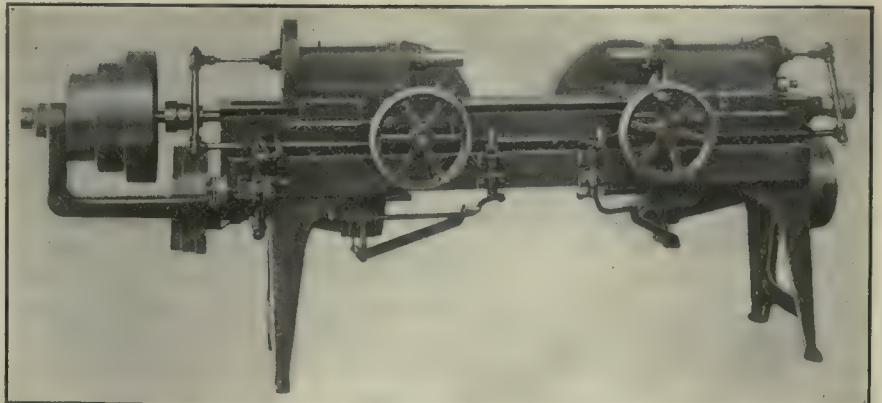
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Duplex Horizontal Drilling Machine

The general features of design and construction of this machine can be gained from the illustration.

The heads are driven from a central driving shaft; and while ordinarily both spindles are run at the same speed, change gears are provided which permit operating the two spindles at different speeds when desired.

The bed is cast in the form of an oil tank, and its top is solid in the center. This construction is designed to



DUPLEX HORIZONTAL TYPE OF DRILLING MACHINE

Distance between spindles, 4 in. minimum and 30 in. maximum on 7-ft. bed machine; distance of spindles to bed, 6 in.; width of bed, 10 in.; capacity, 1-in. drills

protect the working mechanism from chips or other foreign substances.

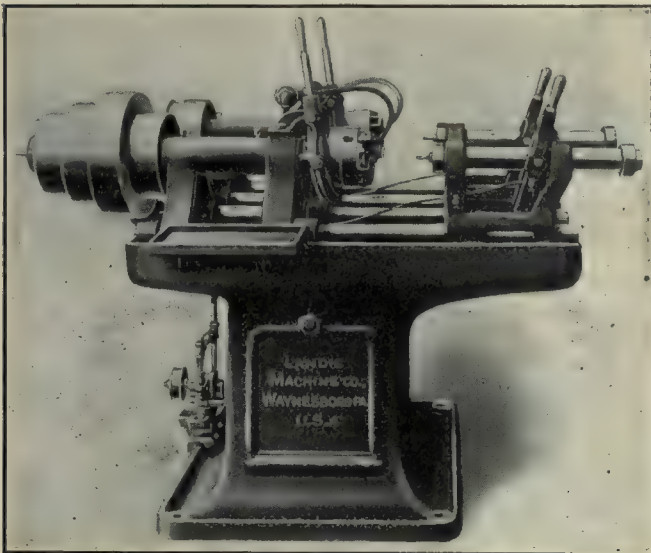
Each spindle is provided with three changes of feed, independent of the other. The machine is furnished with a pump, tank and piping. It is a recent product of the Moline Tool Co., Moline, Ill.

✻

Threading Machine

The illustration represents the latest addition to the line of threading machines made by the Landis Machine Co., Waynesboro, Penn. This machine is equipped with special carriages for threading hollow safety setscrews; and while primarily designed for this purpose, it may be employed in threading stock where there is a continuous thread and a similar method of holding.

The carriages proper are stationary and support two spindles that have a free horizontal movement. These spindles are brought to the threading die heads by means of weights attached by chains to the levers operating the spindles. These weights exercise a continuous force upon the spindles in the direction of the die heads, mak-



THREADING MACHINE

ing it unnecessary for the operator to advance the stock for the threading operation.

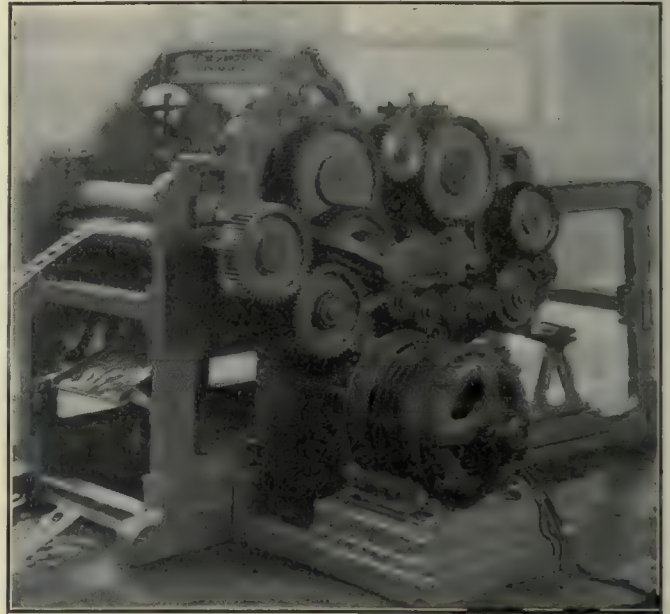
The heads of the spindles are bored and fitted with mandrels for holding the setscrews. A collar is placed on the rear of each spindle, making it adjustable for cutting any desired length of thread. For the threading operation the setscrew is placed upon the mandrel, and the spindle automatically forces it into the die head. When the screw is threaded, it remains in a tube that extends through the spindle from the face of the threading die head to the rear of the machine. The subsequent threading of screws forces the finished pieces through the tube, where they drop into a receptacle placed at the rear of the machine.

The type of machine shown may also be used for threading standard bolts by attaching automatic opening and closing attachments for the die heads. When standard bolts are threaded, the heads of the spindles on the carriages are fitted with bolt sockets for the various diameters within the range of the machine.

Rotary Punch Press

The rotary principle involved in the punch shown is believed to be a new application in punching material such as fiber, leather cloth, cardboard, tin, lead, copper, brass, steel, iron or other metal alloys.

The principle is that of a rotary punch and die drum mounted upon suitable shafts, again mounted in suitable



ROTARY PUNCH PRESS

Capacity for material $\frac{1}{4}$ in. thick, 12 in. wide; speed of punch shaft, 50 r.p.m.; drive, 10-hp. motor through gearing; weight, including two heads and one set of punches and dies, 10,000 lb.

bearings. Upon these respective drums are set multiple punches and dies of the shape of the piece to be punched. The punches are entered into the dies a distance of $\frac{1}{2}$ in., sufficient to drive the die; the die drum floats on the shaft upon which it is mounted, and the die shaft floats in its bearings. The outside diameter of the punches and dies, after they are placed upon their respective drums, is ground to a certain fixed diameter. The production is governed entirely by the number of punches and dies mounted upon the drums, and this is governed by the size of the piece to be punched.

The punch action is that of a shearing cut. As the punches enter the dies on a radius and as the punches are the only means of driving the dies while the metal is being fed in between automatically, the principle can be compared with that of a straight-tooth spur gear. The punch and die drums are made of solid cast-iron blocks, machined properly to receive multiple punches and dies. All punches and dies are made of tool steel and are hardened and ground.

The machine can be used for plain blanking, for piercing and blanking, or for piercing, forming and blanking. In such instances a second or a third head is provided and mounted upon the main frame of the machine. All machines are manufactured to accommodate two heads. Wherever a third head is required, a special section is inserted between the front part of the machine and the rear part.

The material to be punched is fed into the punches and dies by feed rollers in the rear part of the machine. These are turned to proper diameter and timed with

proper gearing so as to feed the material at the same peripheral speed as the punches and dies would pull the material. If material is extra thin and comes in spools, an unwinder is designed and placed in the rear end of the main frame to accommodate the spools. In this instance the material is fed over idlers into the feed rollers and from there through the various heads into the front end of the machine. Wherever the material is heavy enough and comes in lengths or strips or sheets, these are placed on top of the idlers in the rear end of the main frame and also automatically gripped by the feed rollers and fed through the punches and dies.

In the extreme front of the machine the pull rollers are mounted, turned to the same diameter as the feed rollers in the rear end and also properly timed through gears. The scrap stock is fed through these rollers and taken away by the operator. The punchings drop out of the die block down into a chute in the main body of the machine and from there down into baskets placed in front between the main frames.

The main side frames of the machine are of semi-steel castings. The motor base and all connecting-rods are of cast iron. The pitch of all gears is standard five pitch. The face of all gears is $3\frac{1}{2}$ in. All drivers are of phosphor-bronze castings running into steel castings, and all gears used for feed mechanism are of cast iron driven from steel castings.

Upon the operator's side of the machine is a flywheel also acting as a handwheel, and by the use of it the punches and dies are easily adjusted and entered into each other properly. On all the finer working parts safety-head capscrews and setscrews are used, and self-closing oilers are mounted upon all bearings.

The machine is a recent development of the Malm Machine Co., Dayton, Ohio.

■

National Machine Tool Builders Annual Convention]

The fifteenth annual convention of the National Machine Tool Builders Association was held in the Hotel Astor, New York City, Tuesday and Wednesday, Oct. 24 and 25. The address of the President, J. B. Doan, after greeting the members of the association, turned to business matters, with a few references to the political situation. Mr. Doan's impressive outline of some of the problems facing machine-tool builders follows:

A special feature of this association is the good fellowship of its members. Good fellowship, in the deeper sense of binding men together by the powerful ties of mutual self-interest and profound friendship, is a most valuable element in the development of every industry. Men have learned that coöperation is one of the necessities of business success. By combining our wisdom we learn better methods of manufacture, we learn that there is some better system of business than merely trying to cut the throat of a competitor, and we find that the concentrated rays of business friendship, like concentrated sunbeams, will melt the coldest and hardest markets. In other words, coöperation and the exchange of business ideas teach us to manufacture more scientifically, to keep costs more accurately, and to market our product more successfully. So let this membership get together, abandon business suspicion and build up business confidence.

There never was a time when these fundamental laws of success were so essential to business men. We are living in the most momentous days of history and are witnesses of the results which follow when national suspicion becomes national fear, and national fear turns to national hatred, leading to international destruction. We in America, enjoying as we do the privilege of living as a people without internal hatreds, without internal suspicions, without deep internal antagonisms, do not yet realize the greatness of these privileges. Such associations as ours keep alive in our country the great spirit of national trust and national coöperation. We come from coast to coast, from north to south, and meet with a common language and a common purpose. Let this unity increase and grow, and in the midst of this unity, do not fail to observe the horror that overwhelms nations and peoples who do not enjoy it.

THREE ELEMENTS OF PROFOUND INFLUENCE

As far-seeing business men living in these historic days, there are three elements of profound influence on the future which I would suggest that we consider deeply. First, the effect of the international war in Europe on our future, both at home and abroad. Second, the effect of the enormous business expansion which has come about in this country as a result of the war, both in the enlargement of old machine-tool factories and the addition of new ones, and third, the effect of whatever changes in national laws which may be made after the forthcoming Presidential election.

None but those who are blind and deaf can fail to comprehend that there will be terrific effects following the ending of the European War. Those effects follow all wars as they follow floods, hurricanes and earthquakes. Even small wars leave an aftermath of physical and financial upheaval and distress. There will be debts to stagger the imagination, and there will be an instantaneous disappearance of certain business demands created by war. Peace will return to the industries of Europe approximately 20,000,000 men, supplemented by many women workers. The man who does not realize these conditions is in my opinion due for a rude shock. It will be a time for wise heads to acquire and use greater wisdom than they ever before possessed. No one can accurately forecast that future. It's all in the second act of the great tragedy now being enacted.

We do know that after the Civil War, much as the South had need of everything under heaven, the South staggered on in poverty, unable to buy freely for more than a quarter of a century. Europe will be in need of everything, but the wherewith to buy, what about that? For Europe is blowing up its capital at the rate of the cost of a Panama Canal every week.

OUR IMMENSE BUSINESS DEVELOPMENT

In the United States there has been immense business development during the last two years. Old machinery has been put in shape for work and new machinery has been built with breakneck speed. New buildings have been erected and expansion has been the order of the day in the machine-tool industry along with others. Our demand has been due to the enormous call for machinery and supplies of every kind from Europe. We might picture business in America as a great forge made white hot, as the demand from Europe has blown upon it like a mighty bellows. The anvils have rung, the workers

have toiled, and still the cry has been for more, more. But this Hercules of war will grow weary. The giant bellows will lose their force. Will there then be a sufficient demand to keep all busy? America wants and needs all the prosperity it can get, so in the midst of unprecedented prosperity let us not forget to prepare for other days.

In the days that are to come we need to enlarge our vision and build up the friendliest possible relations with other nations. In building up that business, the fundamental principle still holds. Tell exactly what your machine is when you try to sell it, and make it exactly as you have agreed to make it before you ship it. We want no soft spots in machine tools, no matter where they go. We are going to meet these different nations in the future, not merely on foreign soil, but perhaps on ours. It may be surprising to those who have not followed the statistics to know that notwithstanding the fact that practically all Europe is at war, we imported from the world during the fiscal year ending in 1916, goods valued at the astounding total of \$2,197,000,000. This would have had a tremendous effect upon American industries and workmen if it were not offset in a measure by war orders. It will tax the ingenuity of Americans to meet that competition of the future. America is in a condition of the fat and well favored today. The old adage was "a lean hound for a long race." We will have to race with a lean and hungry hound after this war, so let us prepare for it.

The members of this Association are all optimists, but unless we discourage the entrance into the business of those untrained in the manufacture of machine tools who seek only the profits of a temporary demand, many of them would easily become pessimists. Let us keep the business sound. Let us plan to keep it steady. Let us plan to keep it permanent.

OUR FUNDAMENTAL INDUSTRY

We represent an industry that is fundamental in the world, more fundamental today than ever before. The struggle of the world has become one of machinery against machinery. If we did not know it before, the European War has taught us this fact. The nation with the largest and most powerful machinery and the most of it, wins. It is still true as Napoleon said, that "God

fights on the side of the heaviest artillery." Our lathes, our turret machines, our planers, our millers, our fine mechanical devices of every nature, are the war weapons of civilization. We represent a great industry. We manufacture the mechanism which keeps men always at the topmost point of civilized development. It is an honor to be a machine-tool builder. It is a great honor to be a builder of good machine tools. It is more than an honor, it is a national responsibility, as it never was before, that the machine-tool builders of America should be the builders of the best machine tools.

HEALTH COMPENSATION

The general address of the first session was made by Frank F. Dresser, of Worcester, Mass., on "Health Compensation." This is reviewed editorially in this issue. Following a suggestion made by Mr. Dresser, a Prevention of Illness Committee was appointed to employ an expert on health in the shops of machine-tool builders. This committee consists of Fred Geier, chairman; W. A. Viall and C. H. Norton. The afternoon of Tuesday was employed in the usual committee meetings, and the third session, Wednesday morning, was partly given up to a confidential talk over the business situation, which was followed by an address by Alexander Luchars on the situation here and abroad in relation to the machine-tool industry.

Wednesday afternoon the principal feature was an address by James A. Emery, of Washington, D. C. The officers were all reelected. J. B. Doan, of the American Tool Works, Cincinnati, president; D. M. Wright, of the Henry & Wright Co., Hartford, first vice-president; August Teuchter, Cincinnati-Bickford Machine Tool Co., Cincinnati, second vice-president; A. E. Newton, Reed-Prentice Co., Worcester, Mass., treasurer; Charles L. Taylor, Taylor & Fenn, Hartford, secretary, and Charles E. Hildreth, Whitcomb-Blaisdell Co., Worcester, Mass., general manager.

Five new firms were elected to membership in the association. They are W. & C. F. Tucker, Hartford; Cincinnati Grinder Co., Cincinnati; Sipp Machine Co., Paterson, N. J.; Nutter & Barnes, Hinsdale, N. H., and Fitchburg Grinder Co., Fitchburg, Mass.

The spring meeting is to be held in Cincinnati, May 21 and 22, 1917.

Personals

H. W. Dowd, assistant sales manager of the Nordberg Mfg. Co., Milwaukee, Wis., has succeeded Fred W. O'Neil, recently resigned, as sales manager.

Fred W. O'Neil, for many years sales manager of the Nordberg Mfg. Co., Milwaukee, Wis., has resigned to join the executive organization of the Ingersoll-Rand Co., New York City.

Carl E. Akeley, sculptor and explorer, has been awarded the John Scott Legacy Medal and Premium, at the recommendation of the Franklin Institute for his invention of the cement gun.

R. W. Ellingham, formerly general superintendent of the Remington Arms Co., Bridgeport, Conn., has accepted the position of sales manager of the Standard Manufacturing Co., Bridgeport, Conn.

Harry F. Clifford, for some time connected with John Bath & Co., Inc., Worcester, Mass., and an occasional contributor to the columns of the "American Machinist," has been promoted to the superintendency of the plant.

Geo. O. Smalley, who has been associated with the Bound Brook Oil-Less Bearing Co., Bound Brook, N. J., for the past ten years, latterly in the capacity of assistant general manager and assistant treasurer, has become first vice-president and general manager, succeeding the late Leigh S. Bache.

Obituary

Charles J. Healy, founder of the Bridgeport Knife Co., and for many years identified with the cutlery manufacturing industry, died at his home in New York City on Oct. 21.

Prof. David Nelson Camp, president of the Skinner Chuck Co., and for a great many years a prominent figure in the civic life of New Britain and national educational affairs, died on Oct. 19, aged 96 years.

Charles Fleischman, for the past 13 years associated with the executive division of the E. W. Bliss Co., Brooklyn, N. Y., and previously employed in the Paris office of the Bliss company, died at his home in Brooklyn on Oct. 9, after a brief illness.

Forthcoming Meetings

American Society of Mechanical Engineers. Annual meeting, Dec. 5-8, Engineering Building, New York City. Calvin W. Rice, secretary, 29 West 39th St., New York City.

American Society of Mechanical Engineers. Monthly meeting, first Tuesday. Calvin W. Rice, secretary, 29 West 39th St., New York City.

Boston Branch National Metal Trades Association. Monthly meeting on first Wednesday of each month, Young's Hotel. W. W. Poole, secretary, 40 Central St., Boston, Mass.

Providence Association of Mechanical Engineers. Monthly meeting, fourth Wednesday of each month. J. A. Brooks, secretary, Brown University, Providence, R. I.

New England Foundrymen's Association. Regular meeting, second Wednesday of each month, Exchange Club, Boston, Mass. Fred F. Stockwell, 205 Broadway, Cambridgeport, Mass.

Engineers' Society of Western Pennsylvania. Monthly meeting, third Tuesday; section meeting, first Tuesday. Elmer K. Hiles, secretary, Oliver Building, Pittsburgh, Penn.

Rochester Society of Technical Draftsmen. Monthly meeting, last Thursday. O. L. Angevine, Jr., secretary, 357 Genesee St., Rochester, N. Y.

Superintendents' and Foremen's Club of Cleveland. Monthly meeting, third Saturday. Philip Frankel, secretary, 310 New England Building, Cleveland, Ohio.

Western Society of Engineers, Chicago, Ill. Regular meeting, first Wednesday evening of each month, excepting July and August. J. H. Warder, secretary, 1785 Monadnock Block, Chicago, Ill.

Philadelphia Foundrymen's Association. Meetings first Wednesday of each month. Manufacturers' Club, Philadelphia, Penn. Howard Evans, secretary, Pier 45 North, Philadelphia, Penn.

Technical League of America. Regular meeting, second Friday of each month. Oscar S. Teale, secretary, 35 Broadway, New York, N. Y.

Design of Dies, Punches, Subpresses and Power Presses*

BY EDWARD DEAN†

SYNOPSIS—This article—the last of four that have taken up the progress of press-tool design and construction—deals more particularly with the modifications and improvements in the mechanical construction of the dies, their holding devices and the machines in which they are used. Changes have been made in the dies themselves, in the bolsters, the subpresses and the power presses. In fact, commercial machines are not adapted to the cutting tools that have been developed during the author's twenty years of study of press tools.

The three articles already printed in this series of articles tell of the progress, improvement and results that have come from my study of punches, dies and press

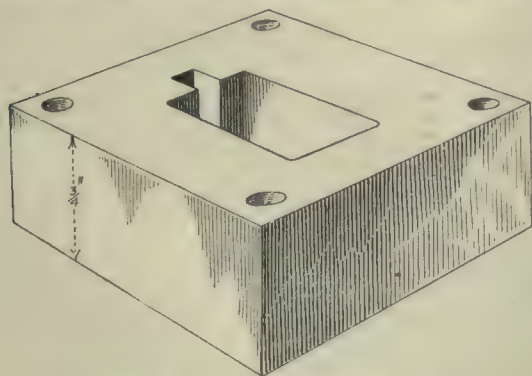


FIG. 1. SOLID NOTCHING DIE

in the mechanical construction of dies, their holding devices and the machines in which they are used.

My starting point will be single-punch notching dies. The first of these that I ever made and used were solid dies $\frac{3}{4}$ in. thick. The blanking holes were drilled out and then filed to shape. There was no clearance. After hardening, the die maker had to do a long, tedious job of oil-stoning the holes in order to make them straight and of the proper size. If one of these dies could be used until $\frac{1}{4}$ in. had been ground from its upper surface it was considered a very good one. The general type of this kind of die is shown in Fig. 1.

The many disadvantages exhibited by this type caused us to attempt to improve it. The result was a split die of the kind shown in Fig. 2. This is made with a clearance between top and bottom of 0.004 in. in the total size of the hole for a depth of 1 in. As a general rule, my experience has shown that if a die of this kind is properly made, it can be worn down to a thickness of $\frac{1}{8}$ to $\frac{3}{16}$ in. It might even be used until it was somewhat thinner, except for the difficulty of holding it securely in the bolster.

The change of size as the die is ground off, due to the clearance in the hole, is cared for by grinding off 0.0005 in. from the surfaces of the split when the die is half-worn. As a general rule two sets of punches are required to wear out one die where dies are not split; the second set of punches is made slightly larger than the first, thus making the actual fit between the second set of punches, when it is first used, and the half-worn die

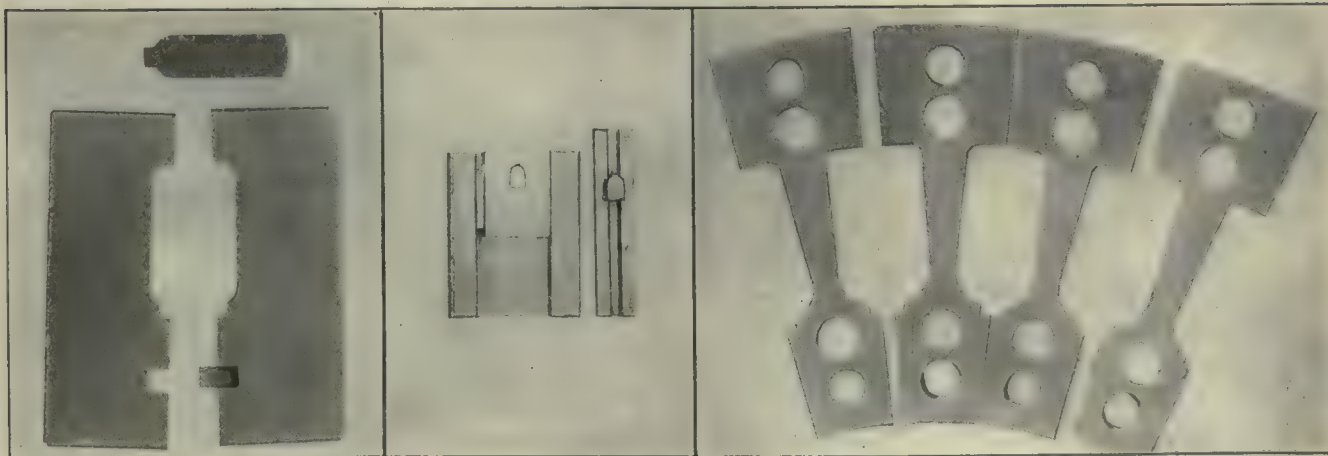


FIG. 2. SPLIT NOTCHING DIE

FIG. 3. SEGMENTS OF FULL-CIRCLE LAMINATION DIE

tools. They also show the equipment that I am using in making these tools today, and the laboratory apparatus and instruments that have contributed so much to the knowledge of the principles of die design, making and hardening. One of the former articles also outlines these principles. To round out the information it now becomes necessary to say something about the modifications

the same as the fit between the first set of punches and the new die.

Turning now to another kind of die—that used for punching laminations, or full-circle dies—the first ones that I used were built up of 32 sections screwed and doweled to a machine-steel plate. The center was a round die also provided with dowel and screw holes. Segments of one of these dies are shown in Fig. 3.

This type of die was followed by the four-segment die having a center the same as used for parts of Fig. 3.

*Three other articles on die making by Mr. Dean were published on pages 661, 705 and 769.

†Superintendent, Century Electric Co.

The segments were screwed to a machine-steel plate for assembling. One of its features of construction was that all the working holes or slots had to be drilled out and finished by hand. To overcome some of these difficulties

before the others begin to cut. This type of die is used for punching laminations of the fields of electric motors, and also for armature-punching dies where there is space enough in the design to make its application successful.

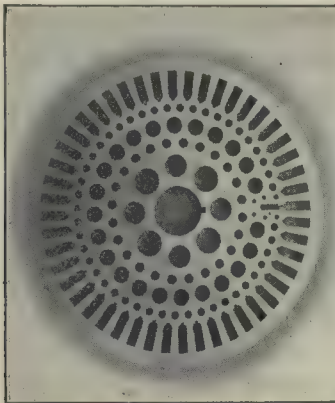


FIG. 4. SOLID-CENTER DIE WITH MILLED SLOTS

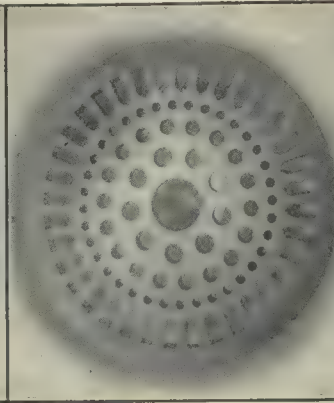


FIG. 5. DIE WITH MILLED SLOTS AND LOWER SUPPORTING PLATE

in construction, the die shown in Fig. 4 was designed. This is made of a solid plate with all the holes in the center. The round holes are finished by taper reaming from the back part in the case of the small ones and by grinding after hardening in the case of the larger ones. The slots, however, were milled in the center, and the dies were finished by fitting a ring to the outside. This ring was doweled in place, care being exercised to make the pins from the same stock as was used for both center and ring. In fact, this is a necessary rule in all built-up dies. Every part, with the exception of the screws, must be made from the same kind and grade of steel.

In order to harden such a die properly, it was necessary to introduce proportion holes to equalize the strain and to obtain a uniform thickness of the hard outside shell. In fact, the proportioning of all the parts of built-up dies must be very carefully handled. This is especially true of the type where the bars between the cutting holes are supported on the outer end in a ring, and on the inner end in a center, corresponding to the spokes of a wheel which are compressed between the rim and the hub. Fig. 6 shows such a form of construction.

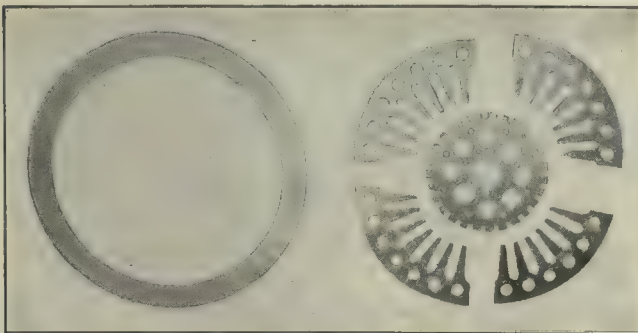
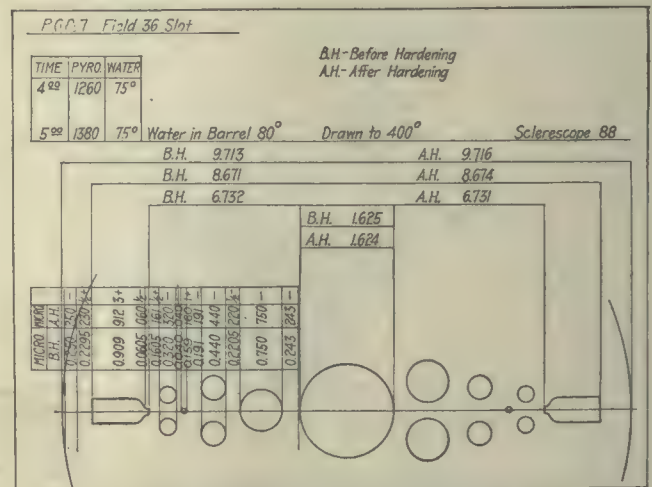


FIG. 6. FOUR-SEGMENT DIE MILLED FROM INSIDE INSTEAD OF OUTSIDE, AS IN DESIGN OF FIG. 4

The next modification is shown in Fig. 5. It is similar to the die shown in Fig. 4, except that a plate is fitted below the die in order to support the fingers. To lessen the pressure on such a die in punching, it is customary to set the punches so that the one for the large center hole has passed about halfway through the stock



For all these segmental dies a special indexing fixture is used on the miller when cutting the slots. One segment is put into the fixture and all the slots are milled with the exception of the last, which overlaps the joint

first is for a die 9.713 in. in outside diameter. The readings given are for distances between a series of five scribed lines, measured before (B. H.) and after hardening (A. H.). The differences are negligible. These

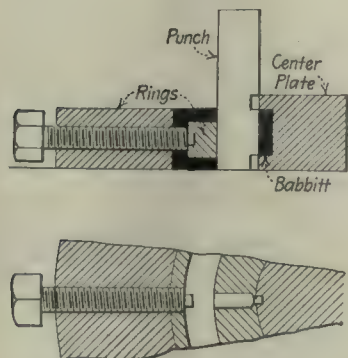


FIG. 9. SECTION OF PUNCH PLATE—PUNCH HELD BY WHITE METAL



FIG. 13. GROUP OF PRESSES FOR PUNCHING MOTOR LAMINATIONS

between two segments. The adjacent segment is then clamped in place and the overlapping slot is milled in both at the same time. The first segment is then removed. This process is continued until all four segments are cut.

To show how little distortion takes place in hardening these built-up dies, Figs. 7 and 8 are presented. The

measurements were made by a microscope. Fig. 8 is for a smaller die 6.676 in. in outside diameter.

Turning now to the punches, the principal modification has been in the method of inserting them in the punch plate, which takes the place of the tedious operation of making an expensive punch plate fitting in all the punches and then shearing them into the die. The punch plate is

made in skeleton form as shown in Fig. 9. The punches are made up in lots, milled accurately to dimensions, and fitted into the die. The construction of each punch is such that on its edge toward the center it fits into a supporting groove, and at its outer edge comes in contact with the outside ring. Opposite each punch location a hole is drilled through this ring receiving the turned-down end of a small setscrew. However, this setscrew does not pass through the ring. Thus each punch is held by a three-point support—on the center, the outside ring and the back plate. It will be evident to any tool maker that it is not a difficult job to set and hold these punches in this punch plate, at the same time accurately lining them up with the die. When this is accomplished, white metal is poured into the punch plate around the punches, thus holding them immovably in position.

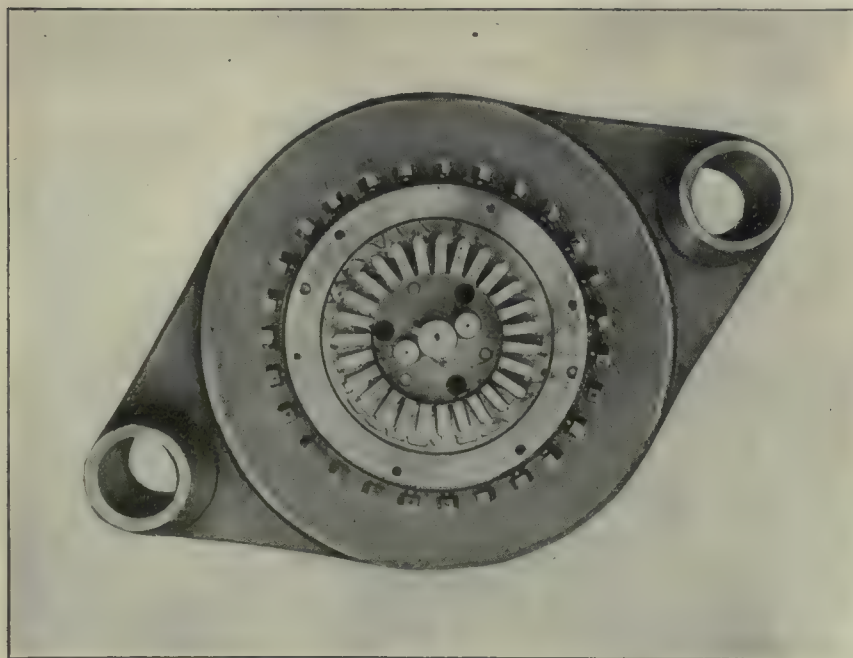


FIG. 10. BUILT-UP PUNCH PLATE COMPLETE

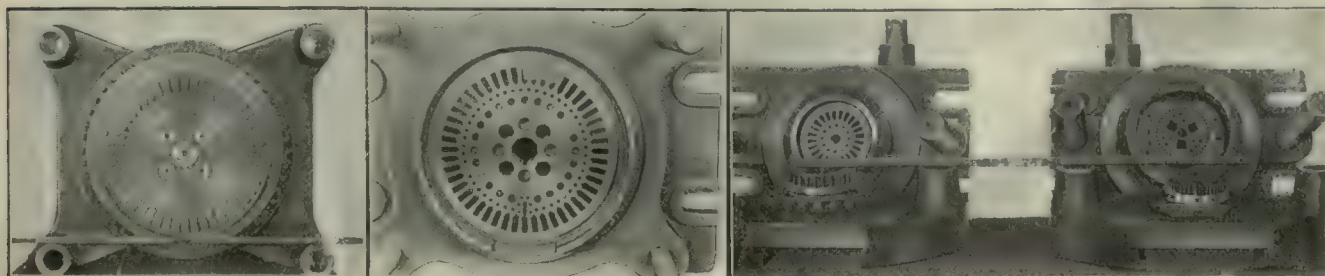


FIG. 11. GROUP OF SUBPRESSES REPRESENTATIVE OF RECENT DESIGNS

This is a quick and inexpensive method of setting a large number of punches and has the further advantage of easily permitting repairs. If a punch should be broken or damaged, the surrounding white metal is drilled through and the punch cut out. A new one is then fitted into position and fresh white metal poured in. This completes the repair. Fig. 10 shows one of these built-up punch plates. The principal improvement in strip-per design has been to do away with filing the slots. These are now milled from the outside and a ring is then attached to the outside of the projecting fingers. Various methods are used in attaching these rings, depending upon the particular design of plate. The changes I have found necessary in subpresses are to make them heavier and more rugged than the usual design. A few of these have been grouped together in Fig. 11. These changes in the press tools, together with the needs of rigidity in high-duty punching, have made it necessary for me to order power presses with several modifications over the manufacturer's standard design. I am now using 100-ton presses to punch stock only 0.016 in. thick. Even with this heavy machine the high-duty service tends to rack it. For years I have insisted that every punch press that I bought must have a bronze-bushed flywheel. Because of the increase in height and

rigidity of the subpresses, I usually need a longer gap than is standard with press manufacturers.

There is perhaps no better way to close these four articles than to show the pressroom of the Century Electric Co., St. Louis, Mo., and some of the machines now in use there. Fig. 12 shows the large blanking and drawing presses. Fig. 13 shows the type of machine used for punching laminations, also several stacks of punchings.

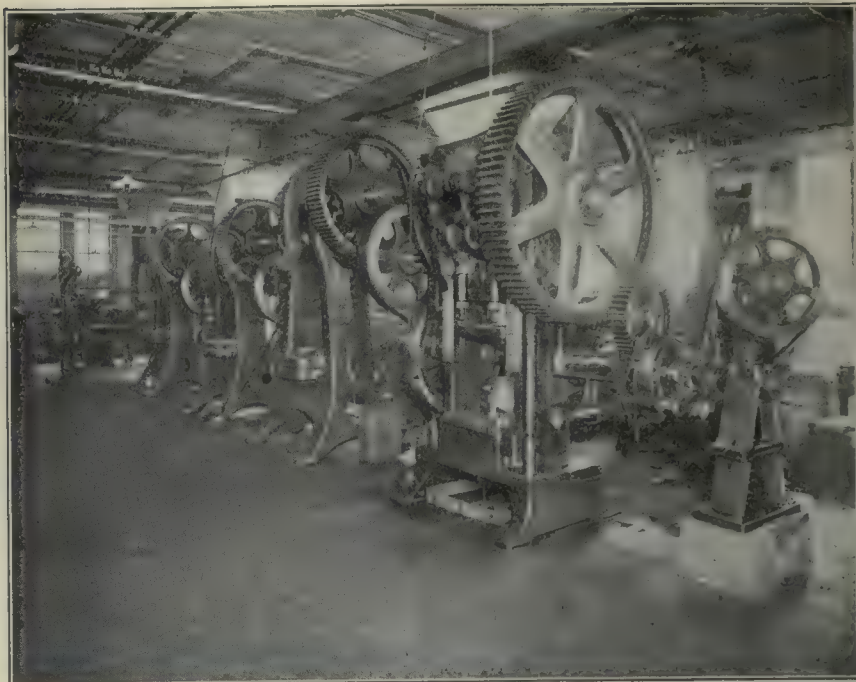


FIG. 12. GROUP OF LARGE BLANKING AND DRAWING PRESSES

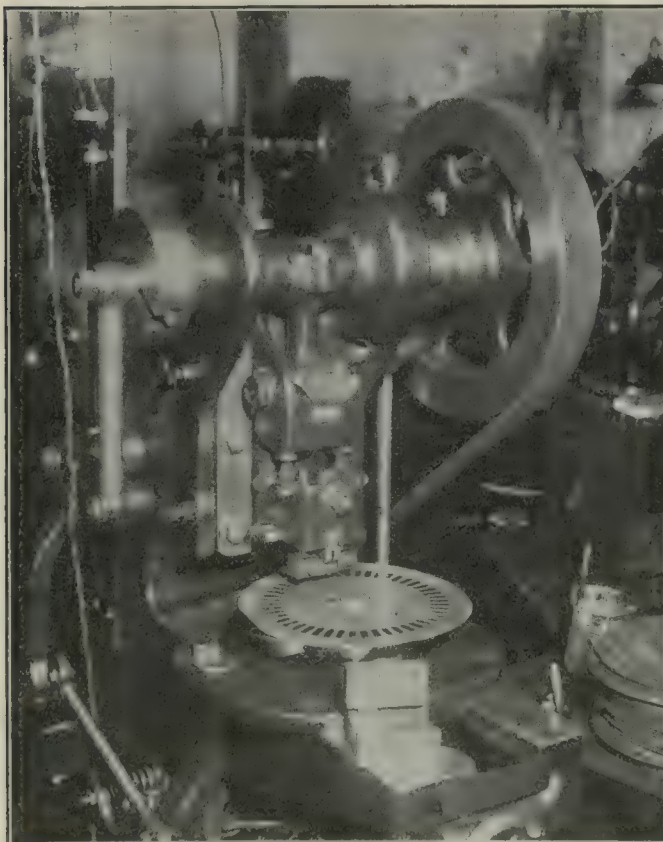


FIG. 14. NOTCHING PRESS WITH NOTCHING DIE IN FOREGROUND

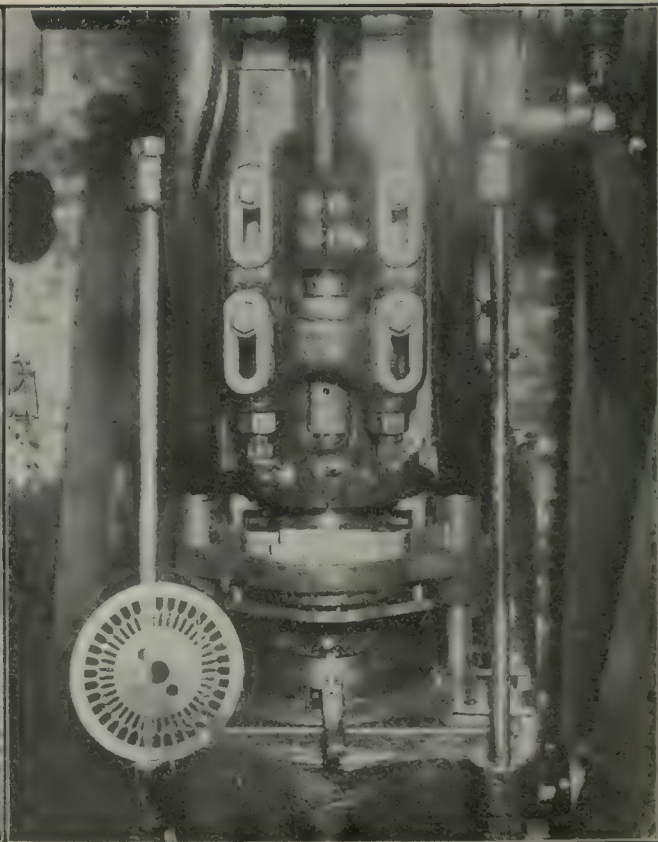


FIG. 15. SMALL TWO-STEP LAMINATION DIE IN DOUBLE-ACTING PRESS

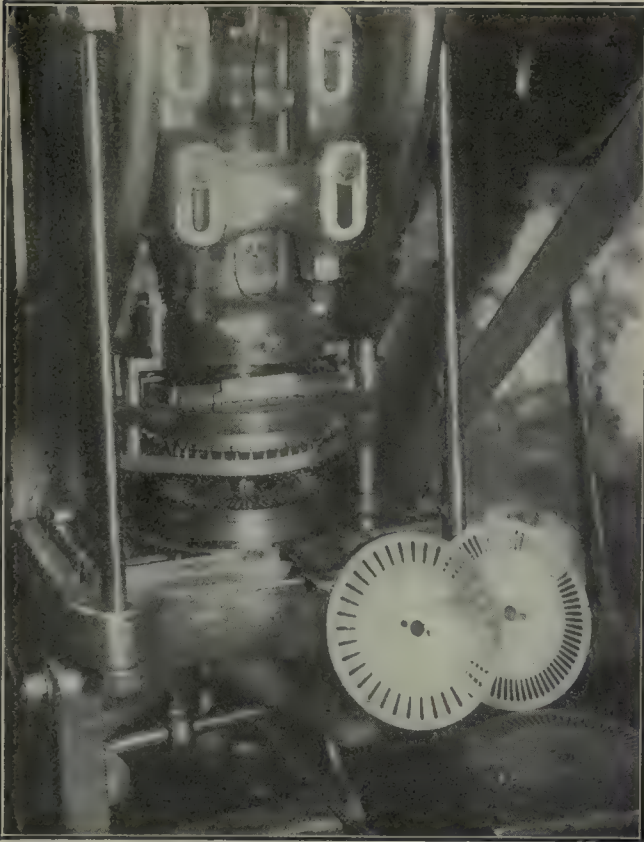


FIG. 16. LARGE TWO-STEP LAMINATION DIE

Fig. 14 shows a notching press working at a speed of 500 r.p.m.; in front, resting on the knee, is a test notching die. A notched blank is shown in the machine.

Fig. 15 shows a small two-step lamination die in a double-acting press. Two strokes are necessary to finish a blank. By means of the handle projecting from the bottom of the subpress the blank, after one-half of the notches have been punched, is indexed into position for punching the second half.

Fig. 16 shows a larger two-step die set up in a double-acting press. In front, and leaning against the press, are two blanks. The first has one-half of the notches cut, while the second is completely notched.

Fig. 17 shows a small one-step die set up in a single-acting press, with a perforated blank alongside the subpress. Fig. 18 shows a large one-step die in a single-acting press used for punching the outer row of small holes in a blank shown at the right of the machine.

Finally, in closing this last article, I can do no more than repeat what has been said before: My purpose in writing this series has been to help the die draftsmen and tool makers who have to deal with the many, none-too-well understood problems that surround the making, hardening and use of high-production dies.

The Corrosion of Iron and Steel was an important topic discussed before the fall meeting of the American Electrochemical Society. The following summary was presented: (1) Copper-bearing steels are decidedly superior to pure iron, steel or charcoal iron. (2) The addition of copper to pure iron increases its resistance to corrosion, but to no such extent as similar additions to steel. (3) Charcoal iron and pure iron are superior to steel as regards resistance to atmospheric corrosion. (4) Charcoal iron is very similar to pure iron in its resistance to corrosion. (5) Copper is believed to decrease corrosion, due to some mutual influence of manganese and copper. (6) The additions of larger amounts of manganese and copper to pure iron or steel are suggested as well as additions of copper-chromium, copper-vanadium or copper-tungsten. (7) Mill scale stimulates corrosion in rapidly rusting materials and retards it in slowly rusting materials.

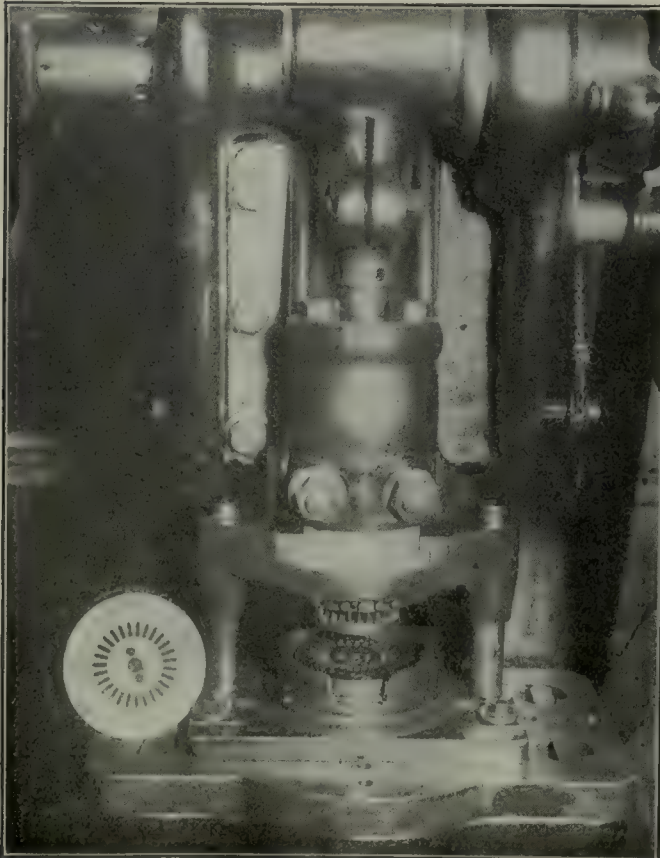


FIG. 17. SMALL ONE-STEP LAMINATION DIE IN SINGLE-ACTING PRESS

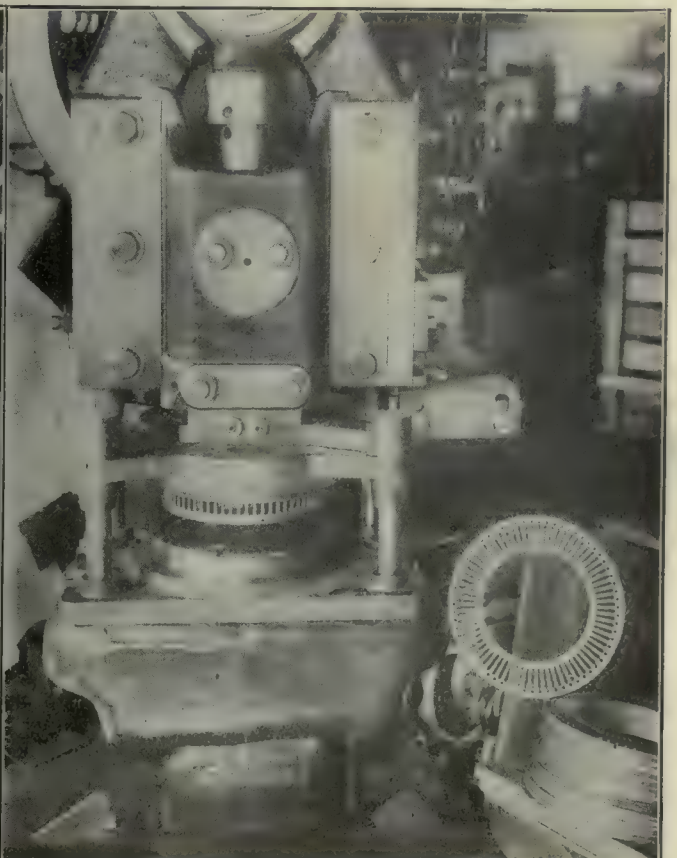


FIG. 18. LARGE ONE-STEP DIE PUNCHING ROUND HOLES

Special Tools for Manufacturing Hosiery Machines

BY ROBERT MAWSON

SYNOPSIS—On this and the accompanying data page are shown some of the jigs and fixtures for machining details on hosiery machines. Various types of jigs are illustrated, comprising the cam latch, box and plate. A turning fixture is shown that holds four parts which are located by a tongue fitting in a machine slot. The tools are quick in action, as will be observed by referring to the times given in the article.

On pages 666, 718 and 754 were shown some of the special small tools, jigs and fixtures used in machining elements for hosiery machines. These tools are in service at

the plant of the Jenekes Knitting Machine Co., Pawtucket, R. I. In this article are illustrated other jigs and fixtures for machining other parts. It will be seen that the tools are of modern design and are proving successful as regards quality and quantity of production.

It will be observed from a close examination of the respective jigs and fixtures that special attention has been given to securing positive locating and clamping devices. This phase of jig and fixture design is one to which too much attention cannot be given if the most economical and accurate production is to be effected. At the same time the locating and holding devices must be kept simple and of such a nature as to be rapidly brought into action without any lost motion by the operator.

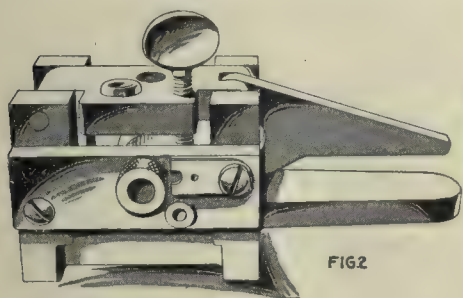


FIG. 2

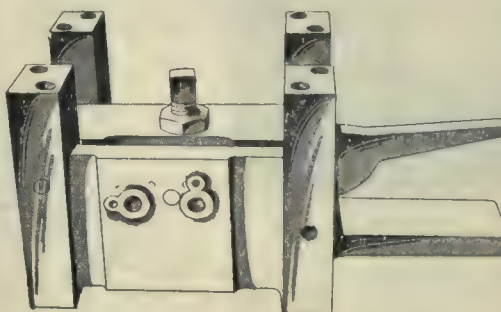


FIG. 4

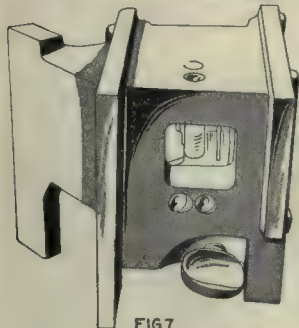


FIG. 7

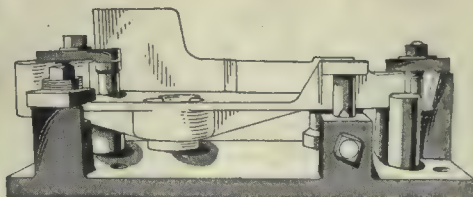


FIG. 9

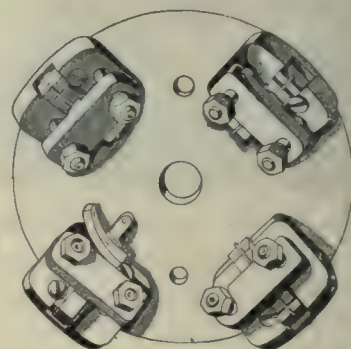


FIG. 6

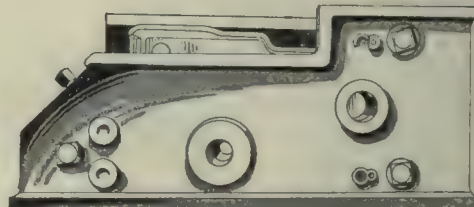


FIG. 10

JIGS AND FIXTURES USED IN MANUFACTURING HOSIERY-MACHINE ELEMENTS, WITH WORK SHOWN IN POSITION

FIGS. 2 AND 2-A

Operation—Drilling stop-lever rocker, Fig. 1. The casting is located in a V-block against a stop pin. The cam-operated cover is then swung down, and a thumb-screw tightened on the part holds it in position.

Holes Machined—One $\frac{1}{8}$ -in. spot drilled and reamed; one hole drilled to suit 10-24 threads; one No. 40 and one No. 21 drilled.

FIGS. 4 AND 4-A

Operation—Drilling fashioning-shaft block, Fig. 3. The rough casting is located in a V-block, the end of the part being pushed against a stop. The cam-latch cover is then swung down, and the setscrew bearing against the piece holds it securely in the jig.

Holes Machined—One $\frac{1}{8}$ -in. spot drilled and reamed; two $\frac{1}{16}$ -in. and two No. 38 drilled.

FIGS. 6 AND 6-A

Operation—Turning splicing-thread eye-slide bracket, Fig. 5. The castings, four in number, are located in the fixture by a tongue that fits into a slot previously machined. The pieces are pushed back against the end of the lugs of the fixture, and the strap tightened on them holds them securely during the machining operation. The clamps are of the swing type, pivoted on one of the studs, to facilitate insertion and removal of the work.

Surface Machined—Circular contour, using an ordinary turning tool held in the cross-slide of the lathe.

FIGS. 7 AND 7-A

Operation—Drilling splicing-thread eye slide, Fig. 5. The casting is again located by a tongue fitting in the machined slot and pushed down against a stop. A thumb-screw is tightened against the piece to hold it securely in the jig.

Holes Machined—Two No. 42, one No. 30, one No. 28, two No. 19 drilled; two holes drilled to suit No. 4-36 threads, and one hole drilled to suit No. 6-32 threads.

FIGS. 9 AND 9-A

Operation—Milling frame, Fig. 8. The casting is placed on height pads and fastened down with two straps. Spring plungers are then allowed to come against the surfaces on the under side of the part to hold it against machining stresses.

Surface Machined—Under joint surface, using a $2\frac{1}{4}$ -in. end mill operating at 320 r.p.m., the feed being controlled by hand.

FIGS. 10 AND 10-A

Operation—Drilling and reaming frame, Fig. 8. The milled casting is placed in the jig, being located in a V-block and forced against an adjustable screw at the other end of the piece. Three straps are then tightened on the casting to hold it securely in the jig.

Holes Machined—One $1\frac{1}{4}$ -in. and one $\frac{3}{4}$ -in. spot drilled and reamed; two No. 11 drilled and reamed; two No. 11, two $\frac{3}{64}$ -in. and two $\frac{1}{16}$ -in. drilled; two holes drilled to suit No. 12-24 threads.

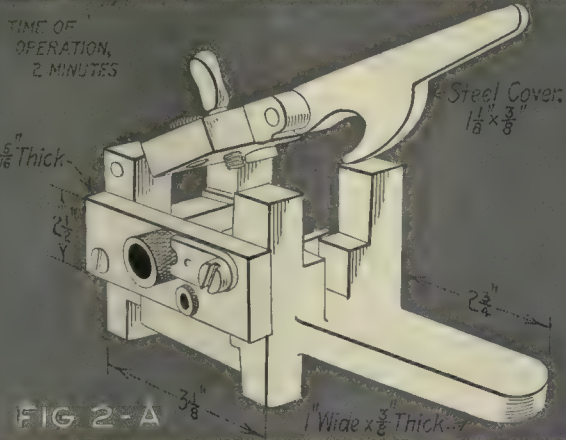


FIG 2-A

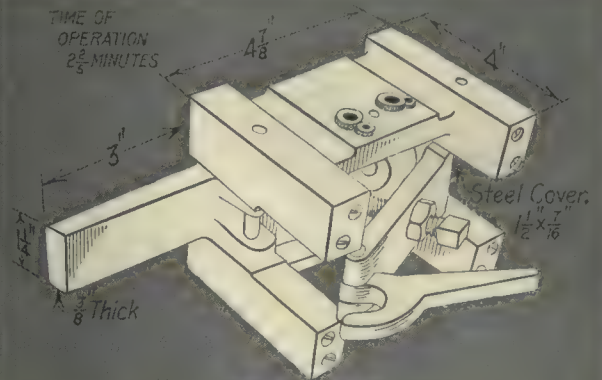


FIG 4-A

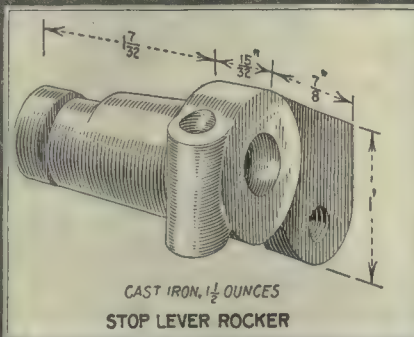


FIG 1

NOTE

ALL BUSHINGS USED FOR GUIDING TOOLS ARE BLACKENED. ALL JIG AND FIXTURE BODIES ARE CAST IRON, STRAPS AND FASTENINGS, MACHINERY STEEL. GUIDE BUSHINGS ARE TOOL STEEL, HARDENED AND GROUND

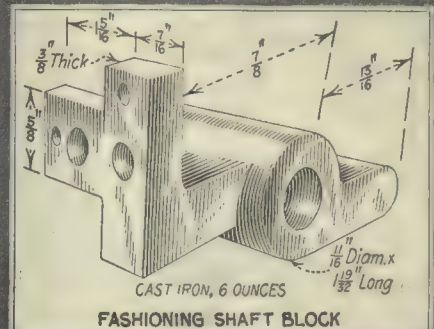


FIG 3

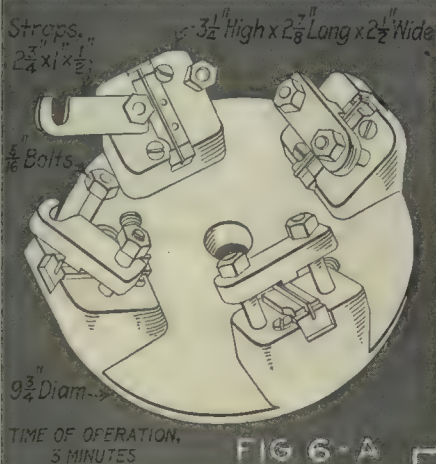


FIG 6-A

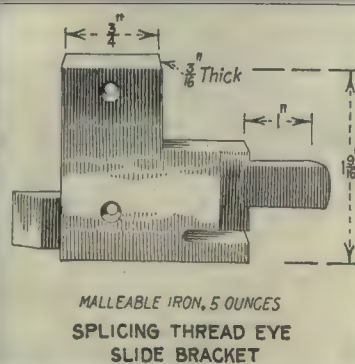


FIG 5

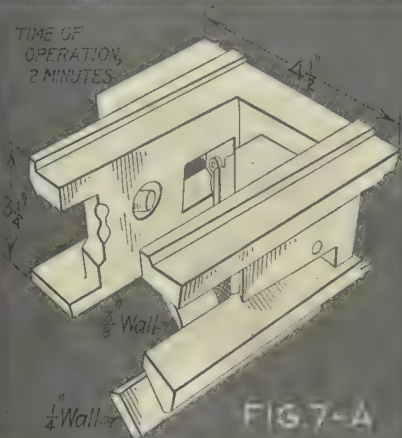


FIG 7-A

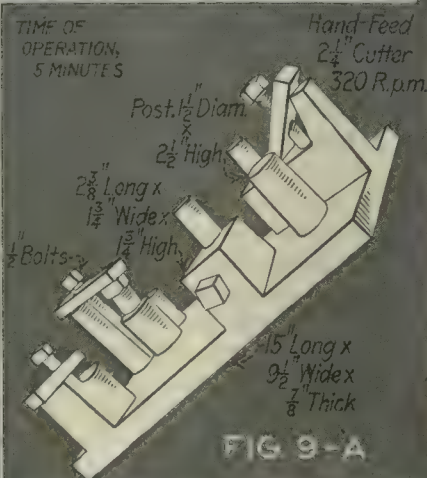


FIG 9-A

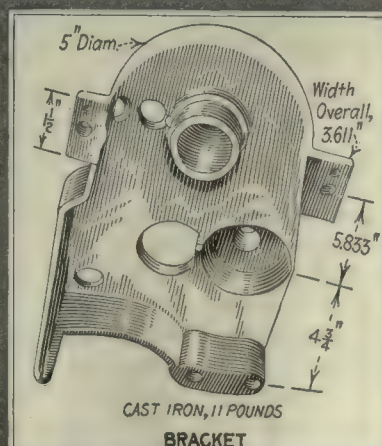


FIG 8

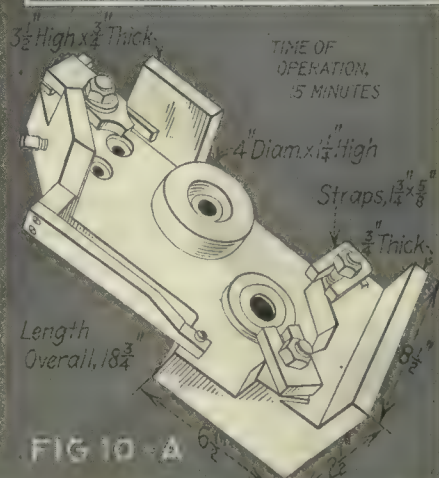


FIG 10-A

Jig and Fixtures for Clutch-Plate Withdraw Lever

BY FRED J. BOWEN

The lever, Fig. 1, which is part of a clutch that goes with a T-head four-cylinder gasoline omnibus motor built by the Rochester Motors Co., Rochester, N. Y., is made from a steel forging. The first operation is drilling *A* and *B* in the drill seen in Fig. 2. The rate of production is 2 in. in 1 min. under a multiple-spindle drill press. The second operation is to straddle-mill sides *C* with the continuous milling fixture, Fig. 3, on a Becker vertical miller. The rate of production is 40 in. in 30 min. In the third operation *D* is straddle-milled with

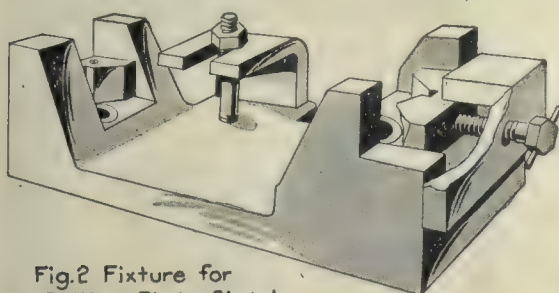


Fig. 2 Fixture for Drilling Plate Clutch Inner Withdrawal Lever

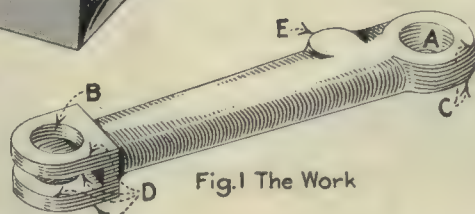


Fig. 1 The Work

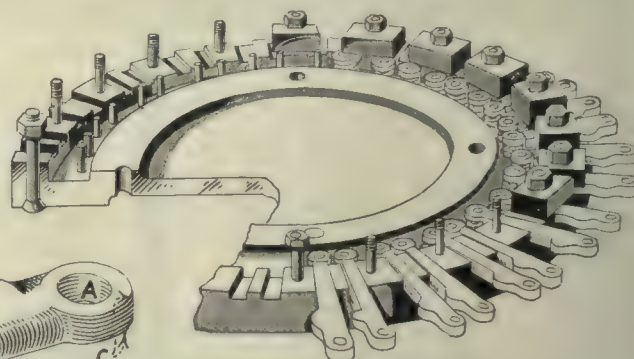


Fig. 3 Milling Fixture

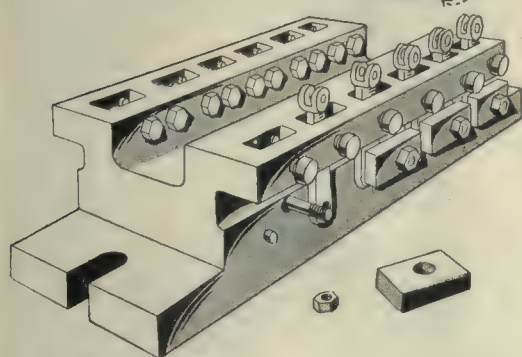


Fig. 4 Straddle Milling Fixture

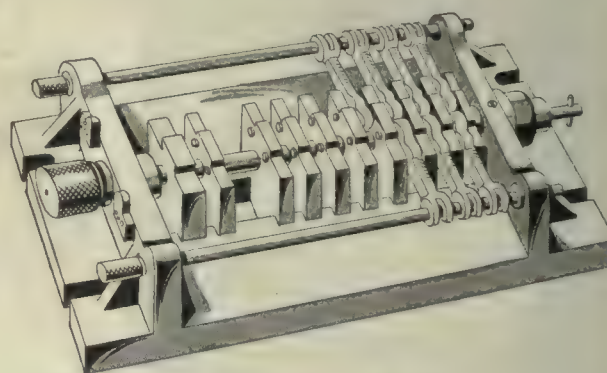


Fig. 5 Milling Fixture for Boss

DETAILS OF JIGS AND FIXTURES USED IN PRODUCING A CLUTCH-PLATE WITHDRAW LEVER

Fig. 1—The work. Fig. 2—Fixture for drilling plate clutch inner withdrawal lever. Fig. 3—Milling fixture. Fig. 4—Straddle-milling fixture. Fig. 5—Milling fixture for boss

the milling fixture, Fig. 4, at the rate of 1 per min. The fourth operation, milling the rod at *E* with a pair of radius cutters in the fixture in Fig. 5, is performed at the rate of 2 per min.

The levers are made in quantities; therefore it is not necessary to stop the machine until the lot is run through. The levers then go to the straddle-milling table, which carries 24 at a time with 12 on a side. As the cutters are set up to gages, they are always interchangeable. Next, the levers are transferred to the radius-milling fixture, where they are again handled 24 at a time. The cutters are set up to gages on the fixture, which eliminates all scrap. After case hardening and inspection the levers are sent to the stockroom, from which they are distributed in the regular way.

The total time required to machine one of these parts is 2 min. 45 sec.

Small Core Venting of Irregular Forms

BY FRANK R. CALKINS

The venting of small cores of irregular form is ever accompanied by chance when the wire method is utilized.

The wax-taper method of venting such small cores has been successfully employed by a concern that formerly experienced daily losses of small—but expensive—castings on account of defective venting. The wax tapers were "home-made" in a simple and inexpensive manner.

The cutting plate of an ordinary meat-chopping machine was removed and a special plate containing a die substituted. The crank of the chopper was replaced

with a wooden disk, or pulley, and the machine clamped to the frame of a power hack saw. The belt operating the saw also operated the taper machine. Ordinary paraffin wax was the material used, and first-class tapers were turned out with little effort.

Occasional heating of the chopper body and die by means of a foundry or other wick torch kept the previously warmed wax in a workable condition. The tapers are given a generous coating of black lead, which prevents the core sand from adhering too firmly to them during the ramming operation.

The tapers can be made to conform to any irregular shape, and when the core is fired, or baked, the wax melts and an unobstructed gas vent remains. The principle is the same as the well known wire perdue or lost wax method of molding statuary, etc. where the pattern is made of wax, buried in the sand of the mold and baked out.

Construction of Machinery for Laundries--I

By FRANK A. STANLEY

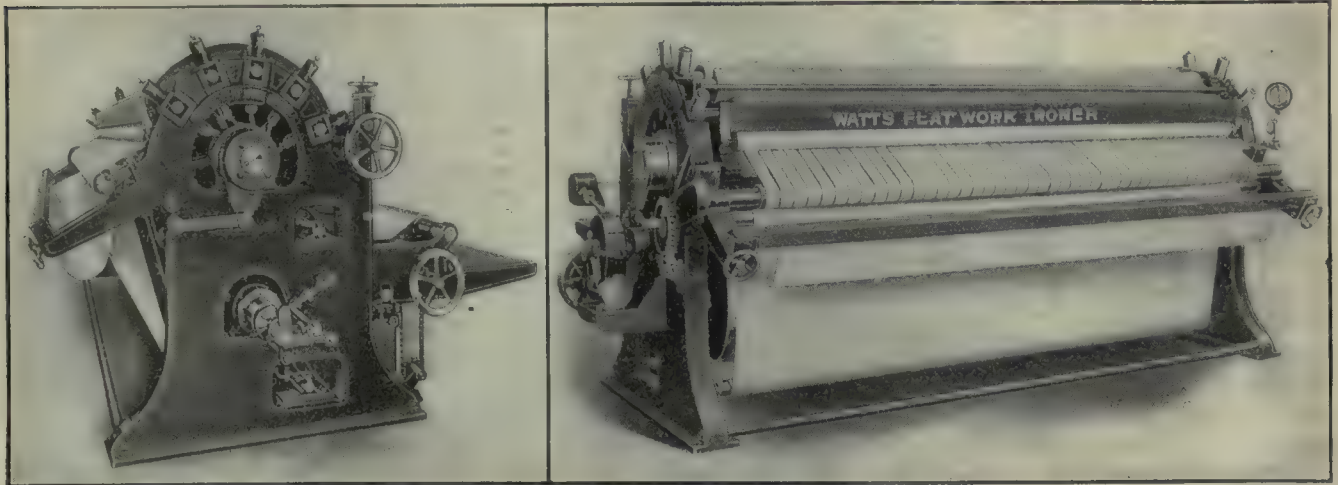
SYNOPSIS—Laundry machinery in its operation has to meet certain peculiar conditions that must be recognized by the builders of such equipment. These factors are pointed out herewith, and some peculiarities of design and construction to take care of practical requirements are discussed in detail.

Like the manufacturers of other lines of machinery, builders of steam-laundry equipment have to give consideration in the turning out of their product to the peculiarities of the business in which their apparatus is utilized. Machine-tool builders, for example, must keep in mind such considerations as a high degree of accuracy

proved machine equipment; and perhaps as great work as any has been that of the management in training operatives to realize that a certain degree of skill and commonsense must be applied even to the washing and ironing of articles of clothing.

When we consider particularly what is commonly known as flat work, including table cloths, sheets, pillow cases and the like, which are now finished by ironing in the "mangle," or what is called the clothes ironer, there are certain conditions peculiar to the process of laundering that have a degree of interest for machine designers as well as for housekeepers.

We have all experienced the nuisance and inconvenience of having such articles returned to the house not



FIGS. 1 AND 2. FLAT-WORK AND CLOTHES IRONER

in the product of their machines, rapidity and convenience of operation, and facility in securing the work. Makers of textile machines, paper machines and a long line of other equipment have to consider the special peculiarities in the materials to be worked, with the attendant difficulties of handling them in different stages, coupled with the facts that high speeds must always be maintained and yet the materials passing through the machine must be kept free from liability of tearing apart or hampering the action of the apparatus and so affecting the quality of the work produced. Laundry-machinery builders know that the success of their equipment, when installed in service, depends upon such factors as the speed with which the work can be passed through, the quality of the work as it comes forth, the convenience and safety of the operatives, the general cost of operation and upkeep.

It unquestionably is the case that people engaged in the laundry business are making efforts constantly toward getting better equipment for this service and better work out of the present equipment, all tending toward more satisfactory results to the customer as well as to the laundry proprietor himself. Machinery has done a great deal toward helping along this condition. The laundryman himself has also done a great deal in the way of installing certain systems of procedure and applying im-

ready to be put to immediate use, because they require a further drying-out process before they can go into service. Sometimes also the same condition is found in the case of wearing apparel not hand-ironed. There is a well-understood reason for this—well understood at least by practical laundrymen and also by a good many builders of laundry machinery. It will probably exist for a long time, until enough designers have turned their attention to the problem to bring some kind of satisfactory solution. Briefly stated—and it is well worth stating here because it has a very definite bearing upon the design of all new laundry apparatus dealing with a certain class of work, and is likely to be of timely interest for a considerable period to readers of this journal—it involves a consideration of the whole question of moisture in the operation or ironing apparatus.

Suppose 100 pounds of material is to be washed. Flat work of the kind referred to comes to the laundry and is placed in the washing machine. After passing through the washing process and leaving the machine, the fabric will usually be found to contain about 60 pounds of water, meaning that the wet material weighs 160 pounds. The next process is to remove some of this water preliminary to the work of ironing in the mangle. Although the flat work is placed in the separator, which is

run at the usual high rate of speed to take out the water by centrifugal action, it has commonly been found impossible to remove in this way under practical conditions much more than 20 pounds of water, meaning that the work then weighs 140 pounds approximately.

Experience has established the fact that about 20 pounds of moisture forms a suitable condition for the ironing of 100 pounds of flat work. Therefore, under the conditions normally obtaining there is about 20 pounds of excess moisture in the material to be handled in the ironer. This means that the machine must be speeded down to such a point that the rate of progress of the work through the mangle is abnormally slow, making it both expensive as an operation and dangerous to certain parts of the fabric through the possibility of scorching at various points. So one of the problems of the laundryman and of the laundry-machine builder has been to get up some practicable means whereby a reasonable share of this 20 pounds of excess water may be removed from the material before it goes to the mangle. Now this matter of ironing flat work, particularly in small places where one machine is depended upon for a great variety of work, including both household and wearing apparel, brings about another peculiarity of immediate interest to the designer of equipment for such establishments. In the

attempt to facilitate so far as feasible the ironing process there is a tendency to put down the feeding and pressing rolls rather heavily to produce an increased squeezing effect upon the work and to hasten the ironing. Then after the flat work has been run through, the operatives are only too apt to undertake to put through a lot of underclothing and similar articles with many buttons, which are likely to be smashed or stripped off entirely when the work is driven too tightly in the feeding process around the drier cylinder. This point is a difficulty continually arising where strict observation cannot be kept upon the operatives.

Another feature closely related to this is brought about through the normal action of the mangle rolls themselves. As they are spaced around the top of the drier, the action of each roll is at a different angle from the perpendicular, and the effect of gravity, tending to hold these rolls upon the work, varies with the angle of position of the rolls themselves. Accordingly, if they are left entirely to their own weight an irregular degree of pressure

is applied by each roll to the work passing under it. Therefore, some way to compensate for this difference in the net pressure of the rolls due to position is a most desirable feature of design. Still further, a means of readily lifting the entire series of rolls away from the drier to a distance that allows the machine to be quickly changed from the flat-work process to the ironing of body and button goods is of equal importance.

Quite recently a new clothes ironer has been constructed for laundry use by the Watts Laundry Machinery Co., Willimantic, Conn. This ironer embodies certain interesting features of design along the lines we are pointing out somewhat in detail in this article, and the shop con-

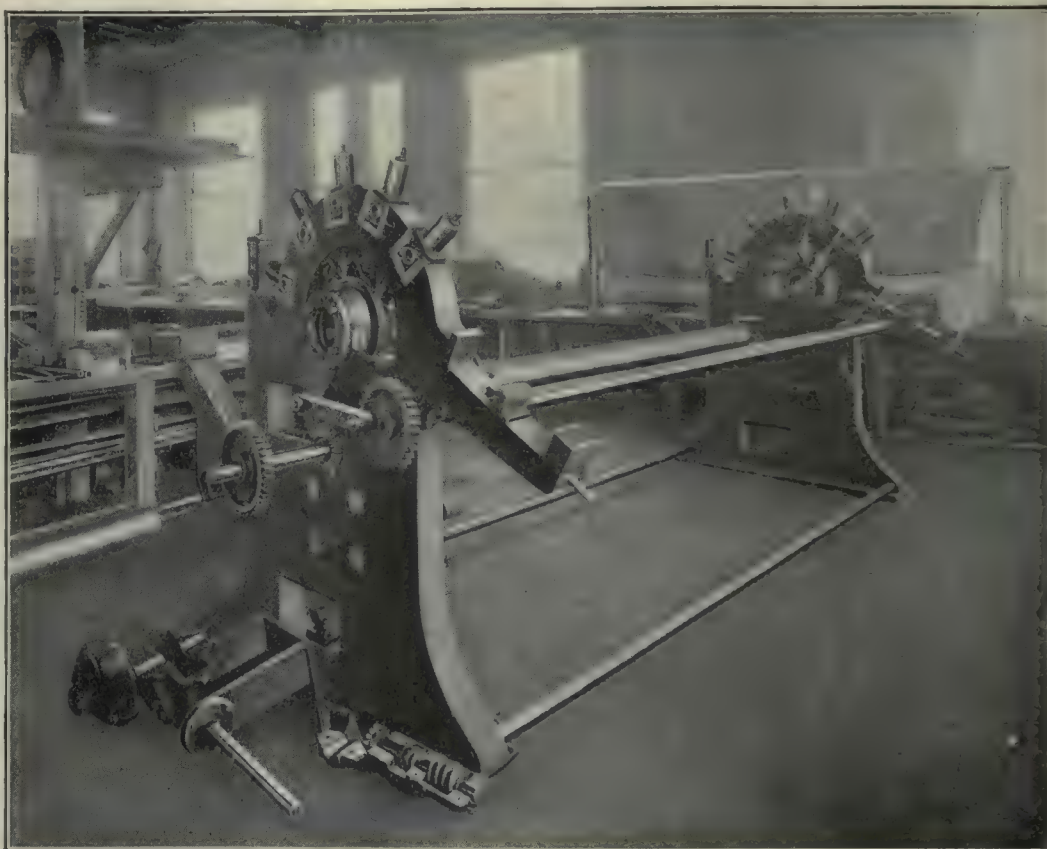


FIG. 3. LAUNDRY IRONER UNDER PROCESS OF ERECTION

tains a number of interesting features in the way of practical methods of handling medium and fairly heavy work both in the machining process and in the operation of erecting the completed machine.

In order to describe clearly some of these operations it is first desirable to refer to the assembled machine itself, as illustrated in Figs. 1 and 2. In this connection it will be of interest to point out certain unusual elements of design facilitating the operation and control of the machine.

Laundry mangles, or ironers, customarily consist of one or more steam-heated driers, usually cylindrical in form, carried between heavy housings or uprights that are adapted also to support the rolls which carry the feeding apron and supply pressure to the work. As compared with the general run of machinery the mangle as a class is peculiar in that the supporting housings, which are upright, are connected to each other with simple cross-girts or ties, usually of heavy gas pipe, instead of being mounted upon continuous bedplates.

The pipe lengths serve as spacing girts to maintain a desired distance between the two side frames, while long through-rods are passed through from end to end and the whole structure is secured by nuts and washers at the outside of the frames. Considering this construction by itself, when one looks at the two housings and bears in mind that they may be 10 or 12 ft. apart, it is sometimes difficult to understand how they can be kept in alignment permanently without a tendency for offsetting of the frames to bring a clamp upon the journals of the rolls and drier.

Hence, in actual practice it is found that there is little more difficulty due to lack of alignment in this respect after erection than would be the case were the housings secured to a substantial bedplate forming an integral part of the machine; for placed upon suitable foundations and properly erected, there is little about the actual operation of the machine to tend to work either end out of alignment with the other. Moreover, the tendency of this drier, with its very large and long journals, combined with the fact that a large number of the rolls are similarly journaled at each end, is to keep the whole construction

in proper alignment even though some disturbing influence in the running of the machine is brought to bear toward affecting the alignment adversely.

The ironer illustrated in this article is made in two or more sizes. The one shown carries two steam cylinders 30 in. in diameter by 120 in. long. It has five 6¾-in. padded rolls acting as pressure rolls upon two canvas aprons for passing the work over the heated surface of the driers. The general design is indicated in Figs. 1 and 2, and the appearance of the frame members, consisting of the two housings referred to, the pipe struts and through-bolts, is clearly represented in Fig. 3, which shows the machine in the process of erection on the shop floor. Without going into too great detail, it may be stated that the drier rotation is obtained through the medium of the worm and worm gear shown at the left-hand end of the machine in Fig. 3, the worm box being here represented lying on the floor ready for attaching to the upright. The power is transmitted to the drier and pressure rolls by spur gears, as can be clearly seen in Fig. 2.

(To be concluded)

Continuous Drilling

By W. G. GROOCKOCK

SYNOPSIS—Practically continuous cutting can be done on all machines, given the requisite number of pieces to produce. In many respects the drilling machine lends itself to continuous performance far better than other machines. When the subject of continuous drilling is mentioned it is often dismissed by those in charge, from a belief that continuous drilling cannot be performed without expensive jigs. As a matter of fact continuous drilling may be performed without jigs, with simple jigs and with jigs designed specifically for it.

In a shop where piecework was in vogue the management was not satisfied with the output and accordingly made a promise that no price should be cut unless some

After the promise not to cut prices, one of the drillers had an inspiration. While the drill was running through one of the brackets he bolted another one to the table and after finishing the drilling of the first it was only a matter of seconds before he started the drill into the second piece. By adopting this scheme, which is shown diagrammatically in Fig. 1, he approached the ideal production for a single-spindle machine—that is, continuous drilling without any expense for fixtures.

The man was very much pleased to earn nearly double his previous pay on the job. What that particular management thought will be seen from the sequel. When the next batch of this job came around, the driller was told that a double jig had been provided; and the price was cut nearly in half. This particular man made up his mind that in future he would not give way to in-

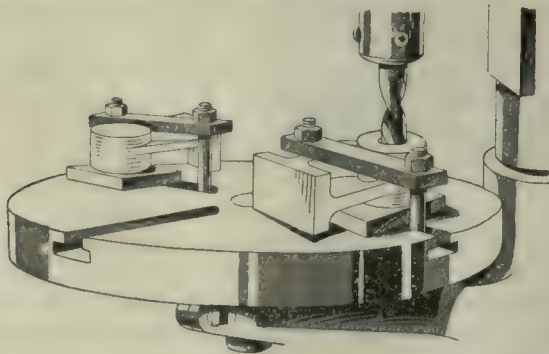


FIG. 1. CONTINUOUS DRILLING WITHOUT FIXTURES

improved method was introduced. One of the jobs in the drilling section was a cast-iron bracket with a cored hole. The method followed was the familiar one where the work is bolted to the table of a radial drilling machine with two parallels underneath to allow a clearance for the point of the drill that is used.

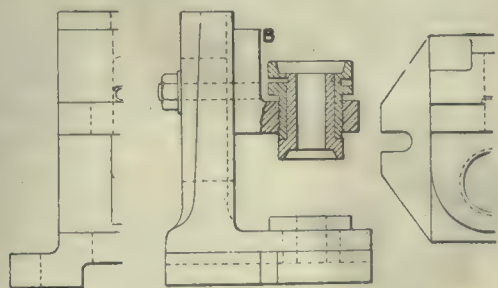


FIG. 2. TYPE OF JIG FOR DRILLING BOSSES

spirations unless he had some absolute guarantee that he would be allowed to reap the reward—at least for a time.

Another method that may be adopted in cases where only a single jig exists is to select two jobs—preferably single-hole jobs—that each require, say, a ¾-in. hole

drilled in them and fix each jig on the table, packing one of the jigs up so that in each case the drill will finish work at the same height. By doing this the "knock-off" of the machine may be set; consequently, the operator need not watch for the drill to finish, but is free to give his whole attention to loading the empty jig.

An extension of this idea is to use any two jigs where the drills required should run at about the same speed. In such a case when shifting over from one jig to the other the drill must be changed; but if a quick-change socket is used, the time required is only fractional compared with the time saved in loading the other jig during drilling time.

One of the most useful jigs, for general service, is the type shown in Fig. 2. This jig is intended for drilling

double jigs rather than to have duplicate ones of the same form. The type shown in Fig. 4, having been used by the writer on several occasions with success, will serve to illustrate this point. It will be seen that as designed the jig will weigh less—thus costing less for the casting—and will take up less room for storage than two single jigs would. Further, it will cost less to make. By bolting such a jig to the machine table so that one movement will bring the drill from one bushing to the other we have practically continuous drilling.

Double jigs such as this can of course be used on a multi-spindle machine and both pieces be drilled at once, but in such cases the machine is standing while the jig is being loaded. Quite frequently it will be found that the output from such a jig, when used on a

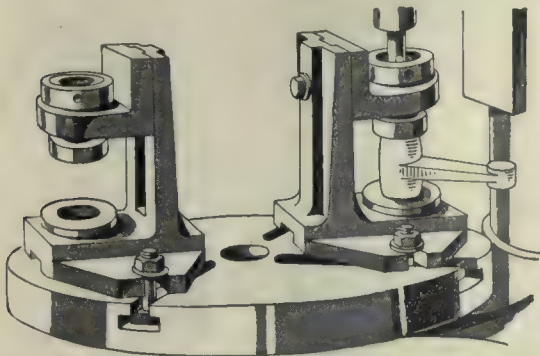


FIG. 3. APPLICATION OF TYPE SHOWN IN FIG. 2

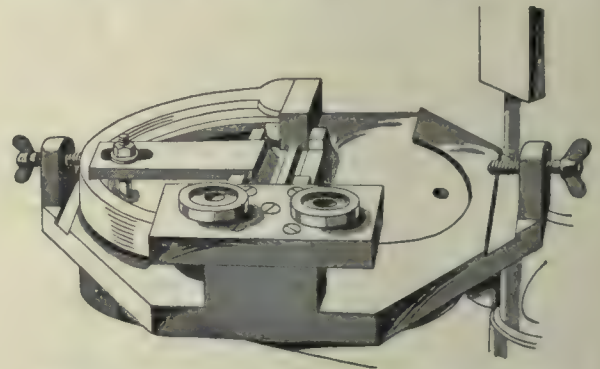


FIG. 4. TWO JIGS SECURED TO BASE PLATE

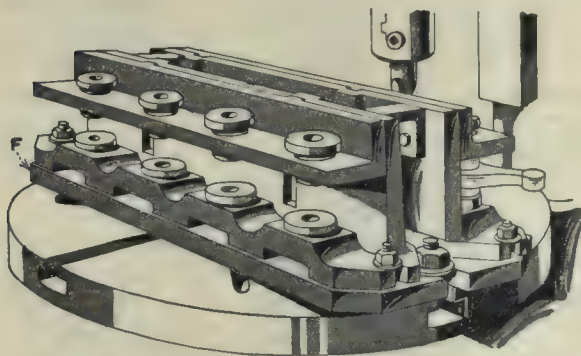


FIG. 5. TWO FOUR-STATION JIGS ON TABLE

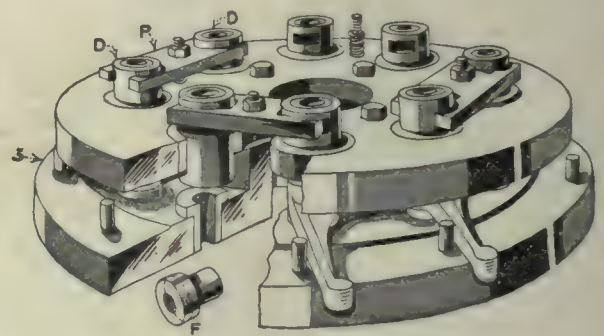


FIG. 6. JIG WITH CLAMPED SLIP BUSHINGS

holes through any piece that requires a hole through a boss. The number of jobs that a universal jig of this type will accommodate is legion. It will be noticed that the drill bushings are in two parts, the outer part being screwed into the carrier *B* and the inner or drill bushings being made to interchange for the various jobs.

This type of jig should always be made in pairs. By fixing them on the circular table of the drilling machine so that as the table is rotated each jig in turn is brought under the drill, quite 95 per cent. of the time is cutting time. The idea is outlined in Fig. 3, where the drill is shown operating on a lever in one jig while the other is ready for loading. If the drilling machine is of the radial-arm type, the jigs should be fixed on the table in such a position that the arm of the machine may remain locked right through the batch. The operator then only has to traverse the drill from one jig to the other. Stops may be fixed on the arm of the machine, which will definitely locate the drill over each jig.

If continuous drilling is kept in mind when designing the jigs it will generally be found cheaper to make

double- or multi-spindle machine, will be no greater than when the jig is used on a single-spindle machine for which it was designed.

When we come to consider the question of jigs specifically designed for continuous drilling under multi-spindle machines there are many excellent examples. To limit the scope of this article I will consider only such types as will appeal to the larger number of shops—namely, multiple drilling on single-hole jobs.

The principle of adjustability adopted in the jig shown in Fig. 2 for the single-spindle machine may also be used with advantage for multi-spindle work. In Fig. 5 is shown a jig designed by the writer along these lines. It is, as before, really two jigs both of which are bolted to a ribbed base plate *F*. It will be noticed that the end views of Fig. 5 and Fig. 2 are similar, while the front elevation shows four work stations for the former. When using such a jig on a batch of levers the four drills are operating on the side shown containing the work, while the other side of the jig—near the operator—is being loaded.

There is a great objection in some plants to screw bushings for securing work in jigs, because such bushings sometimes stick and cause delay, particularly when used on drop-forged mild steel. As a rule, however, they work very well on malleable-iron castings and rarely give any trouble. As an alternative to screw bushings for this type of jig, those shown in Fig. 6 may be used. For many single-hole jobs, this kind of jig has much in its favor. Four pieces are loaded while the other four are

that require drilling need not be faced. For such cases, if coned-mouth bushings are provided at *F* instead of plain ones, the work is then centered at both sides of the boss. The pins *S* act as stops to prevent the work from moving around when the drill begins to cut.

Another design for multiple work, which the writer has found of advantage, is shown in Fig. 7. The bushings in this, as in all the other illustrations, are shown solid black to distinguish them. This type is particu-

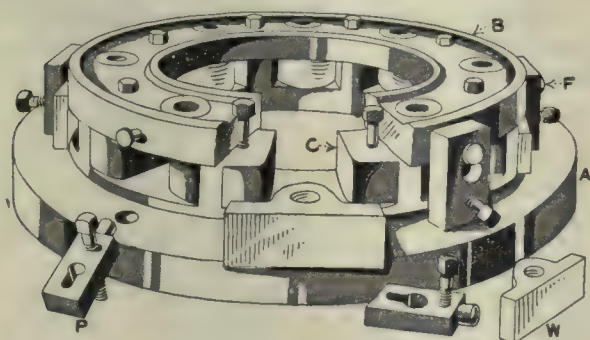


FIG. 7. JIG FOR MULTIPLE DRILLING

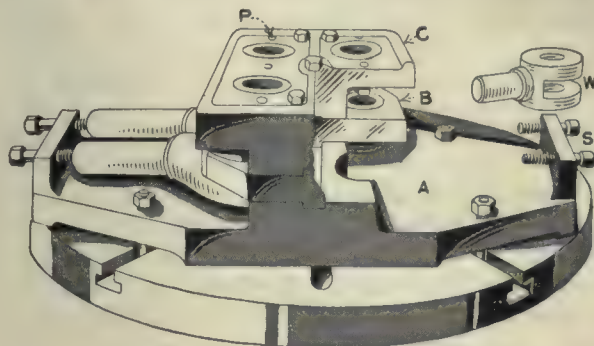


FIG. 8. JIG WITH LOCATING PINS

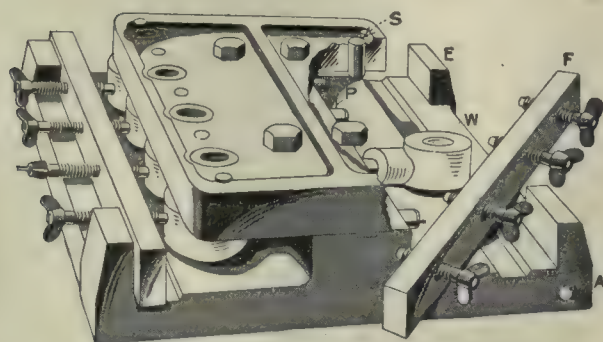


FIG. 9. ANOTHER TYPE OF JIG WITH LOCATING PINS

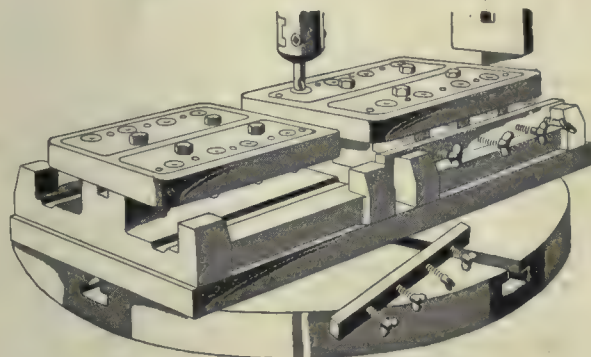


FIG. 10. JIGS MOUNTED ON SPECIAL BASEPLATE

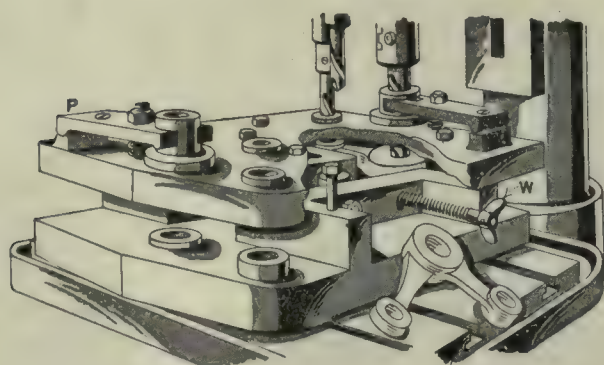


FIG. 11. SINGLE- OR MULTIPLE-SPINDLE JIG

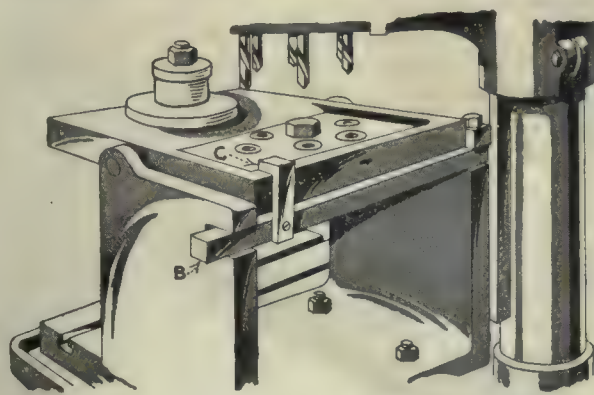


FIG. 12. A SWING-OVER JIG

being drilled. The plate *P* pulls both coned bushings *D* down and thus centers the work in position for drilling. The holes need to be equally spaced so that when the drills are once set they can be used in any other four bushings.

When this type of jig is adopted for drilling the bosses of levers, etc., a limited range—in length of work—can be accommodated by providing base bushes of different length, as shown by full and dotted lines at *F* in Fig. 6. Another method is to use washers under the base bushings to raise them. In many cases the bosses of levers

largely suitable for drilling holes in castings (like the one shown at *W*) that are not machined on their sides. The work *W* is pushed into an opening in the jig and secured in position by the screw in the slip plate *P*.

The base of the jig *A* has eight lugs *C* cast on it. These answer the treble purpose of locating the work, locating and supporting the bush carrying the casting *B*. In the top plate *B* opposite each of the work stations a stud *F* is screwed, and underneath in the plate *A* is a hole into which the slip plate *P* is inserted to prevent slippage.

When the quantity admits of the expense, this type of jig should be made in duplicate so that one is being loaded while the other is under the drills. For smaller quantities, however, this jig may be used to advantage by drilling four articles and loading four. In such a case the water channel on the top of the jig should have a partition across so that the coolant can be cut off from the loading side of the jig. This facilitates both the cleaning and the loading of the jig.

An altogether different type of jig is shown in Fig. 8. This jig is composed of three main pieces—the cast-iron base *A* (with two lugs for securing the screws *S*), to which is tongued the mild-steel positioning piece *B* and the cast-iron bush plate *C*, which is tongued to *B*. The work, which has been previously turned and milled, is slipped onto the positioning plate *B*, is located sidewise by means of the pegs *P* and is secured in position by means of the screws *S*. This type of location—pegs—is quite satisfactory when the hole may vary with reference to the axis of the piece.

As drawn, the jig was designed to drill two pieces *W* at once, while two similar pieces were being loaded on the opposite side. Obviously, one need not stop at two on each side, for if the quantities warrant it the jig might be designed for six on each side; but care should be taken on all of these jigs that no more work stations are provided than the operator can fill in the drilling time, unless he is to have assistance in loading.

Another type of jig that has pegs for locating the work is shown in Fig. 9. This was for drilling a hole in the end of the piece of work *W*.

The method of loading is as follows: The plate *F* being removed and the jig clean, a piece of work is pushed between each pair of the locating stops *S* until it is in position on the stud *P*. When the four pieces are in place the plate *F* is dropped into position between the work and the lugs *E* (cast solid on the base *A* of the jig); a turn or two on each of the wing-headed screws secures each piece in position.

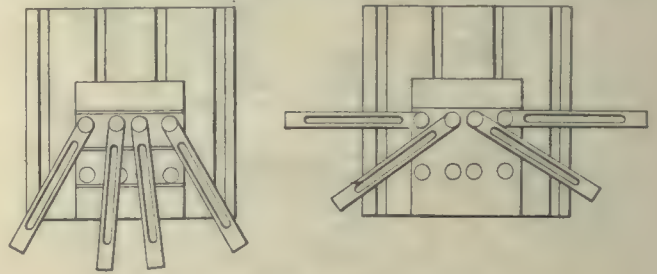
The great advantage of such a jig is that we may consider it as a unit which can be easily duplicated should the quantities at any future time warrant the extra expense. Undoubtedly when a jig of this type is duplicated the two jigs should be mounted on a ribbed plate, as shown in Fig. 10, where the same notation is followed. The limit is, How many can the operator load while the drills are running through the work?

All the previous examples of multiple jigs have been those designed for single-hole jobs. An interesting variation is the type shown in Fig. 11. This jig was designed for drilling a bell-crank lever having three holes, one end of the jig being used for drilling while another piece was being loaded at the opposite end. We have made several of these and, speaking quite generally, the type has no disadvantages.

The method of loading is as follows: The work is inserted into the open end of the jig, and the coned bushing is brought lightly down to the central boss. The wing-head stop *W* is then screwed up, after which the clamp plate *P* is tightened and drilling proceeds. Meanwhile the other end can be loaded. It will be obvious that when the quantity of work permits, this jig may be duplicated and mounted on a plate. In such a case six holes would be drilled at once instead of three. The jig as designed in Fig. 11 would of course be equally ap-

plicable for use under the single-spindle machine, as it would provide continuous drilling within the capacity of the machine.

The last type of jig to be discussed is that shown in Fig. 12, known as the "swing-over" type. This design is applicable to any kind of job within its scope and has practically no drawbacks. It is, however, best suited to that kind of work where drilling against the bolt is not a disadvantage. The jig itself—shown in heavy lines—is simply a long plate that, when in use, is pivoted about its center. In action it is supported on a channel-shaped base. Each end of the jig plate has a flush face on which the work can be loaded, and on



FIGS. 13 AND 14. WRONG AND RIGHT WAYS TO ARRANGE SPINDLES

the other side a rib runs right round to contain a flood of coolant so that all the drills get a full supply. The method of using this type is as follows: A piece of work is placed on the jig at the loading station and secured in position. The locking bar *B*, to which is secured the catch *C*, is swung outward when the jig plate can be turned over, thus bringing the work into position under the drills. The locking bar is then pulled into position, and drilling can begin. Meanwhile another piece is put on at the loading station. The job shown is a six-hole one that is located on the plate by a central spigot, but all kinds of locating arrangements can be adopted.

This type is capable of almost universal application, and the measure of its adaptability may be emphasized by the statement that the writer has already made more than fifty of this style and hopes to make many more. The great feature about this kind is the fact that the jig plates may be prepared in batches at any time before they are actually required, thus saving time. Only a few bases are required, say one for each multi-spindle machine, but it is essential, naturally, that bases and plates should be interchangeable.

If we want continuous performance we must make the operating conditions comfortable. Now in setting the spindles for a jig most operators will arrange the spindles as shown in diagram in Fig. 13. This is wrong, because they will have to stoop under the drill spindle arms to load the jig. A far better method is to adopt the spacing outlined in Fig. 14. The front is left clear of arms, and loading can be performed without fear of knocking one's head—and in comfort, if the work table is high enough. A larger table would often be an advantage; but when two jigs are mounted on a plate, as shown in Fig. 10, the loading station may be clear of the machine.

In conclusion it may be mentioned that there are two important factors that largely influence the success, or otherwise, of continuous performance. The provision

of up-to-date jigs, designed for the purpose of producing the last ounce in the way of continuous cutting, is not in itself any guarantee that we shall get continuous drilling. This can only be achieved and maintained with certainty by the aid of a shop staff who will see that the cutting is continuous. The management should

supplement this by means of some incentive that will insure that the operators are coöperating by keeping fully loaded the jigs that have been supplied. Unless these important factors are attended to, then in spite of expensive fixtures, continuous drilling will most likely degenerate into continuous shirking.

Machining Small Lathe Parts

BY A. R. DE KUZELEWSKI

SYNOPSIS—This article gives a few of the interesting methods employed by the R. K. LeBlond Machine Tool Co., Cincinnati, Ohio, in making small parts for some of its lathes. Simple fixtures on plain machines are utilized to increase production and reduce costs.

The handwheel is one of the most common parts of a machine. While such wheels vary very little in design, no two shops seem to employ the same methods of machining. The detail drawing, especially the cross-section, shows that the polished surface of the rim extends beyond the center line, which makes the finishing more difficult. It will also be seen that the hub is turned and faced on the back and faced on the front. The sequence of operations is:

1. Turn, bore, face back and form in chucking lathe.
2. Polish rim and hub.
3. Broach round and keyway in broaching machine.
4. Face front of hub in drilling machine.
5. Drill for handle.
6. Paint.

The first operation is performed in a 21-in. single-pulley universal turret lathe with three-jaw universal chuck with special jaws. This holds the wheel by the inside of the rim with the hub out.

As seen in Fig. 2, the turret holds two box tools. The roughing tool carries a drill; the finishing tool, with a reamer, floats 0.005 in. This equipment takes care of the hub. The rim is finished by means of two forming

tools, one roughing and one finishing, which are held on the square-turret tool post.

The finish-forming tool is designed in such a way that when the tool passes over the wheel, it is turned to the standard width of $1\frac{1}{8}$ in. Side movement of tools finishes the rim. The construction of the drill jig, as will be seen later, necessitates the outside diameter of the

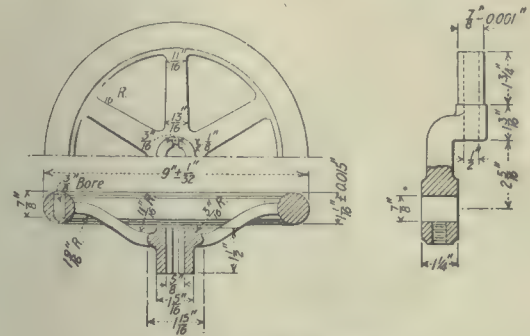


FIG. 1. HANDWHEEL

rim being within $\pm 1/64$ in. of size. The time for this first operation averages 7 min. in lots of 200 pieces.

After being polished, the wheel goes to the broaching machine, which sizes the $5/8$ -in. hole and cuts the keyway. The broaching has been found much more economical than hand reaming, besides saving handling. Next comes the drilling operation of facing the front of the hub. A counterbore with a pilot is used to good advantage. The next operation is drilling for the handle.

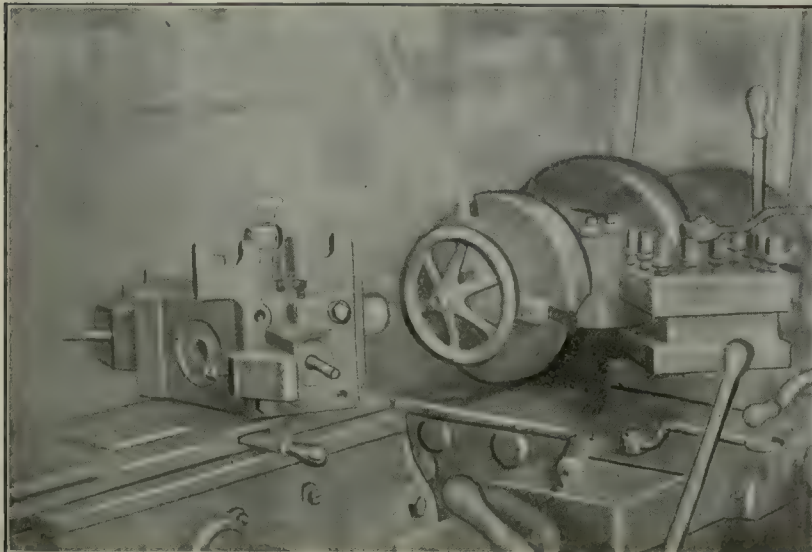


FIG. 2. TURNING AND BORING THE HANDWHEEL

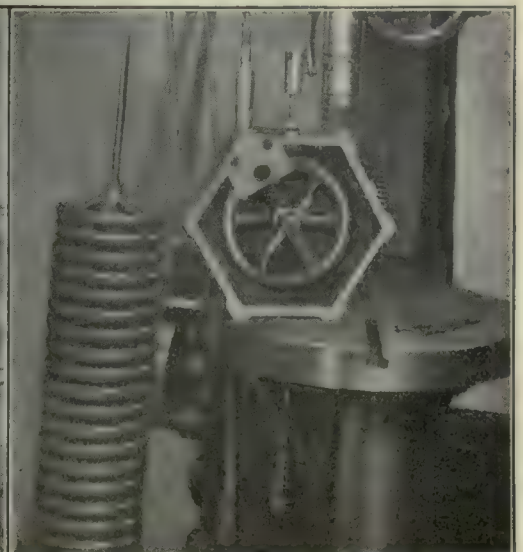


FIG. 3. DRILL JIG FOR HANDLE

Fig. 3 shows the drill jig used. The hole is drilled at the end of one of the spokes and then counterbored to receive the round part of the handle. It will be noticed that the drill jig has six sides. This is for handwheels with six pilot handles on the circumference and one in front, and the one jig takes care of both operations. The jig locates the wheel by the circumference. The wheels are stacked on rods, as shown at the left. This method of finishing handwheels is very simple. The average time, including the fitting in of the handle, is 16 min.

There are in every machine shop many jobs that seemingly do not require any jiggling and still show a great

due to the fact that the work is held rigidly, so that we can use as much feed and speed as the tool can stand.

The clamp that holds the journal box contains an equalizer with two serrated jaws pivoting around a pin and locating the box by its round top, right in the center.

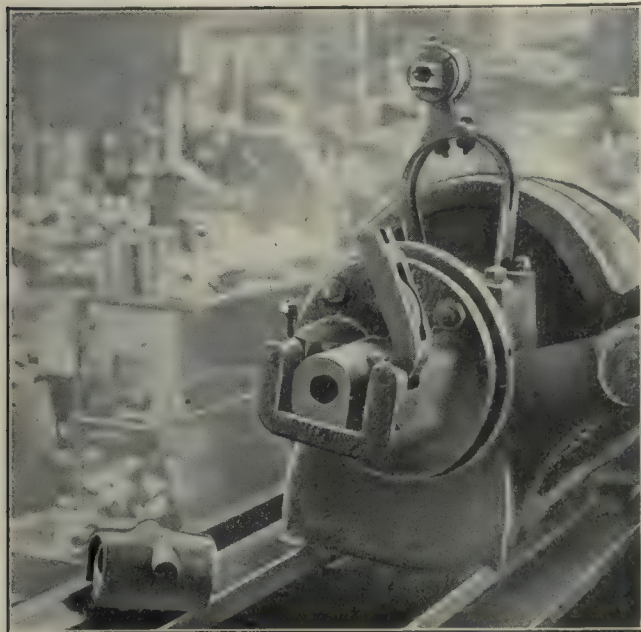


FIG. 4. THE JOURNAL BOX AND BORING JIG

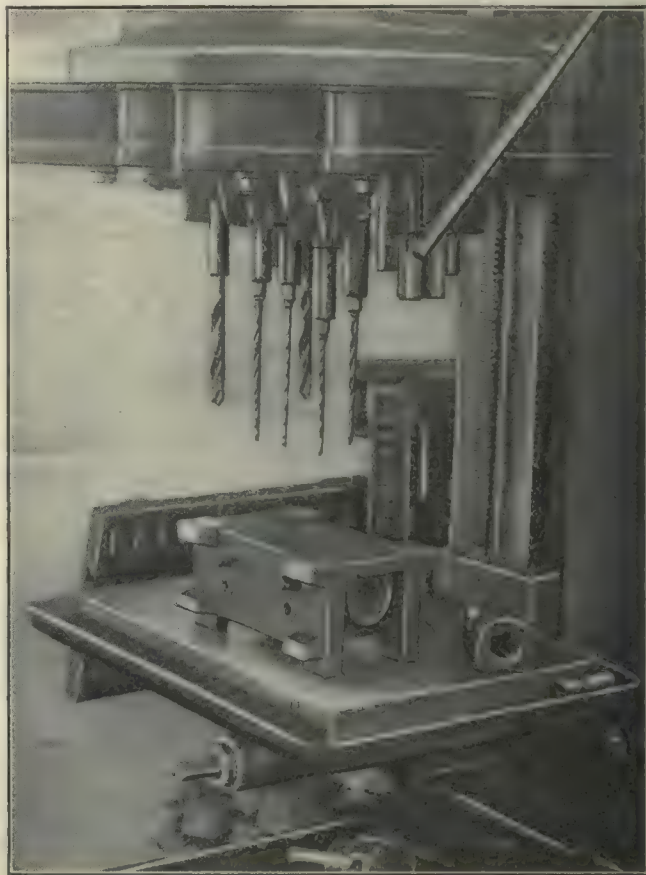


FIG. 5. JIG FOR DRILLING TWO BOXES AT A TIME

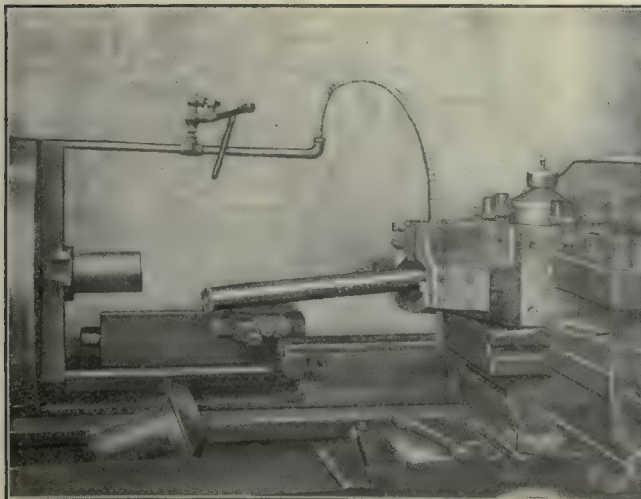


FIG. 6. MACHINING OILER BUSHING



FIG. 7. ANOTHER SPECIAL CHUCK

gain in time if jigged properly. One of these is the journal box for a countershaft, shown in Fig. 4. The only machining is a hole $1\frac{1}{8}$ in. in diameter and $6\frac{1}{2}$ in. long, with a $2\frac{7}{8}$ -in. counterbore $\frac{3}{8}$ in. deep. In many shops this job would be done on a drilling machine or in an engine lathe.

We have found, after trying these methods, that the procedure shown has saved 30 per cent. of the time,

The tools used are a three-lip drill; a four-lip drill, removing only $\frac{1}{32}$ in. on the side; a reamer, removing 0.005 in.; and a counterbore with four blades. The machine is a 21-in. universal turret lathe, the speed being arranged so that we use the second step with high speed on the countershaft for the drills, while for the reamer and counterbore we shift over to the slow speed—all of them on open belt. It will be noticed that the clamp or strap

between the two milled surfaces—the one on which the cutter is now shown in operation and the top of the feet of the casting—is determined by the notches in the stop bar attached to the profiler head, as clearly shown in the illustration.

This stop bar gives the right setting at once for the two positions of the cutter. When the latter is run down

removes at once any possible burr or dust that might be found on the bearing surface of the type-bar plate and at the same time checks the accuracy of the preceding profiling operation.

The type-bar plate, as finished in the machine and with the type guide attached, is placed upon the bench plate, where it is located over guide pins entering holes drilled

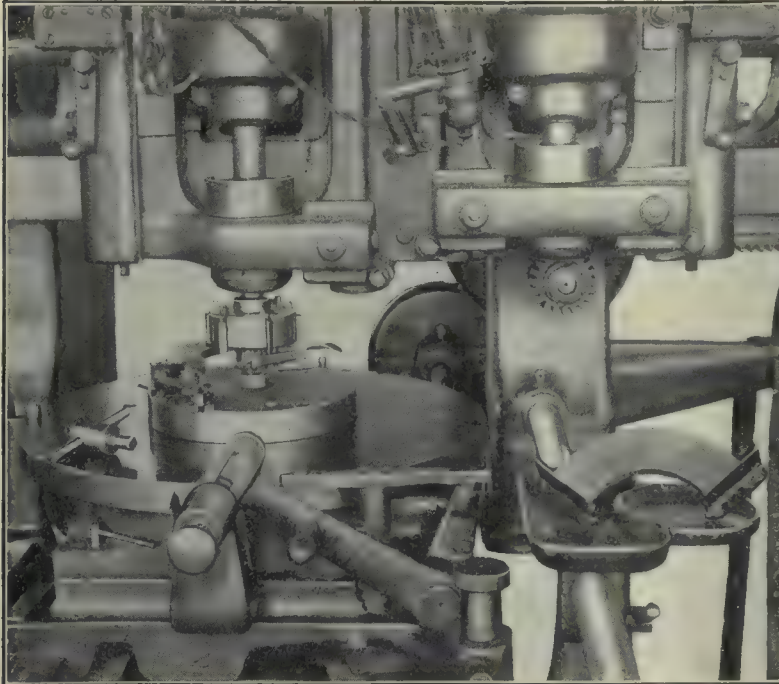


FIG. 2. MACHINING THE TYPE-BAR PLATE IN PROFILER

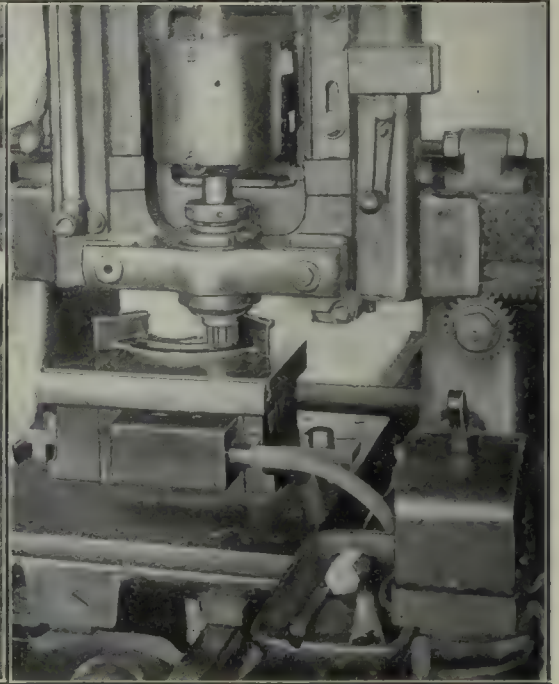


FIG. 3. ANOTHER PROFILING OPERATION ON TYPE-BAR PLATES

to take the bottom cut—that is, position indicated in Fig. 3—it is only necessary to take measures to prevent the cutter teeth from milling into the projecting feet or ledges at the ends of the casting. This possibility of trouble is avoided in a simple fashion—by providing on the top of the cutter a shoulder, in the form of a collar, which is slightly larger than the cutter diameter proper. This collar, in case the cutter approaches too closely to the side wall, contacts with the latter and prevents further movement in that direction, so that it is impossible at any time for the cutter teeth to strike any metal at the ends of the castings. The bearing surface milled in the profiling operation, Fig. 3, is not one continuous plane surface, but consists of two ribs in the form of an arc, which cuts down materially what would otherwise be the possible surface of contact between the tops of the type bars and the under surface of the type-bar plate. This is pretty well shown in Fig. 4, where the finished casting with the sheet-steel type-bar guide attached to its top is shown at the left, also one of the formed-up steel guide members by itself. The operation represented by Fig. 4 is merely an additional refinement in the process of manufacture of this part of the typewriter, which is well worth calling attention to, as it accomplishes a double purpose. It

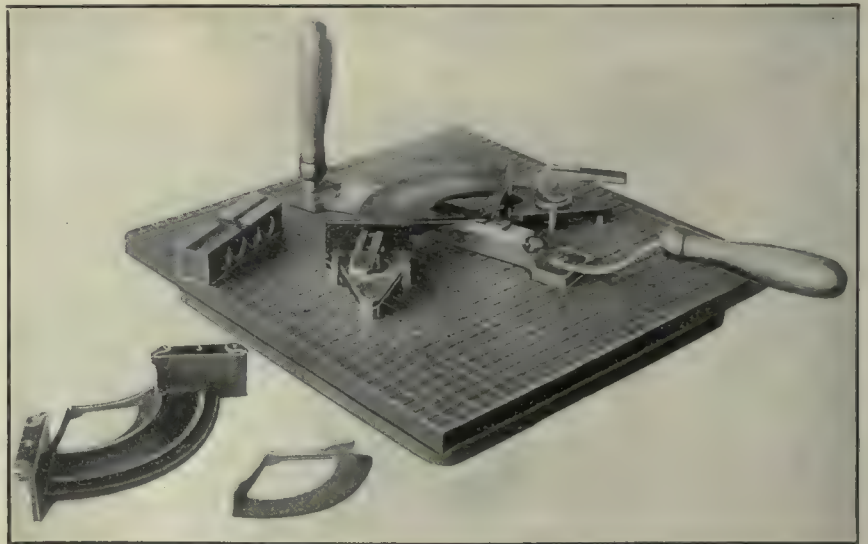


FIG. 4. TOOLS FOR A FINAL REFINEMENT AND TEST IN FINISHING THE TYPE-BAR PLATE

in the feet and lightly secured to the surface of the bench plate by the two cam-operated clamps. A fine or dead-smooth file that is perfectly true on its top surface and whose bottom surface is ground to fit snug upon a taper wedge on the parallel is used under the work. Any minute burr on the corners is thus removed by passing the file a few times back and forth under the casting. This file is adjusted dead to height above the bottom of the taper block, on which it is mounted by means of a micrometer. The whole apparatus might be

considered a filing jig, assuming any metal were left to be removed by the filing process. As a matter of fact, such is not the case, as no metal whatsoever is left with this object in view. It is merely a refinement for brushing off the edges of the work without removing a particle of fresh metal from the surface.

After the filing tool has been slipped out from under the casting, the limit gage, shown at the left on the bench plate, is slid under to test the accuracy of the profiled work. There is a small fraction of a thousandth difference between the thickness at opposite ends of this limit gage, which is of course on the "no and go" principle, it being the intention that one end shall just slide under the casting and that the other shall not enter at all.

As the type-bar plate comes from this bench-plate test block, it is certain that it will assemble properly on the top plate of the typewriter and allow the requisite depth of opening for the type bars that travel underneath it.

✽

A Miniature Conveyor Screw

BY SAMUEL GAHAN

While I believe that many of your readers will be interested in the manner of making the conveyor screw, described here, I am submitting this article, not so much for the purpose of showing how this particular screw was made as for the purpose of hinting at how a lot of ordinary screw cutting could be done more economically than by the usual methods. The fixture shown is simple and crude, made in a hurry—but the idea embodied may be elaborated on. It can be made without backlash, and may be used on both the miller and the grinder.

The screw illustrated in Fig. 1 turns inside a tube connected with a hopper and is used to convey or feed a granular substance. It formed an important part of an inventor's model made by the writer at the shops of the E. V. Baillard Co., Frankfort St., New York City. A good idea of the proportions may be obtained from the rule shown with it. The outside diameter is $\frac{5}{16}$ in., the root diameter $\frac{1}{8}$ in. and the pitch three threads per inch.

Previously, for the same model, I had cut a somewhat similar though larger screw on the lathe, and although the completed screw was satisfactory, the trouble of making it was such that I did not care to repeat the operation. There was also to be considered the possibility of still

ter and about 8 in. long. Through the center of this piece a hole was drilled and bored $\frac{1}{2}$ in. in diameter for about 6 in. of its length, and $\frac{5}{16}$ in. in diameter for the remainder of the length. This piece was then squared up on the bottom and sides and milled down on the top

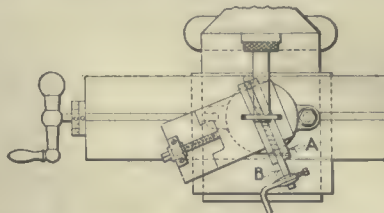


FIG. 3. POSITION OF WORK IN MILLER

until part of the top of the hole was cut away as indicated.

The part B, or master screw, also of brass, was made to fit the large part of the hole in A and was a little longer than the depth of the hole. A shallow thread of about 15- or 20-deg. included angle was cut on this piece for a distance a little greater than the length of the screw to be milled. A hole was drilled in the threaded end for the shank of the conveyor screw. A piece of steel C

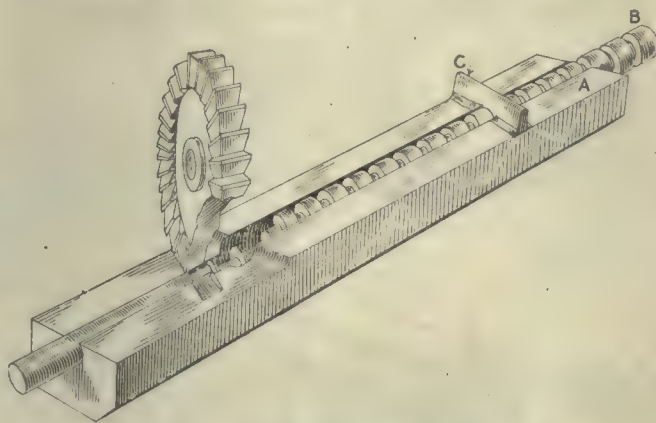


FIG. 4. THE WORK, FIXTURE AND CUTTER

was fitted to the thread in B and then soldered onto A as shown. This served as a nut and moves the master screw in or out of A when it is turned.

The shank of the screw was soldered in the hole in the part B. The holder A was gripped in the miller vise,

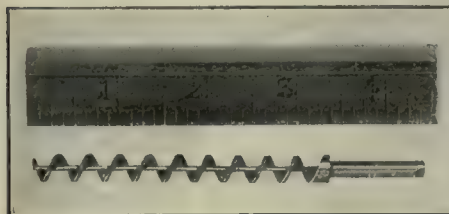


FIG. 1. A MINIATURE CONVEYOR SCREW

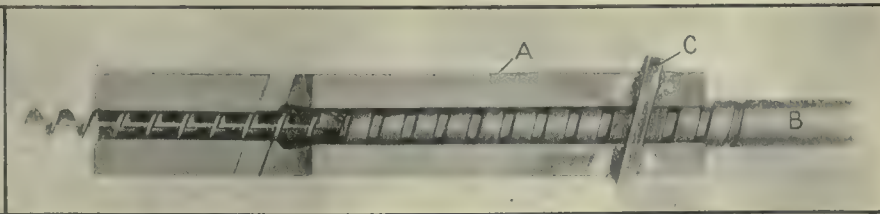


FIG. 2. THE SCREW, MASTER SCREW, GUIDE AND SINGLE HALF THREAD NUT

another and longer screw being needed. I therefore decided to try milling the threads. The vertical spindle attachment for the miller was not available, or I might possibly have tried another way, though I do not believe the result would have been so satisfactory.

The first thing started on was the part A, Fig. 2. For this I took a piece of round brass about $1\frac{3}{8}$ in. in diame-

which was swiveled around to the correct angle as shown in Fig. 3. The cutter used was a side milling cutter $\frac{3}{4}$ in. wide and about 3 in. in diameter. An enlarged view is shown in Fig. 4. The cut was started at the shoulder, or the end next the master screw B, the work being turned by a dog on the outer end. The master screw and the milled screw were removed from the ma-

chine after each cut, and the burr that was thrown up by the milling cutter was removed with a file.

None of the difficulties anticipated on account of the slenderness of the work were experienced in the milling operation as the screw, while extremely flexible, was able to withstand quite a surprising torsional strain. The actual milling time was only about 20 min., and a second screw could have been cut in less than half that time.

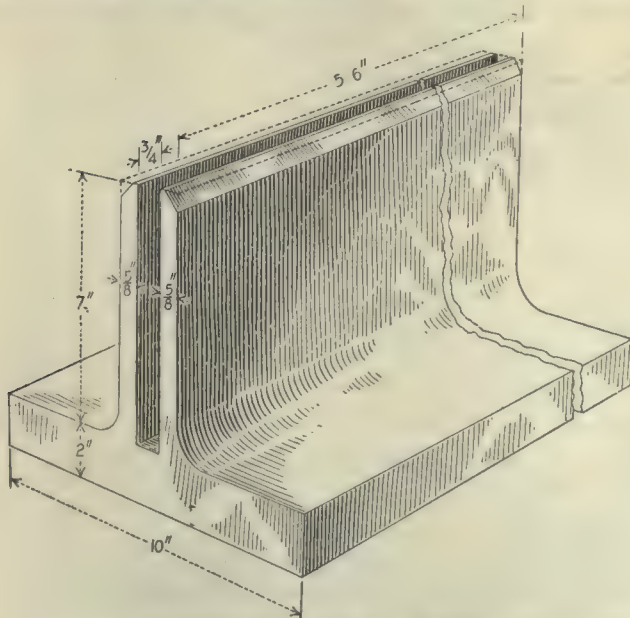
Of course a thread with straight and parallel sides cannot be cut with a milling cutter and these sides were somewhat undercut.

The holder was taken from the miller vise and placed in a vise—similarly set with relation to the grinding wheel—on the surface grinder. The grinding wheel was not dressed with parallel sides like the milling cutter, but was made with a slight angle on each side. The grinding was done on a Norton No. 1 universal tool and cutter grinder because with this machine it is possible to turn the table and slides around the central column of the machine and thus dress the sides of the emery wheel to the required angles. The grinding, however, in this case was done more for the purpose of polishing up the screw than for correcting the errors.

How Would You Machine This Job?

BY F. P. TERRY

The illustration herewith shows a machining job we were asked to undertake recently, and as my price staggered the parties interested in the deal, I thought



THE PART TO BE MACHINED

it worthy of being passed along, hoping that someone may have a better way of doing the work than I have, and prove me at fault.

Ten mild-steel T-rails were to be supplied 5 ft. 6 in. long, which were to be machined all over. A 3/4-in. slot 7 in. deep was to be cut from the solid, as shown. This was required to be within the limit of 0.0015 in., as were also the 5/8-in. side walls. The 3/4-in. slot was to have a smooth finish and be perfectly straight.

I intended to try the job on a modern high-speed planer. What would you do?

Chart for the Design of Jig and Fixture Cams

BY W. BURR BENNETT

Aside from a few details of proportion and the general arrangement the three important factors involved in the design of eccentric cams for jigs and fixtures are the lift, or rise, the angle of throw, or the movement of the cam, and the radius. Usually it is desirable that such cams shall not slip when tightened up; hence the cam should be designed with a friction angle, or angle of repose, of about 10 deg. Experience has shown this value to be good practice. Of the three factors mentioned the rise and throw are always known, being determined by the

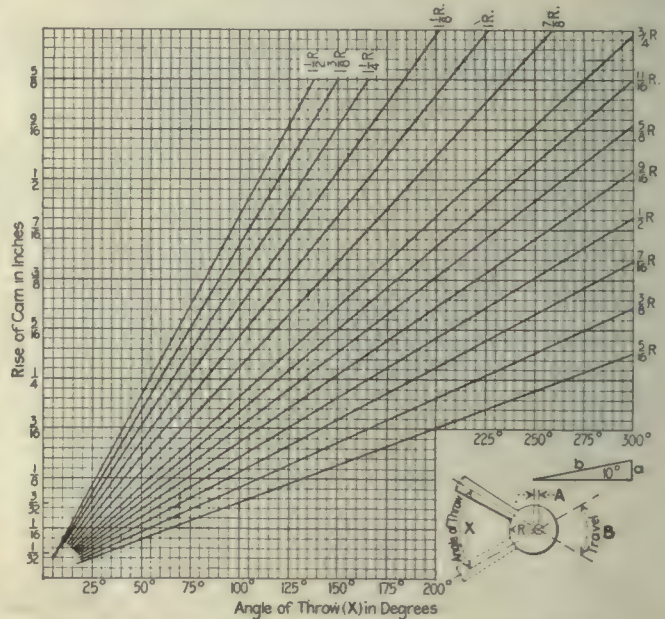


CHART FOR JIG AND FIXTURE CAM DESIGN

design of the jig. Therefore, it remains to find a radius such that the cam will possess an angle of repose of 10 deg. for a given rise and angle of throw. Let

- A = Rise of cam;
- B = Travel of cam;
- C = Circumference of cam;
- R = Radius of cam;
- X = Angle of throw of cam.

Then in a 10-deg. triangle where A is the opposite side and B the hypotenuse, the $\sin 10 \text{ deg.} = \frac{A}{B}$, or $B =$

$\frac{A}{\sin 10 \text{ deg.}}$, or $\frac{A}{0.17365}$. Now,

$$C = \left(\frac{360}{X}\right) B, \text{ or } C = \left(\frac{360}{X}\right) \left(\frac{A}{0.17365}\right)$$

Also,

$$C = 2\pi R$$

Therefore,

$$2\pi R = \left(\frac{360}{X}\right) \left(\frac{A}{0.17365}\right)$$

Reducing,

$$X = \frac{329.9483A}{R}; R = \frac{329.9483A}{X}; A = \frac{XR}{329.9483}$$

The accompanying curve is based on the foregoing and will be found very handy in the design of jig and fixture cams. To use this curve, find the intersection of the rise and angle-of-throw ordinates; the first diagonal above this point will give a safe value for a radius.

United States Munitions*

The Springfield Model 1903 Service Rifle

Operations on the Receiver--I

SYNOPSIS—The receiver is an example of an extensive series of machine operations on one piece which would be hard to equal, weight for weight, in any other mechanical part manufactured in quantity. It presents many interesting milling and profiling operations which are handled in jigs and fixtures that represent exceptionally good practice.

The receiver, which is probably the most complicated component of the rifle, judged from the number of operations performed on it, is a drop forging weighing 4.75

mandrel, which is a good push fit through the hole, is used in nearly all operations on the receiver. This mandrel locates the forging with relation to the bore, and the milled surfaces referred to are forced against stops by a clamping device. As will be seen in the various operations, much of the milling is done in pairs.

It will also be noticed that many formed cutters are used in this connection, some of them being built up of a large number of separate milling cutters. Interlocking cutters have been found much more satisfactory than large, solid formed cutters, both on account of the replacement costs being lower and because they are more easily ground. In this connection it is interesting to observe that the best results are being secured by grinding on the top of the cutting teeth instead of on their

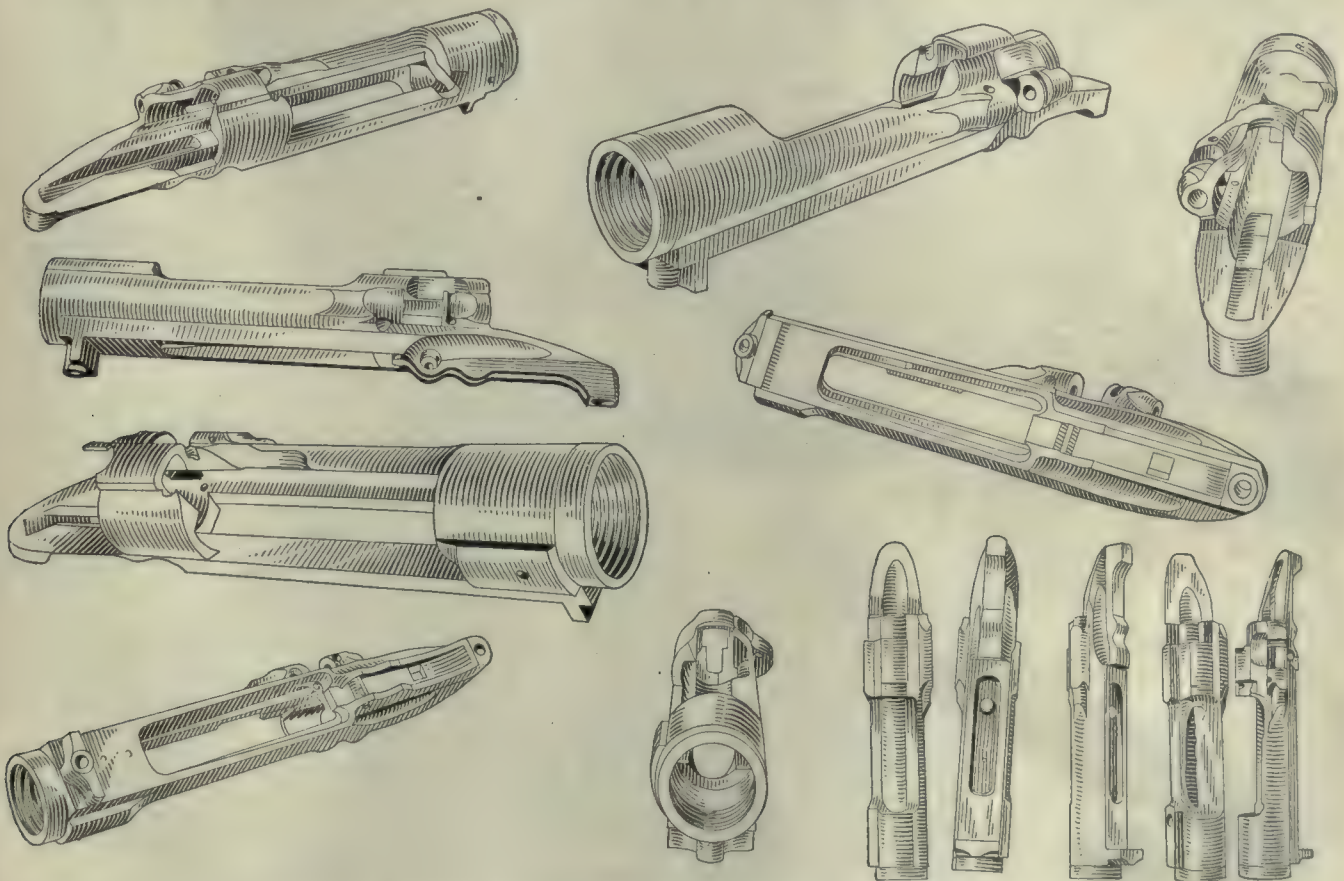
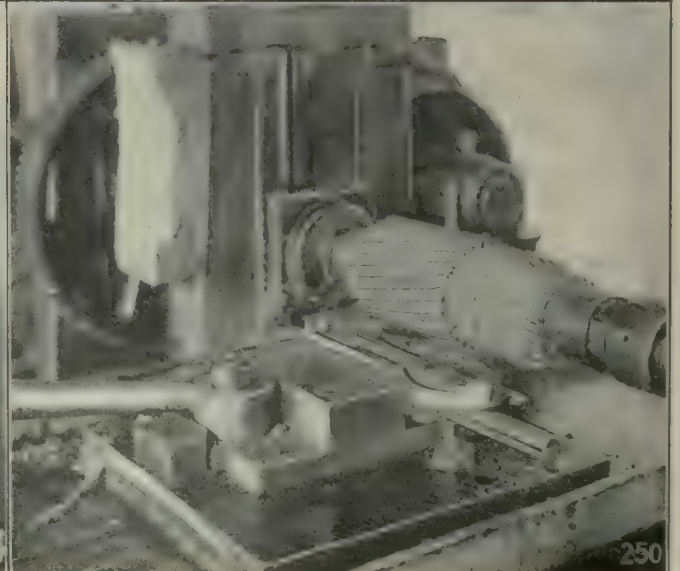
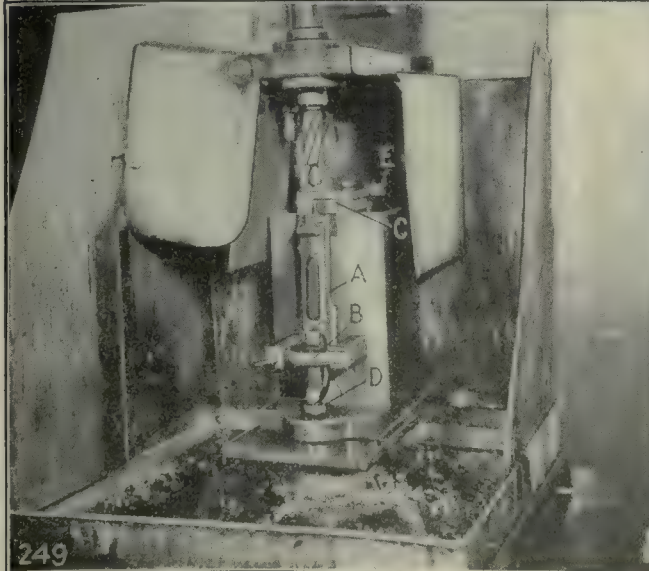
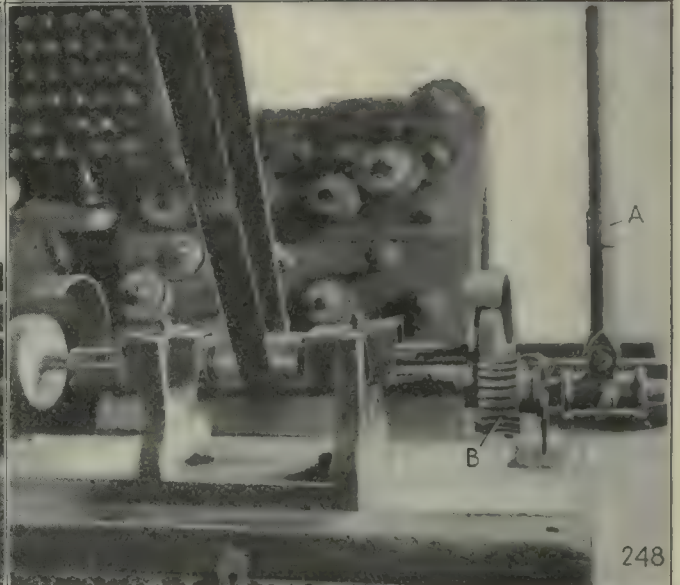
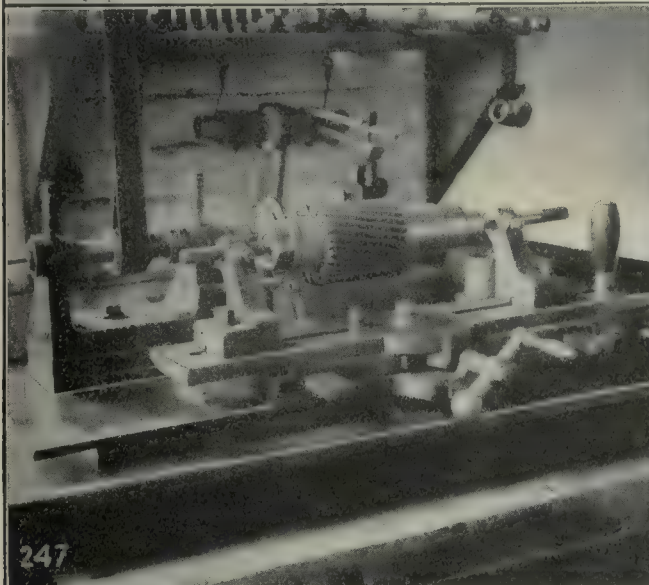
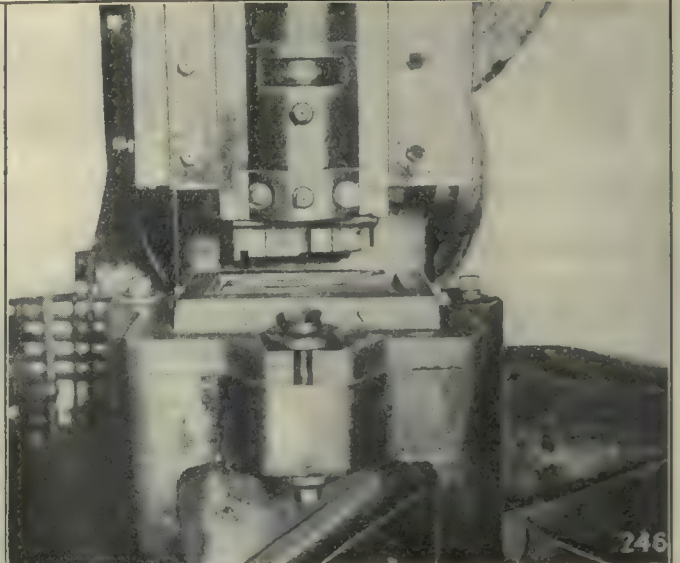
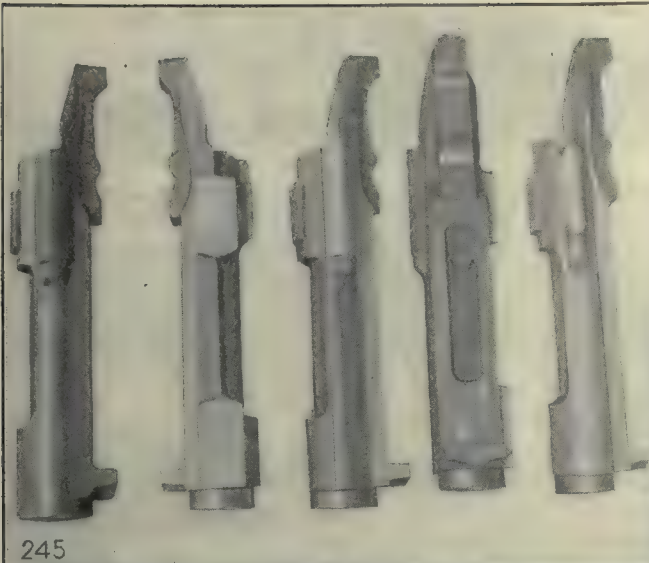


FIG. 245-A. VIEWS OF RECEIVER IN VARIOUS POSITIONS AND STAGES

lb. It is machined until only 0.98 lb. remains. It is Class C steel, $1\frac{3}{4} \times 1\frac{3}{8}$ rectangular, in multiples of 15 in. Some idea of this transformation can be had from Fig. 245. The first operation is to bore the bolt or well hole, and this forms the working point for future operations. After the bottom and left side are milled, they are also used as working points in connection with the bore. A

faces, as is usual with formed cutters. Special appliances for grinding, among them a sort of pendulum support for the cutter, make this less difficult than might be supposed. One of these devices is shown in Fig. 248, while Fig. 247 shows another special grinder for straight-faced cutters that are grooved on centers.

In order to give some idea of the great many operations necessary on the receiver three views are given in



THE RECEIVER PRESENTS AN INTERESTING AND EXTENSIVE SERIES OF MACHINE OPERATIONS

Fig. 245—Views from various positions. Fig. 246—Trimming the forging. Fig. 247—Cutter grinder. Fig. 248—Formed cutter grinder. Fig. 249—Counterboring in drilling machine. Fig. 250—Milling bottom of receiver

OPERATIONS ON THE SPRINGFIELD RIFLE RECEIVER

- A-1 Blocking from twin billets
 A-2 Blocking from twin billets
 B Drop-forging and hot trimming
 B-1 Pickling
 C Drop-forging to finish and annealing
 C-1 Pickling
 1 Milling front and rear ends and top of tang
 2 Drilling well
 3 Reaming well
 4 Counterboring well in drill press
 6 Reaming well to finish
 7 Hollow milling front end
 7 1/2 Clamp milling tenon, front end
 7 3/4 Face milling front end
 9 Milling right side, rough
 8 Milling bottom, roughing
 10 Milling bottom to finish
 11 Milling right side to finish
 AA Removing burrs left by operation 11
 13 Milling left side to finish
 BB Removing burrs left by operation 13
 14 Milling left side, front end
 15 Milling left side over cutoff-spindle hole
 CC Removing burrs left by operation 14
 17 Marking for barrel
 16 Hand milling for end of thread
 18 Thread milling
 19 Milling top to finish
 20 Milling under side of tang
 21 Profiling under side of tang, right
 DD Removing burrs left by operation 21
 22 Profiling under side of tang, left
 EE Removing burrs left by operation 22
 FF Hand milling to remove stock for operation 23
 23 Drilling guard-screw, ejector-pin and sear-nose holes and two holes rear of magazine
 24 Drilling sear-joint pin hole, clearance and gas-escape hole
 GG Removing burrs left by operations 23 and 24
 25 Milling top of tang and overwell to remove stock
 HH Removing burrs left by operation 25, hand milling, reaming and filing
 26 Drilling and reaming cutoff hole and bottoming hole
 27 Milling for cutoff
 28 Drilling for cutoff, reaming and counterboring sear-joint pin hole
 29 Milling to remove stock, right side
 30 Milling handle seat, roughing
 31 Milling rear of safety-lug slot
 II Removing burrs left by operations 29 and 30 (reamer)
 32 Shaving left locking-lug slot
 33 Shaving right locking-lug slot
 34 Milling clip slot, roughing
 45 Milling tang
 45 1/2 Hand milling to match top of tang
 35 Profiling top of right wall, front and rear shoulders and handle seat to finish
 JJ Removing burrs left by operation 35 (reamer)
 36 Profiling top of left wall
 37 Profiling thumb cut over left wall
 38 Shaving clip slot
 39 Milling corners of clip slot
 40 Drilling hole at front end of ejector slot
 43 Profiling for cutoff thumb piece
 41 Hand milling top and bottom of cutoff cavity (operation 42 combined with this)
 44 Hand milling to remove burrs in cutoff thumb-piece cavity
 44 1/2 Milling front and rear of cutoff cavity
 49 1/2-79 Hand milling to remove stock rear of safety-lug slot; rounding corner over clip slot
 46 Drilling two holes for cutoff-spring spindle
 47 Profiling groove for cutoff-spring spindle
 48 Milling sear slot
 49 Milling cocking-piece groove
 50 Profiling rear of safety-lug slot
 51 Profiling cocking-piece groove
 52 Shaving safety-lug slot
 53 Shaving front locking-lug slot
 54 Shaving ejector slot
 55 Profiling bullet clearance
 56 Milling end of tang
 57 Hand milling safety-lug cam
 58 Hand milling extractor cam
 KK Removing burrs left by operations 48, 49 and 56
 59 Shaving sear-nose slot
 71 Milling rear end of magazine to length and rear of recoil lug
 69 Profiling front end of recoil lug
 60 Milling through magazine rear end
 61 Milling through magazine front end
 62 Milling through magazine from rear to front
 LL Removing burrs left by operation 71
 63 Profiling mouth of magazine
 64 Profiling magazine to finish
 MM Removing burrs left by operation 64 (reamer)
 64 1/2-65 Profiling bevel front-end wall of magazine; profiling rear corners of magazine
 66 Profiling lower ramp
 NN Removing burrs left by operation 64 1/2-65
 68 Counterboring for ejector pin and rear guard screw; milling for front end of guard
 67 Profiling upper ramp
 70 Shaving rear end of magazine
 OO Removing burrs left by operation 70 (reamer)
 73 Milling right side of rear locking-lug seat to finish
 74 Milling right side of front locking lug to finish
 75-76 Profiling bolt-stop cavity, first and second cut
 77-81 Drilling and counterboring for bolt-stop pin
 PP Removing burrs left by operations 73, 74, 77
 78 Hand milling cutoff-spring spindle notch
 82 Seating front end and reaming sear-pin hole
 82 1/2 Drilling three holes for telescope-sight bracket
 95-95 1/2 Shaving for extractor cam on bolt; shaving cam, front end
 95 3/4 Removing burrs

- 83 Polishing circle, front end, for stamping
 84 Reaming and countersinking cutoff spindle, joint-pin, ejector-pin and gas holes
 85 Stamping "U.S., Springfield Armory, Model 1903"
 93 Tapping guard-screw holes
 86 Rotary filing cutoff-spring spindle groove
 87 Rotary filing under side tang under thumb cut and matching and cornering rear end of front circle
 96 Filing top of right wall, matching upper side of tang for polishing and cornering lug right side of front end
 88 Stamping serial number
 89 Polishing all outer surfaces visible in assembled arm
 90 Filing, general cornering
 91 Casehardening
 91-A Sand blasting
 94 1/2 Polishing well
 92 Assembling with bolt stop
 Special Drill three holes for telescope-sight bracket
 Special Tapping three holes for telescope-sight bracket

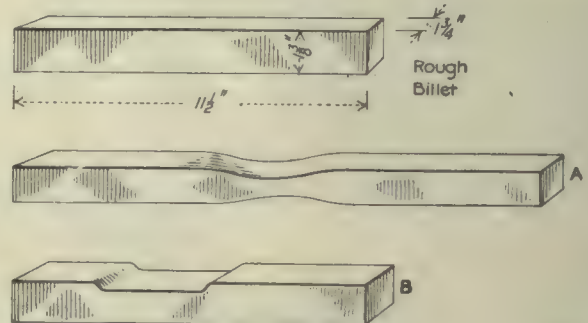


FIG. 253

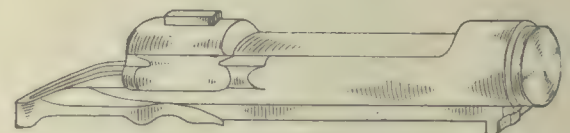


FIG. 254

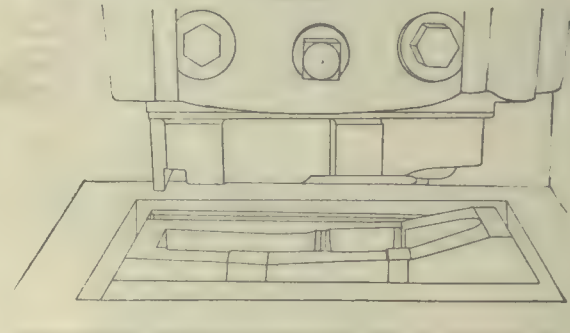


FIG. 255

OPERATION A-1. BLOCKING FROM TWIN BILLETS

Transformation—Fig. 253-A. Number of Operators—One forger and one helper. Description of Operation—Blocking from twin billets; dies held in drop by taper key. Apparatus and Equipment Used—Billings & Spencer 1,200-lb. drop hammer. Gages—None. Production—70 per hr.

OPERATION A-2. BLOCKING FROM TWIN BILLETS

Transformation—Fig. 253-B. Number of Operators—One forger and one helper. Description of Operation—Blocking from twin billets; dies held in drop by taper key; breaks down billet in center ready for rough forging, operation A-1. Apparatus and Equipment Used—Billings & Spencer 1,200-lb. drop hammer. Gages—None. Production—100 per hr.

OPERATION B. DROP FORGING AND HOT TRIMMING

Transformation—Fig. 254. Number of Operators—One man and one helper. Description of Operation—Drop dies held by taper key; trimming dies held in shoe by setscrews; work held by tongs. Apparatus and Equipment Used—Drop hammer, Billings & Spencer, 1,200 lb.; trimming press, T. F. Taft, Worcester, Mass., 10-in. stroke. Gages—None. Production—45 per hr.

OPERATION B-1. PICKLING

Number of Operators—One. Description of Operation—Pickling scale of receiver after drop forging. Apparatus and Equipment Used—Wooden tanks, wire baskets and chain hoists; pickle is 1 part sulphuric acid to 9 parts water. Production—300 per hr. Note—Time required, 15 to 20 min.

in connection with the other two points, both in locating and gaging. This right side remains flat and square with the bottom until operation 74, when the flat portions surrounding the barrel of the receiver are milled

to the proper radius. After this, all measurements from the side are taken from the narrow flat surface that extends along the entire right side beside the magazine opening. Bearing in mind that the front and rear end



FIG. 256

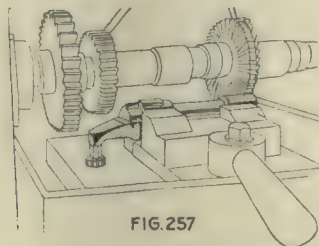


FIG. 257

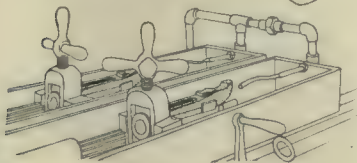


FIG. 265

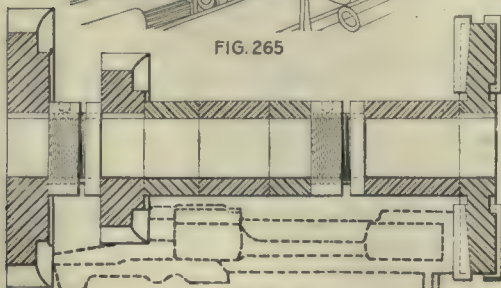


FIG. 259

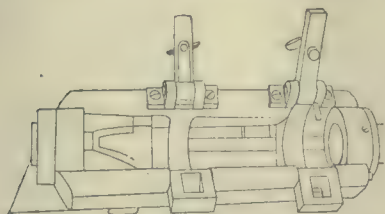


FIG. 263

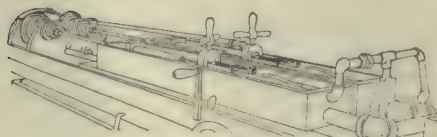


FIG. 265

Fig. 256 to 260 inclusive - Operation 1
Fig. 261 to 267 " - Operation 2

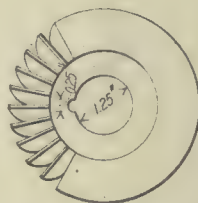


FIG. 258

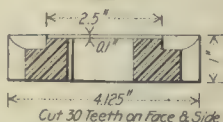


FIG. 260

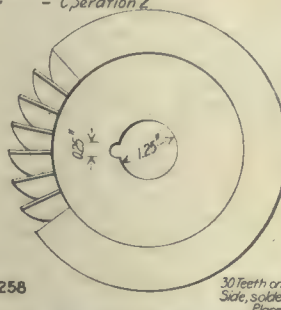


FIG. 258

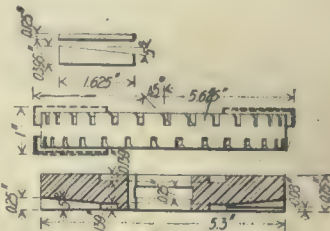


FIG. 262

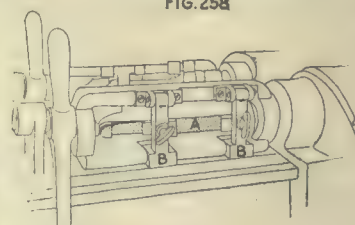


FIG. 262

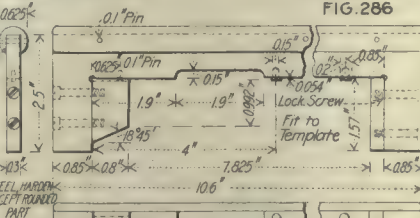


FIG. 260

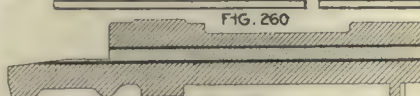


FIG. 261

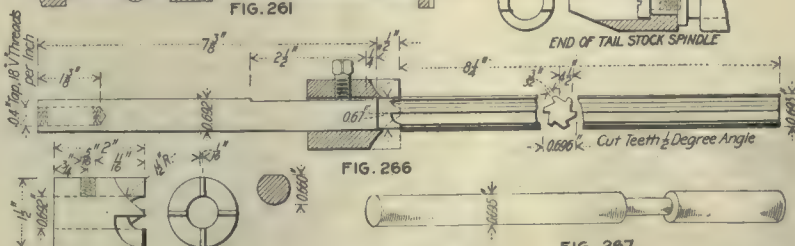


FIG. 266

FIG. 267

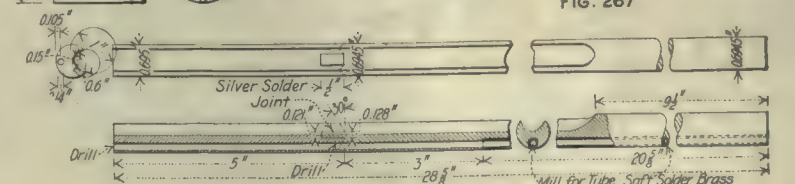


FIG. 264

OPERATION C. DROP FORGING TO FINISH AND ANNEALING

Number of Operators—One. Description of Operation—Hammering block to finish shape. Apparatus and Equipment Used—1,200-lb. Billings & Spencer drop hammer. Production—47 per hr. Note—A suboperation C-1 is to pickle again to remove scale, less time being necessary than in operation B-1.

OPERATION D. TRIMMING

Transformation—Same as Fig. 254. Machine Used—Perkins back-geared press. Number of Operators per Machine—One. Punches and Punch Holders—Punch is a solid block with square shank, which fits clapper-box die, held in shoe by setscrews, Fig. 255. Average Life of Punches—20,000 pieces. Lubricant—None. Gages—None. Production—350 per hr.

OPERATION 1. MILLING FRONT AND REAR ENDS AND TOP OF TANG

Transformation—Fig. 256. Machine Used—Pratt & Whitney Lincoln type miller, No. 2. Number of Machines per Operator—Two. Work-Holding Devices—Work held in vise with grooved jaws, Fig. 257. Tool-Holding Devices—Special arbor. Cutting Tools—Three side-cutting mills, Figs. 258 and 259, 6 in., 7 in., 4 in. Cut Data—60 r.p.m., 1/2-in. feed.

Coolant—Compound, 1/4-in. stream. Average Life of Tool Between Grindings—1,000 pieces. Gages—Length, Fig. 260. Production—30 per hr., one machine. Note—Receivers are handled in boxes of 20 each, a compartment being provided for each piece.

OPERATION 2. DRILLING WELL HOLE OR BORE

Transformation—Fig. 261. Machine Used—Pratt & Whitney, similar to gun-barrel drilling machine. Number of Machines per Operator—14. Work-Holding Devices—Special fixture, closed, Fig. 262, and open, Fig. 263. Tool-Holding Devices—Tool or drill held in carriage by setscrew. Cutting Tools—Barrel drill, size 0.695, Fig. 264. Number of Cuts—One. Cut Data—Receiver runs 1,500 r.p.m.; feed, 1/8 in. per min. Coolant—Triumph cutting oil, under pressure from small pump on lathe. Production—25 min. per machine.

OPERATION 3. REAMING WELL

Transformation—Same as Fig. 261. Machine Used—Ames Manufacturing Co. reaming machine. Number of Operators per Machine—One. Work-Holding Devices—Work held on block by screw clamp, Fig. 265. Tool-Holding Devices—Reamer held in collet by setscrew. Cutting Tools—Reamer and facing tool, Fig. 266. Number of Cuts—One. Cut Data—70 r.p.m.; feed, 10 in. per min. Coolant—Triumph cutting oil, 1/4-in. stream. Average Life of Tool Between Grindings—100 pieces. Gages—Plug, Fig. 267. Production—30 per hr.

OPERATION 4 COUNTERBORING WELL IN DRILL PRESS

Transformation—Fig. 268. Machine Used—Ames Manufacturing Co. vertical machine. Number of Operators per Machine—One. Work-Holding Devices—Work held in stand fixture by straps, Fig. 269. Tool-Holding Devices—Taper shank in spindle. Cutting Tools—1-in. counterbore with pilot, running $1\frac{1}{2}$ in. deep, Fig. 270. Number of Cuts—One. Cut Data—120 r.p.m.; feed, $\frac{5}{16}$ in.; weight feed. Coolant—Cutting oil, $\frac{1}{4}$ -in. stream. Average Life of Tool Between Grindings—300 pieces. Gages—Plug, Fig. 271. Production—35 per hr.

OPERATION 5. REAMING WELL HOLE TO FINISH

Transformation—Same as Fig. 261. Machine Used—Ames Manufacturing Co. reaming machine. Number of Machines per Operator—Two. Work-Holding Devices—Same as Fig. 265. Tool-Holding Devices—Reamer held in chuck by setscrew. Cutting Tools—1 "scrape" reamer, size 0.699 in., Fig. 272. Cut Data—70 r.p.m.; feed, 10 in. Coolant—Cutting oil, $\frac{1}{4}$ -in. stream. Average Life of Tool Between Grindings—1,000 pieces. Gages—Plug, Fig. 273. Production—40 per hr. for two machines.

OPERATION 7. HOLLOW MILLING FRONT END

Transformation—Fig. 274. Machine Used—Upright drilling machine made in arsenal; 18 in. Number of Operators per Machine—One. Work-Holding Devices—Work held in stand fixture, same as Figs. 249 and 269. Tool-Holding Devices—Hollow mill, taper shank. Cutting Tools—Hollow mill, 144 with pilot, Fig. 275; oil feeds into cup A at top of mill and runs down to cutting edge. Number of Cuts—One. Cut Data—Speed, 75 r.p.m.; hand feed. Coolant—Cutting oil, $\frac{1}{4}$ -in. stream. Average Life of Tool Between Grindings—1,000 pieces. Gages—Depth, Fig. 276. Production—30 per hr.

OPERATION 7½. CLAMP MILLING TENON, FRONT END

Transformation—Fig. 277. Machine Used—Machine made in shops. Number of Operators per Machine—One. Work-Holding Devices—Work held on mandrel, using tang for turn-

ing, Fig. 278. Tool-Holding Devices—Tool held in block, set-screw on side and top. Cutting Tools—Special forming shaving cutter, Fig. 279. Number of Cuts—One. Cut Data—Speed, 70 r.p.m.; hand feed. Coolant—Cutting oil, $\frac{1}{4}$ -in. stream. Average Life of Tool Between Grindings—2,000 to 3,000 pieces.

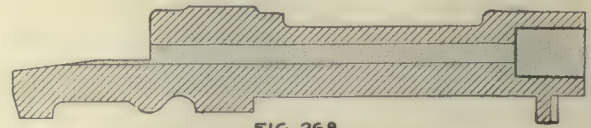


FIG. 268

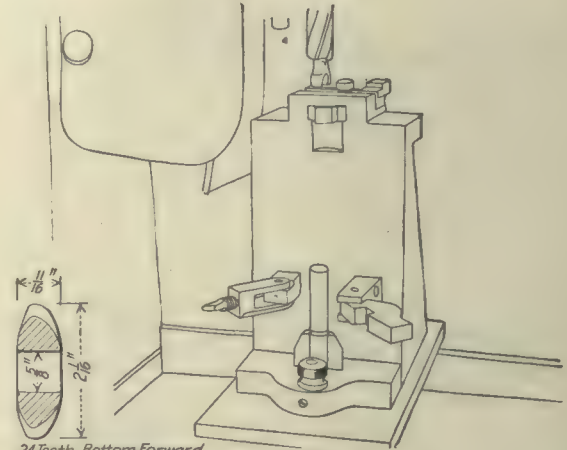


FIG. 269

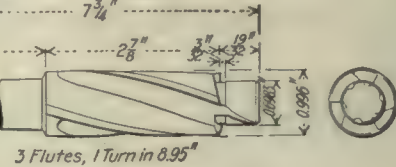


FIG. 270

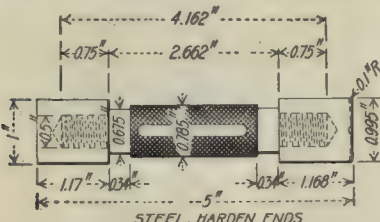


FIG. 271

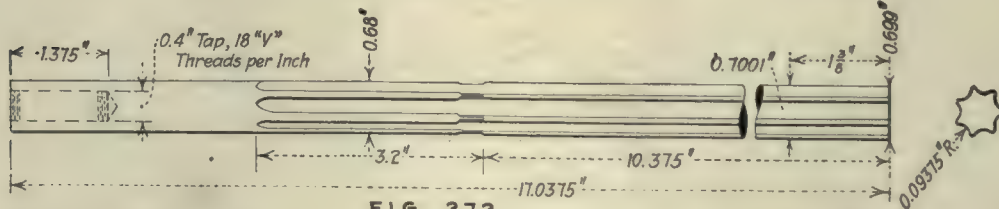


FIG. 272

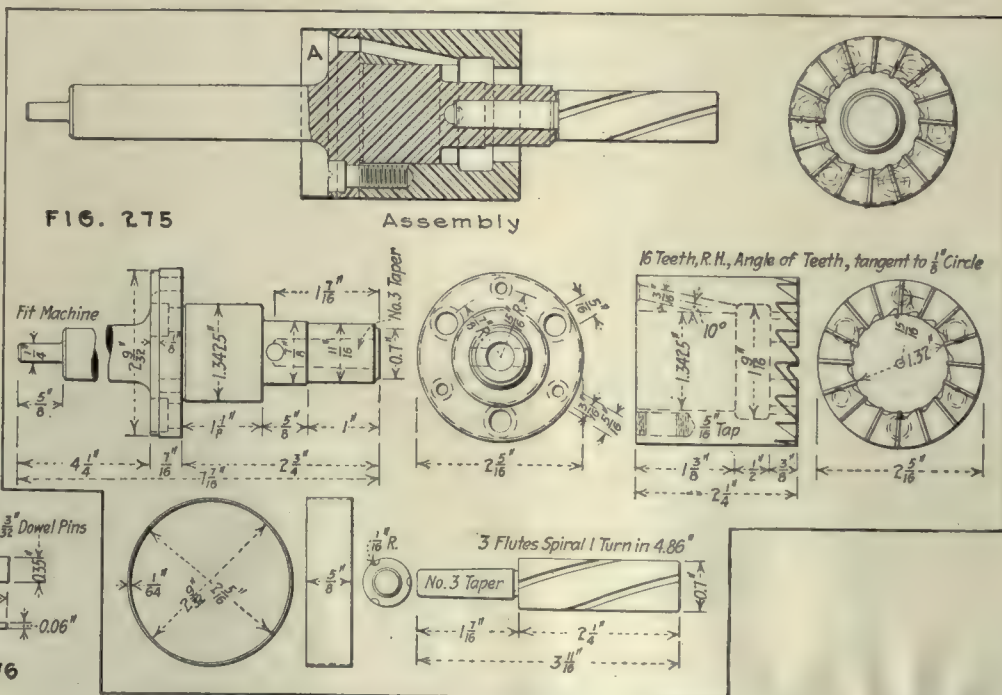


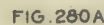
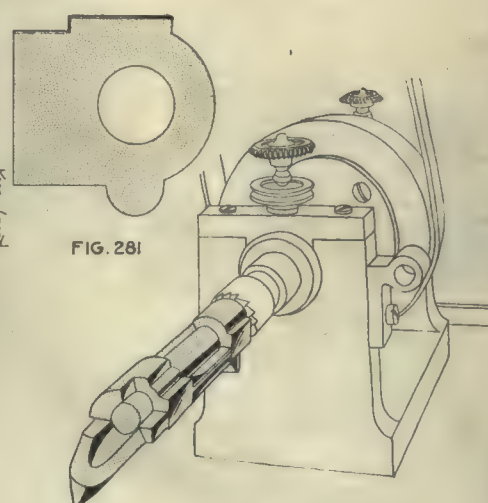
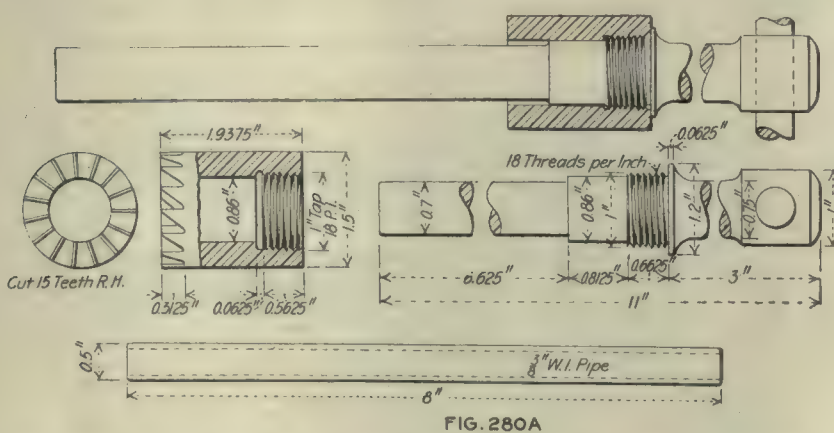
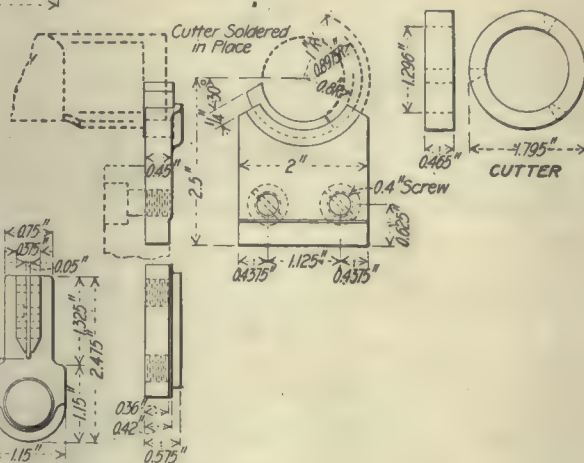
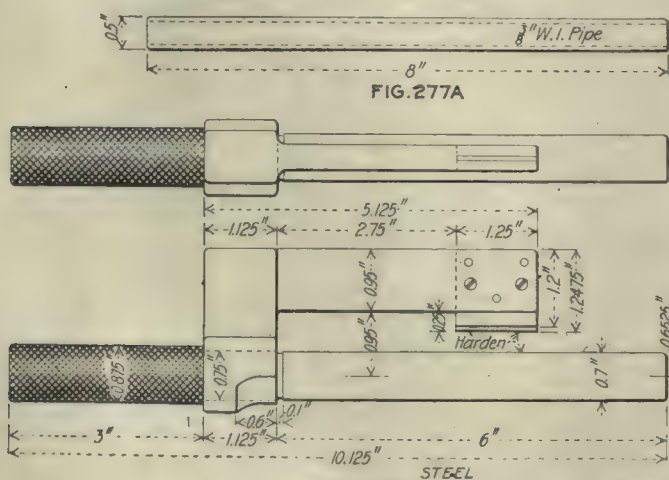
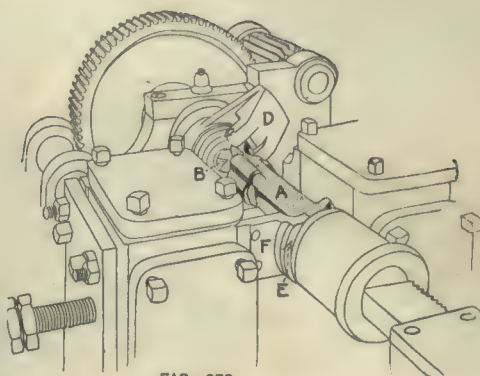
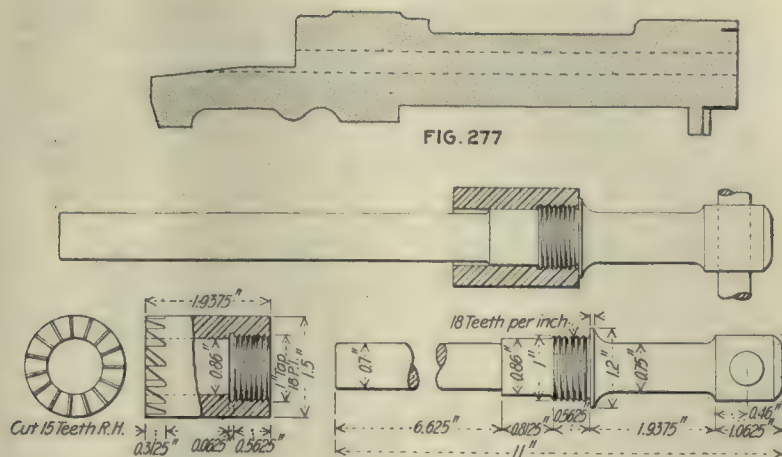
FIG. 275

Assembly

FIG. 273

FIG. 276

FIG. 274



Gages—Snap, size 1.305, Fig. 280. Production—30 per hr. Note—The hole forms the working point until after operation 9, then becomes a holding point, working points being transferred to sides and bottom.

OPERATION 7¾. FACE MILLING FRONT END

Machine Used—Machine built in shops. Number of Operators per Machine—One. Work—Holding Devices—Work held in hands, Fig. 280-A. Tool—Holding Devices—Taper shank for driving face mill. Cutting Tools—Cutter, taper shank; end mill with pilot, 1½ in. in diameter. Number of Cuts—One. Cut Data—Speed, 100 r.p.m. Coolant—Cutting oil put on with brush. Average Life of Tool Between Grindings—15,000 to 20,000 pieces. Gages—None. Production—175 per hr. Note—This simply burrs end after No. 7½ cut.

OPERATION 9. MILLING RIGHT SIDE, ROUGH

Transformation—Fig. 281. Machine Used—Pratt & Whitney Lincoln type, Fig. 282. Number of Operators per Machine—One. Work-Holding Devices—Work clamped to block, using mandrel as a working point. Tool-Holding Devices—Cutters held on arbor. Cutting Tools—Milling cutters, Fig. 283. Cut Data—Speed, 50 r.p.m.; $\frac{3}{4}$ -in. feed. Coolant—Compound. Average Life of Tool Between Grindings—2,000 pieces. Gages—Stand, Fig. 284; A, height; B, width of right side; C, mandrel that holds receiver in D to gage side and bottom. Production—20 per hr. Note—In this and many work-holding fixtures that follow, the mandrel in the receiver is located on adjustable stops A, the work clamped by jaws B, Fig. 282.

of the receiver on the right side remain flat until operation 74 makes clear many of the gaging operations which might otherwise be more or less confusing.

In following the description of the operations on the receiver, the reader will be aided by referring back to Fig. 252, which shows the principal cuts by number. This illustration, in connection with the "transformation diagram" given for each change of shape in the piece, should make clear what is being done.

OPERATION 8. MILLING RECEIVER BOTTOM, ROUGHING

Transformation—Fig. 285. Machine Used—Pratt & Whitney Lincoln type, belt drive. Number of Machines per Operator—Two. Work-Holding Devices—Work held in formed vise jaws, Fig. 286. Tool-Holding Devices—Cutters held on

288; A, profile and height of tang from bottom; B, height of bottom; C, top of well to bottom of tang; D, same as in previous operation. Production—20 per hr. per machine.

OPERATION 10. MILLING BOTTOM TO FINISH

Transformation—See Fig. 285. Machine Used—Pratt & Whitney Lincoln type belt-drive miller. Number of Operators per Machine—One. Work-Holding Devices—In vise with formed vise jaws (see Fig. 286). Tool-Holding Devices—Standard screw arbor. Cutting Tools—Gang of form cutters,

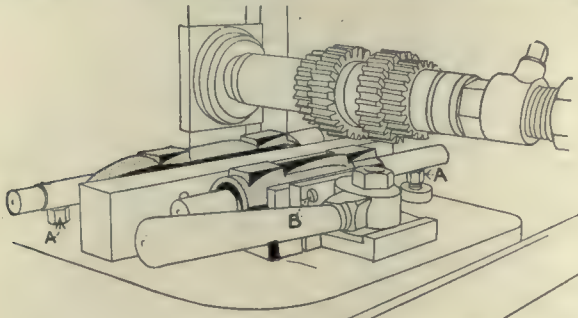


FIG. 282

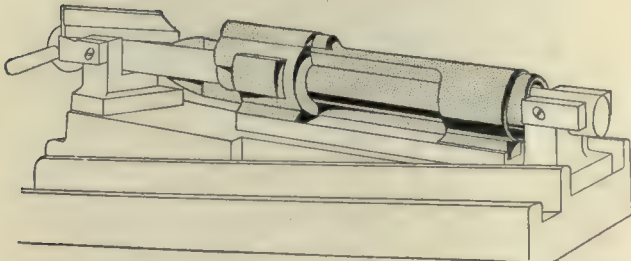


FIG. 284

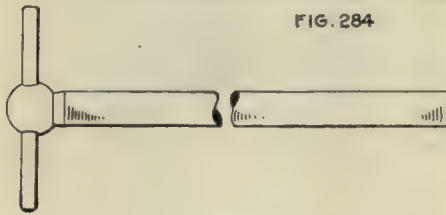


FIG. 284C

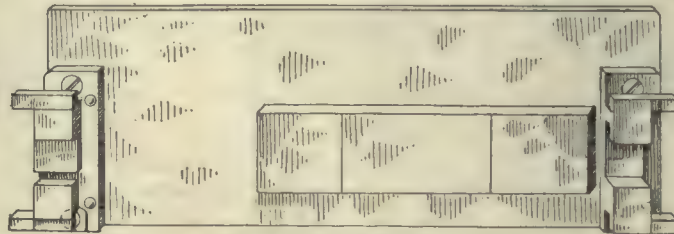


FIG. 284D

FIG. 284B



FIG. 285

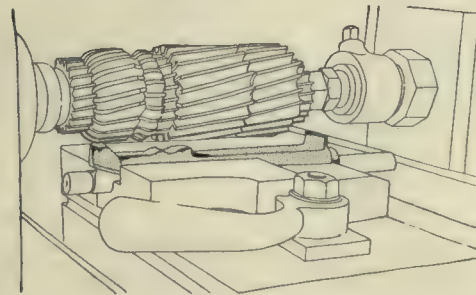


FIG. 286

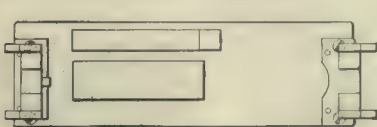


FIG. 288D

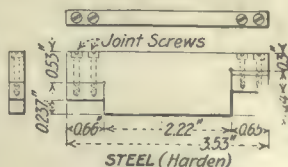
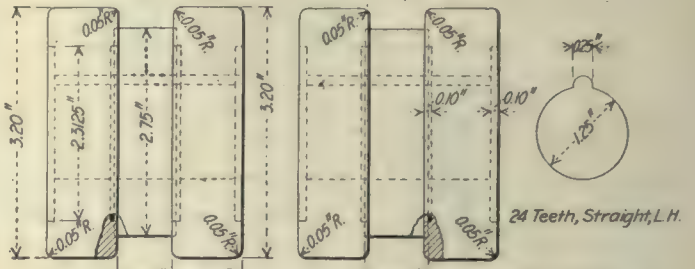
FIG. 288B
OPERATION 8

FIG. 283

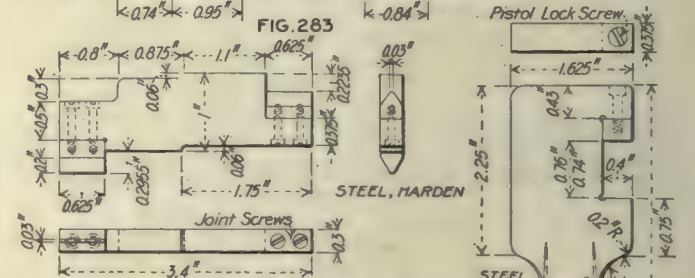


FIG. 284A

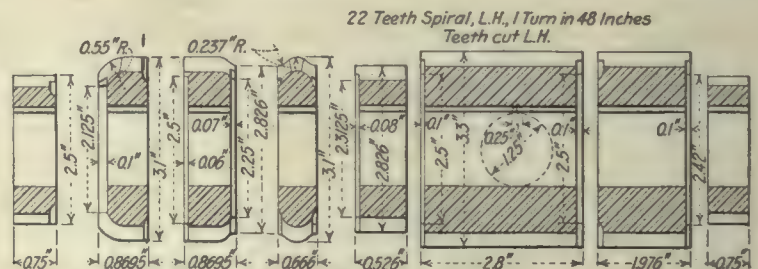


FIG. 287

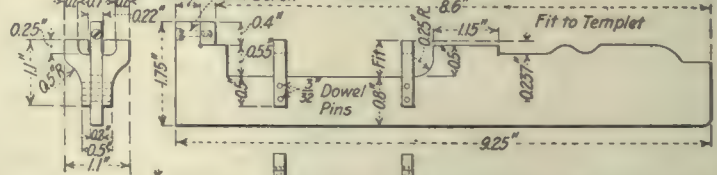


FIG. 288A

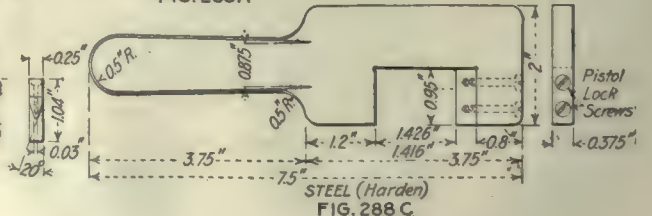
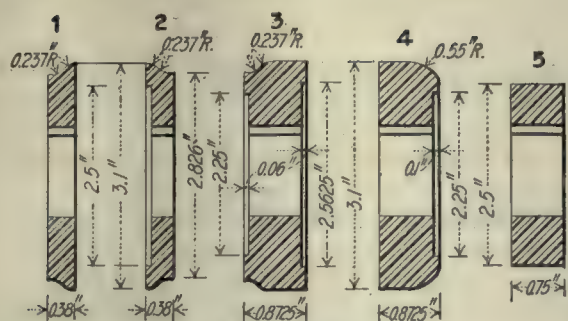


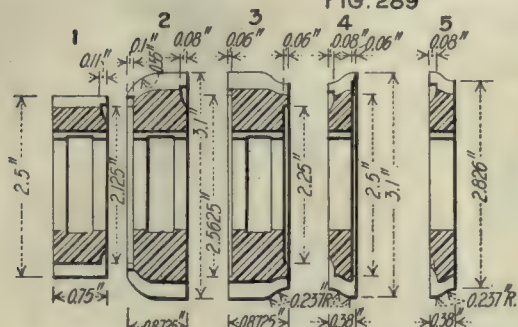
FIG. 288C

arbor. Cutting Tools—Gang-mill form cutters, Fig. 287. Number of Cuts—One. Cut Data—Speed, 50 r.p.m.; feed, 1/2 in. per min. Coolant—Compound, three 1/4-in. streams. Average Life of Tool Between Grindings—2,000 pieces. Gages—Fig.

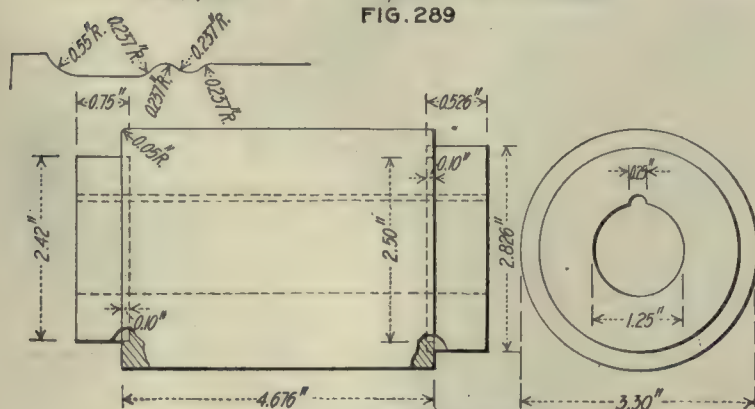
Fig. 289. Number of Cuts—One. Cut Data—50 r.p.m.; 1/2-in. feed per minute. Coolant—Cutting oil, drop at a time. Average Life of Tool Between Grindings—2,000 pieces. Gages—Form, Fig. 290. Production—20 pieces per hr.



Fit to Model
Mills 1 & 2 Cut 28 Teeth, Straight, L.H.
Mills 3, 4 & 5 " " " , Spiral, 1 Turn in 48 Inches, R.H. Teeth, L.H.



Fit to Gage
Mills 4 & 5 Cut 28 Teeth L.H. Straight
Mills 1, 2 & 3 " " " " " Spiral R.H. 1 Turn in 48 Inches



Fit to Model
28 Teeth, Spiral, 1 Turn in 48 Inches, L.H. Teeth Cut L.H.

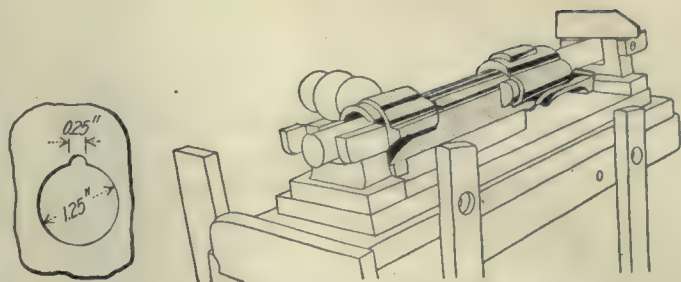


FIG. 290

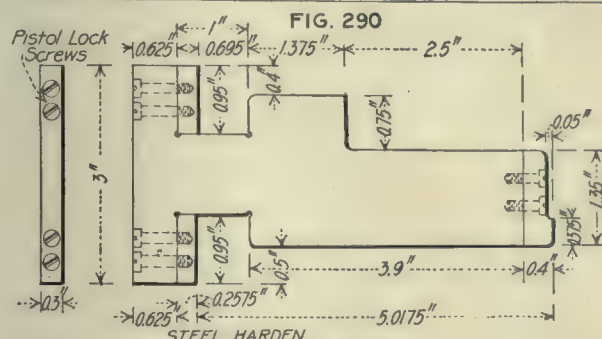
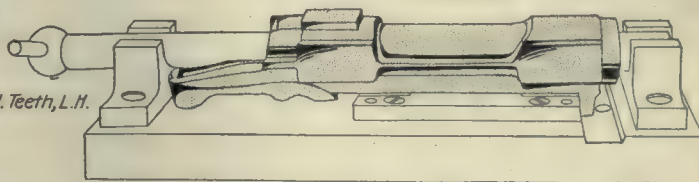


FIG. 290A



FIG. 290 B

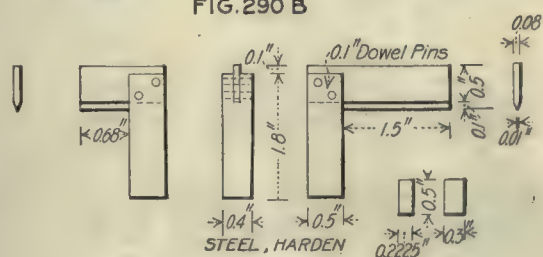


FIG. 290C

The Specialist

BY F. B. JACOBS

The all-round machinist who learned the trade some 25 or more years ago is inclined to look with contempt upon the operator of a machine as a sort of unfinished mechanic whose knowledge of the craft does not amount to much. There are two sides to the question, however, and from my personal observation in many hundred up-to-date shops I am inclined to believe that there are many logical factors in favor of the man who becomes a specialist.

The modern manufacturing plant—the automobile factory, for example—is conducted on far more efficient lines than the average machine shop of my younger days, and this efficiency is due mainly to the fact that we are teaching men to do one thing at a time and to do that one thing as economically as possible.

It does not take much of an efficiency expert to see where we wasted valuable time in manufacturing proc-

OPERATION 10

esses of other days. We used to cut gears on the miller, getting our spacing by means of the dividing head, wherein it was always possible to spoil a gear by making a slight mistake in spacing. We now use an automatic gear-hobbing or generating machine. At one time we were content to make such parts as rings, collars, studs and other comparatively small turned parts on the engine lathe. Now we prefer the manufacturing automatic that practically runs itself. Again, the modern cylindrical grinder has replaced the lathe for finishing such parts as spindles, shafts, etc., while the high-powered surface grinder has superseded the shaper and miller for many plain finishing operations.

Anyone who considers this vast array of modern machine tools will readily admit that it would be a waste of time to employ all-round machinists to operate them, because all-round men are of more value on other kinds of work—repair and experimental work, for instance. Thus the operator has been the natural outcome. Again, operators are easier to train. It takes about eight years of

close application and study, to say nothing of extensive traveling in different localities, to make an all-round machinist, whereas an operator for a specific machine can be trained in a year, often in one shop.

Another factor in favor of becoming an operator is that this class of help makes high wages, from \$30 to \$50 per week being a common occurrence in automobile factories. Perhaps there are all-round machinists who are equally paid, but as yet I have failed to meet any. Why these specialists are able to turn a few months' or possibly two years' training to so good an account is a difficult question to answer. They have no union back of them; indeed they make better money than the union machinist speculates on in his wildest dreams. Perhaps it is because they work under premium and bonus systems, factors that the strict union man will not sanction. While on the subject of high wages for specialists I recall an incident that happened in a large automobile factory in the Middle West about a year ago. Most of the help was on piecework, and the management was confronted with the problem of getting extra production and getting it quick. After careful consideration among the various department heads the men were called together and instructed to make all they possibly could, with the solemn promise that their rates would not be cut. The firm got the extra production and for many months the operators made from \$50 to \$100 per week. Very few of us work because we like to; and if the young man of today can become proficient in a short time at a calling that nets comparatively high wages, it certainly looks logical to become a specialist. Running a manufacturing automatic, a cylindrical grinder, a high-powered engine lathe or a heavy-duty miller may not be the most noble calling in the world, but it certainly is highly paid—in the automobile industry at least. As the average man of today is out for money more than glory, we cannot blame him for choosing work that pays well. Clean hands, a white collar and a "soft job" are all very well in their way; but in the long run money talks, so perhaps the specialist is right after all.

A Double-Acting Punch and Die

By F. C. MASON

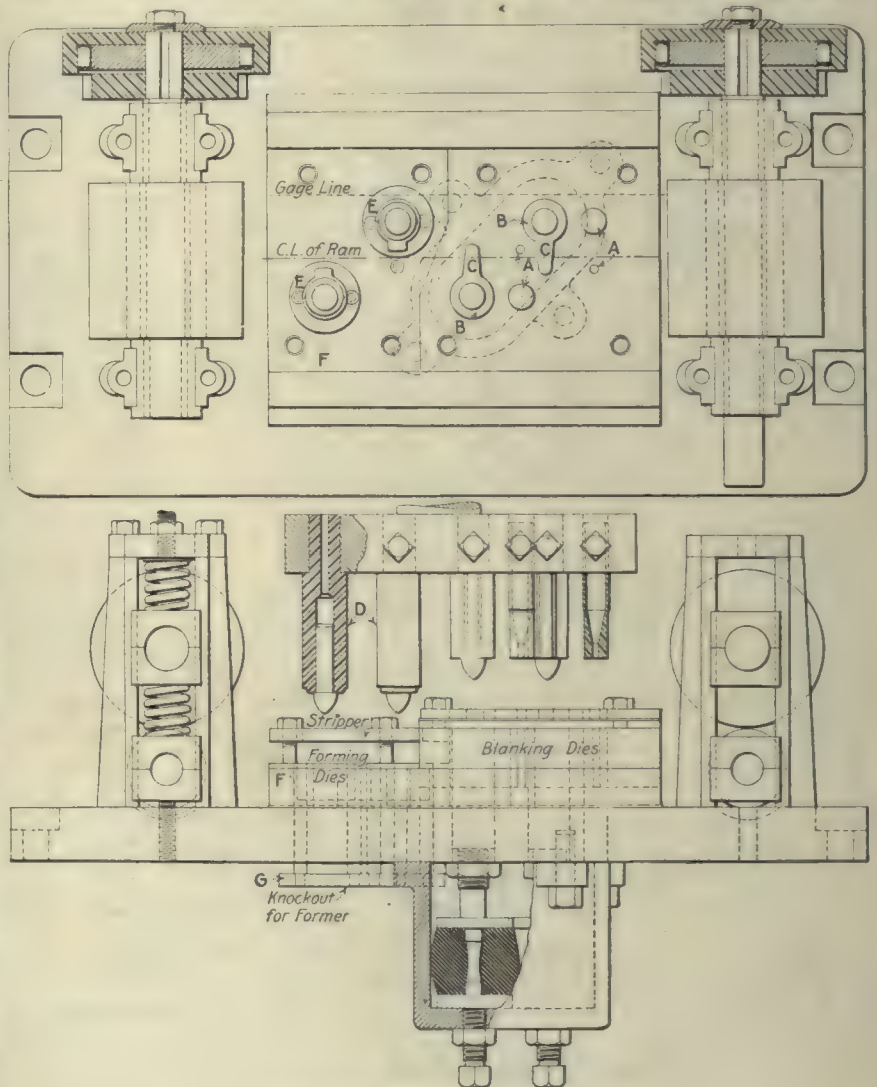
The dies shown illustrate a principle in die making which can be used to advantage in many instances. The principle is first to perforate and blank in the usual manner. The blank, instead of dropping through the blanking die, is then forced back into the stock that it was cut from, and the strip acts as a carrier for the next operation.

In the illustration is shown a top view of the die with the strippers off. *A* are the perforations, *B* is the

blanking die and *C* the knock-back into the strip. This knock-back is actuated by a simple form of rubber spring pad.

The blank is then carried along to the forming punches *D*, which push it from the strip down to the forming dies *E*, and the operation is completed. In the tool these dies are a slip fit in the die shoe and are actuated in an upward direction by the knockout *G*.

This knockout does not raise the dies over $\frac{1}{16}$ in. It is hit on the up stroke by an arm (not shown) which is con-



DOUBLE-ACTING PUNCH AND DIE

needed to the press ram, causing a good jar to be imparted. The press is worked inclined, and the finished pieces are readily discharged from the die by the upward jar. Where this type of die can be used in connection with a roll feed, the production is very rapid on small work such as shown, the press running as high as 240 r.p.m., cutting two at a time.

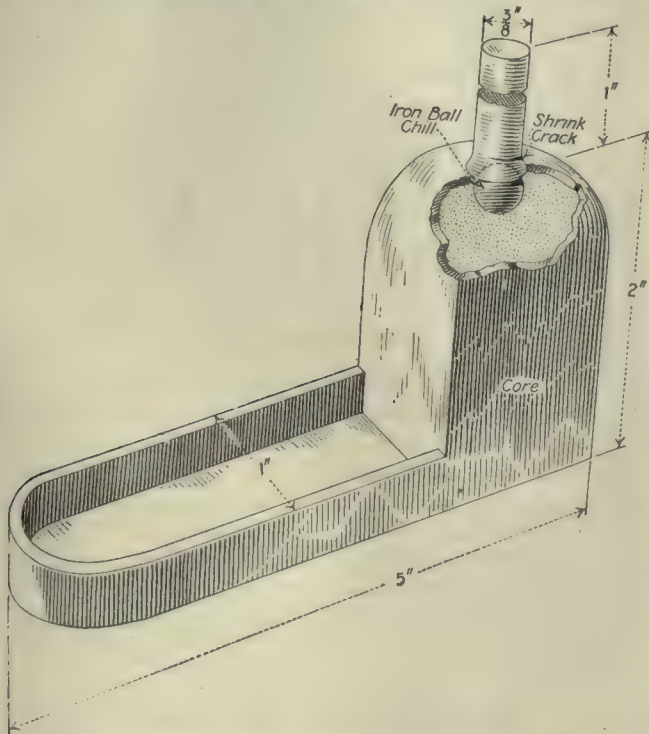
A Method of Protecting Iron by Enamelling is described in the "Foundry Journal," as follows: The metal is first pickled in hydrochloric acid to free it from foundry scale, then washed thoroughly and dried. The first coating applied is composed of 34 parts silica, 2 parts soda, and 15 parts borax, mixed in water. The metal thus coated is exposed for 10 to 15 min. in a dull-red-hot retort. A second coating is then applied, consisting of 34 parts feldspar, 19 silica, 24 borax, 16 oxide of tin, 4 fluorspar, 9 soda and 3 saltpeter. This mixture is first melted in a crucible, then ground to a fine paste in a little water and applied with a brush. The coated piece is then again subjected to white heat in a muffle.

Letters from Practical Men

Preventing Shrinkage Cracks

We had been bothered by the pin on the casting shrinking off or showing a shrink crack, which made the casting useless. We tried out several ways of gating the patterns to overcome the shrink, but without success.

I devised the scheme of making the core with a 1/2-in. iron ball on the top of the core, which acted as a chill



PREVENTING SHRINKAGE CRACKS

and prevented the pin from shrinking. This is accomplished without any additional expense in making the core. A small round depression was made in the bottom of the core box, which was concave; the ball readily dropped into place, and the core was made in the regular way.

A. E. HOLADAY.

Naugatuck, Conn.

Does a Piston Stop at Reversal?

Here is an interesting question about which a controversy has arisen in connection with recent litigation. Put into its simplest form the question is, Does the piston of a steam engine stop when its direction is reversed? This is assuming that there is no lost motion in the parts.

Strange as it may seem, engineers, attorneys and examiners in the Patent Office disagree on the question. I maintain that it does not stop, but that the motion is continuous, and I would be interested if some reader of the *American Machinist* can prove that I am wrong.

To stop means to produce a state of rest. In other words, then, if the piston stops it must rest. Then, how

long does it rest? The curve of a piston's motion, provided the connecting-rod were of infinite length, would be true harmonic. According to one authority, "A harmonic motion may be defined as the motion executed by the foot of a perpendicular let fall on the diameter of a circle from a point moving with *uniform* velocity along the circumference."

It is unnecessary to reproduce here a harmonic curve, because it is one with which we are all familiar. We know that no portion of this curve contains any part of a straight line. Now if there were a rest at each end of the stroke, there would be two flat portions at each extreme of the travel, parallel with the base line. One flatly contradicts the other.

One man argued that there was a point where there would be no motion. What becomes of this argument when we know that a point has no magnitude?

Finally, if the piston stopped even for an infinitesimally small fraction of a second, would not the flywheel to which it is connected stop also?

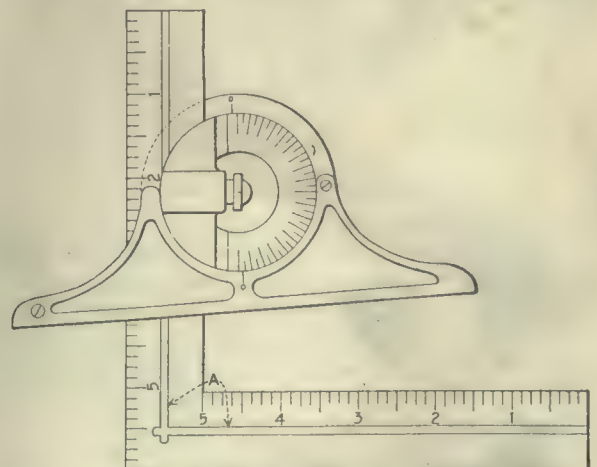
To controvert the theory that the flywheel stops, we find in the definition quoted that the point executing the harmonic motion must move with *uniform* velocity. How can the flywheel stop twice in one revolution and yet have any point in its circumference move with uniform velocity? The motion of the piston is just as continuous as that of the flywheel.

WILLIAM C. GLASS.

Woonsocket, R. I.

Acute-Angle Attachment for Protractor Head

The protractor head that comes with machinists' combination squares is accurate enough for a great deal of the angular work about the shop, but its usefulness is



THE PROTRACTOR ATTACHMENT

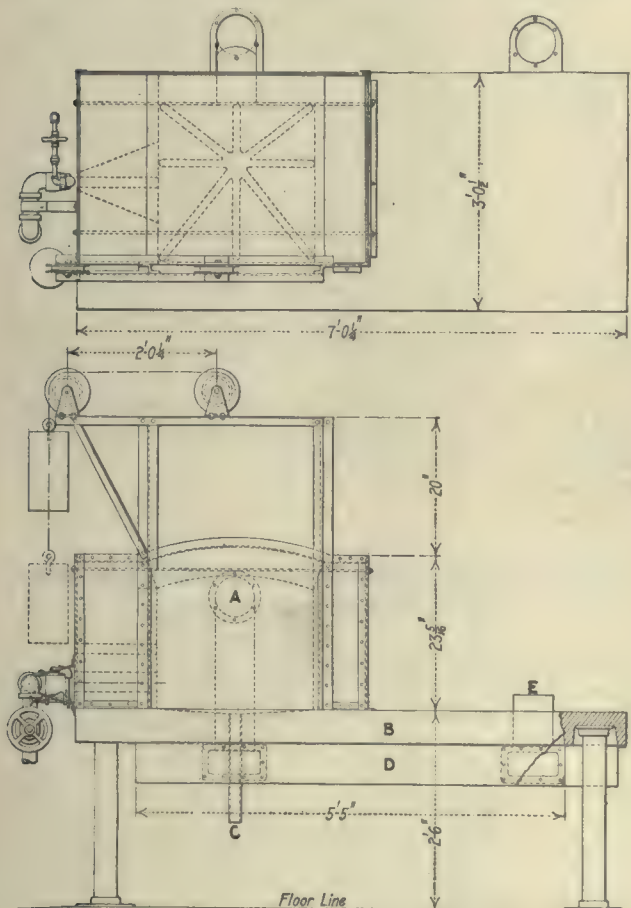
impaired by the fact that it is impossible to test angles of less than 20 deg. with it. To overcome this difficulty I have made an acute-angle attachment, as shown herewith. For this purpose I used the regular 6-in. thin steel

square. This square has graduations on both sides, is of the same width and thickness as the regular 12-in. scale and is soft, so it was an easy matter to mill the two grooves shown at A, which fit the clamp screw on the protractor head.

In addition to other uses that will readily suggest themselves to the reader, I find that this rig makes a handy gage for testing tapers when turning or grinding.
Greenfield, Mass. H. M. DARLING.

Special Furnace for Melting Babbitt Metal

The drawing shows a babbitting furnace which is used to heat and remove the babbitt lining on journal brasses worn to the point where they have to be rebabbitted.



BABBITTING FURNACE

A No. 6 Best oil burner is used for heating this furnace, and the bearings to be cleaned are placed in the furnace through the door in the front, which lifts up. Only a very short time is required to remove all the babbitt after the heat is turned on. As the babbitt melts it runs out at the pipe C, where it is collected in a receptacle on the floor beneath the furnace.

The hot gases from the furnace find their way out through the pipe A, along the galvanized chamber D, under the supporting table B to an outlet pipe E. These gases heat the table and keep the bearings placed on it at a temperature high enough to allow the metal to flow freely when the bearings are rebabbitted.

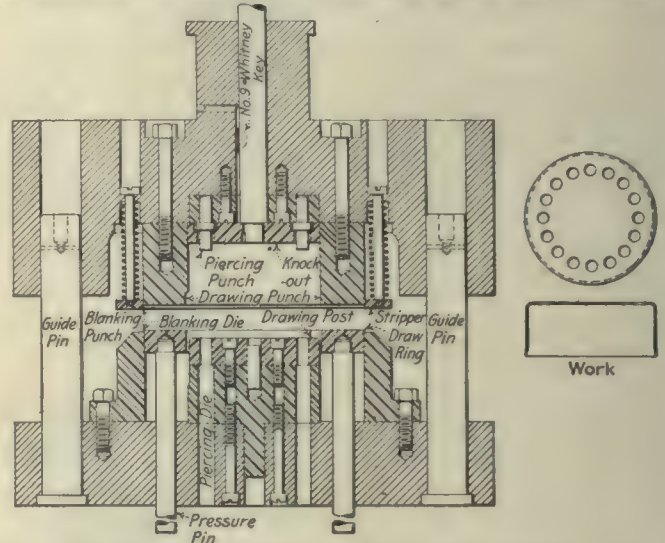
New Haven, Conn.

G. E. BALDWIN.

Combination Follow Die

The illustration is of a combination blanking, drawing, forming and piercing die used in a single-action press for punching muffler cups in automobile construction.

When the blanking punch descends, it enters the blanking die. The blank is held firmly by the drawing ring against the bottom of the blanking punch and prevents



BLANKING, DRAWING, FORMING AND PIERCING DIE

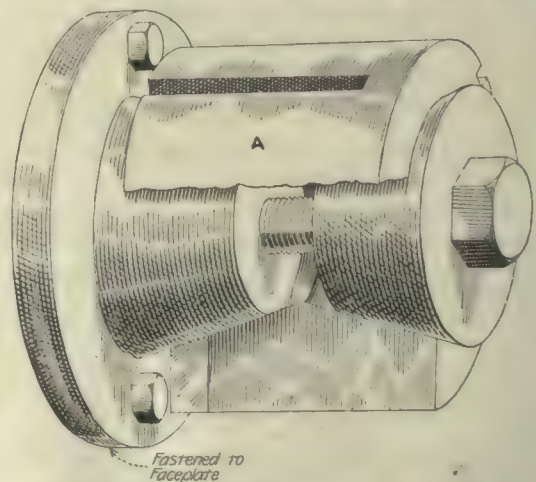
wrinkling. As the downward movement continues, the blank is drawn between the bore of the blanking punch and the drawing punch. As it reaches the end of the stroke, the rim is formed between the shoulder in the blanking punch and the tapered shoulder on the drawing punch. The holes are pierced by punches located in the punch block and the dies in the die block. A spring stripper is used. The knock-out is kept in line with the piercing punches by a Whitney key.

Norfolk Downs, Mass.

W. L. JONES.

Expanding Mandrel

A quick-acting mandrel that proved to be very successful for time saving and good grip is here illustrated. In the center of the faceplate is fastened a conical casting



DOUBLE-CONE EXPANDING MANDREL

with a tight-fitting bolt and conical washer, as shown. The mandrel proper consists of a sleeve A and is placed between the two cones, as illustrated.

M. CARRY.

Chester Park, L. I.

Discussion of Previous Question

Making the British Time Fuse Mark 80-44

Several errors appear in Mr. Colvin's description of the operation of the No. 80 fuse on page 367, and I am writing this article to correct the mistakes noticed.

The composition powder is made to burn slowly, but if it burns too slowly its regularity is impaired. Therefore, when it is necessary for a fuse to burn for a long time, the length of the composition must be increased. Accordingly, two time rings are placed one above the other (rings *B* and *C*, Fig. 2, page 368).

Connection between the two rings is established by means of a powder pellet *P'*. Similar pellets connect the end of ring *B* with the flash powders *F'* and *G'*. When the fuse is being assembled, a cloth washer is shellacked to the face of the body *A* and another to the upper side of the ring *B*. A small hole in each washer leaves the powder pellets exposed.

If the composition were ignited and the gas confined, it would detonate instead of burn. To prevent this, holes

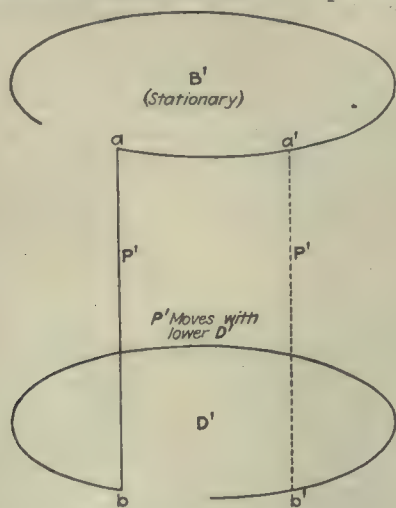


DIAGRAM OF POWDER-TRAIN COMBUSTION

drilled into the composition channels in the two rings lead into escape holes in the sides of the rings, which are filled with waterproof composition and covered with the disks *V*, Fig. 1, page 367. These disks are blown out when the composition is ignited, allowing the gases to escape. The shock of discharge bends up the wings of the stirrup spring *J* and forces the time pellet *F'* down onto the steel needle *P*, the sharp point of which pierces the detonating pellet *K* and explodes it. The flash passes down the chamber *A'* and ignites the mealed powder, which in turn lights the time composition in the ring *C*.

An idea of how the time of burning is regulated can be formed from the illustration here shown, which represents the two composition rings *B'* and *D'* and the powder pellet *P'*. When the lower ring *D'* is in the position *ab*, the flash from the detonating pellet *K* passes straight down through the pellet *P'* and into the powder *G'*. If, however, the lower ring is rotated to the position *a'b'*,

the composition will have to burn from *a* to *a'* down the pellet *P'* and back from *b'* to *b* before the charge *G'* can be ignited.

Regarding the percussion arrangement on the shock of discharge, the tube *R* is forced down over the stirrup spring *S*. The lower detonating pellet *K* is then held back only by the resistance of the light spring *O*. If the time arrangement fails or if the projectile strikes anything while in flight, the shock or impact throws the pellet against the lower needle of *P*, thus sending a flash into the powder *G'*, which in turn ignites the explosive in the shell.

A. R. WHITTLE.

Quebec, Canada.

The Immigrant as an Asset

Favorable circumstances produced in me some clear, unprejudiced ideas, not only on the immigrant, but also on the attitude of the average American toward him. Therefore I was able to enjoy your admirable editorial on page 303 to the fullest extent. It not only gives the immigrant his due, but it also points out shortly and clearly the ways to be followed to cover the shortcomings of the new arrival. I wish to enlarge upon your remarks and recall attention to them. Secondly, I am convinced that the greater part of your readers are not able to appreciate in full the ideals you expressed, because the immigrant and "the why" he is here are misunderstood by the American masses.

If the average American had a clearer insight into why people from the other side come here, he would not be so overbearing; he certainly would not tease, look down upon and often shamelessly underpay the "greenhorn." He would not insist upon harsher entrance rules; he would join the editor of the *American Machinist* and other broad-minded men in clamoring for more night schools to teach English and to give instruction in the history and ideals of this great country. The good will thus shown would be the finest example of beautiful Americanism, and it might cause the immigrant to be less suspicious. It even might make him (I said him, not you) willing to assimilate.

The last sentence may seem strange to you, but is it not stranger to hear that most immigrants look down upon the American co-worker? The childish way in which the latter treats the foreigner, who lacks mentally nothing but a second language, forces the immigrant to regard the American as not altogether up to standard. The underestimation of the immigrant is mainly caused by the distorted ideas Americans have concerning living conditions in various European countries. These conceptions are based on out-of-time tales and on ridiculous women-labor stories, which as a rule are "substantiated" by photographs. Living conditions in several European countries are by far better than in America, and labor laws and sanitary conditions here are backward indeed, compared with those of most white men's countries. This can be proved by figures and facts.

To understand the immigrant the American must get rid of the idea that it was hunger that drove him across. The actual, main reasons for immigration are *wanderlust*, compulsory military service and above all the existing class distinction, unbearable to any freeborn man. That is why the immigrants are the best, the most courageous, the most advanced of the "class" they come from. My statement is backed by the many admirable qualities of the American. He is the immigrant's child. Above all, the immigrant couples are unselfish. They give up, knowingly, all that is dear to them; they offer their whole future to give the children a chance, as they invariably put it.

That is why I think that editorial on page 303 is great, and I hope that my writing will induce many to re-read it, to look at this (for America) great question in a new light, to help in whatever way possible.

Brooklyn, N. Y.

JAN SPAANDER.

Errors in Grinding Due to No Fault of the Operator

W. E. Wickstrom, on page 571, calls attention to a seldom considered fact in grinding that is worthy of amplification. He brings forward the truth that if the headstock and tailstock centers are out of alignment and the pieces are not of the same length or the center holes are not of a uniform depth, no successive piece will be a duplicate of the piece ground on the initial setting.

He cites an incident that came under his observation wherein trouble was caused in grinding small cylinders

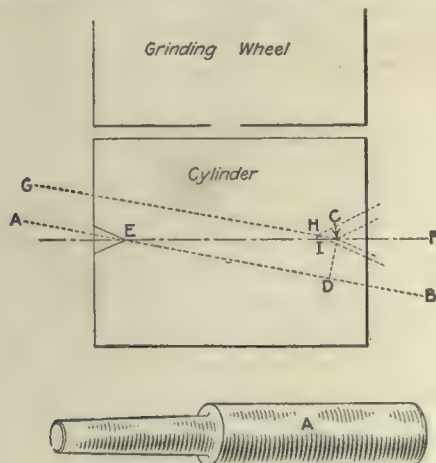


DIAGRAM OF CENTER ALIGNMENT AND TEST CENTER

that possessed unequal center holes. One of the center holes was as much as $\frac{1}{4}$ in. deeper than the preceding holes, and it is this abnormal center hole that I wish to take as an example to illustrate most forcibly the fact that the exact alignment of centers on a grinder is a thing that should have serious consideration.

Let us make a sketch to picture the truth of this. As shown, *AB* represents the true alignment of the centers, while *CD* shows the distance that the tailstock center is away from the true alignment. The line *EF* is the axis of the cylinder, and *GC* represents the constant line that the tailstock center would follow if it were moved, no matter how little. Let us presume that the center point *C* will be moved forward $\frac{1}{4}$ in. on a new cylinder to *H*. Now suppose that the tailstock center is out of align-

ment in a horizontal plane, toward the wheel, a distance of 0.010 in. and that the distance from *E* to *D* is 2 in.; then the angle *CED* would be 17 min. and, of course, the alternate interior angle *HCI* would likewise be 17 min. If the angle *HCI* is 17 min. and the distance from *C* to *H* is $\frac{1}{4}$ in., then the distance from *H* to *I* is 0.0012 in. This figure 0.0012 in. represents the distance the cylinder would be moved toward the wheel by advancing the tailstock center $\frac{1}{4}$ in. and, naturally, just double this amount would be removed from the diameter of the cylinder in grinding, or 0.0024 in.

If the cylinder were shorter, the error would be magnified. For instance, suppose the distance *ED* to be 1 in.; then the angle *HCI* would be 34 min. and the distance *HI* would be 0.0024 in. The amount removed from the diameter would therefore be 0.0048 in., which is considerable.

On short work the centers should be in absolute alignment, as even an error of 0.002 in. will give trouble. Care should be taken to prevent grit from accumulating under either the headstock or the footstock, and the bearing surface should be wiped clean frequently. The least irregularity on the upper bearing surfaces caused by a careless blow will throw the headstock or footstock out of alignment, and every grinder operator should have this knowledge impressed upon him.

Below at *A* is shown a special center for determining whether or not the headstocks and footstocks are in alignment. One of these test centers should be placed in the headstock spindle and the other in the tailstock. Then they should be carefully brought together until they just touch. It is possible to micrometer them where they come together, or to test them with an indicator fastened to the stationary wheel or wheel spindle.

The part *A* should project from the center at least 4 in., and the diameter on both test centers should be identical.

ROBERT J. SPENCE.

Worcester, Mass.

What Is a Gage, a Die, a Jig, a Tool, a Fixture?

As suggested in the editorial on page 479 of the *American Machinist*, it may be interesting to try to define a gage, a die, a jig, a tool and a fixture. Almost anyone with any machine-shop experience could place in its proper class any of the above articles, but to give a "cut-and-dried" definition is a different proposition.

Almost any measuring device can be correctly called a gage, but I should think that only those devices with a fixed dimension, intended to measure only one diameter, one length, one contour, etc., should be called a gage. Therefore I will suggest the following definition: A gage is a simplified measuring device intended for a single purpose.

Under the heading of dies there are several different kinds, such as piercing, bending, blanking, etc., which are used on power presses. There are also threading dies. I would suggest that the definition of a die be under two separate heads, as follows: (a) A die is any tool used on a power press, whether it be for forming, piercing or bending; (b) a die is a tool used for cutting threads.

Jigs and fixtures, although they are widely used machine-shop devices, have been the subject for much dis-

cussion. The following definitions explain my view of the subject: A jig is a mechanical device for holding duplicate parts in the proper position to be machined and has hard-steel bushings or guides for the tools; a fixture is a mechanical device for holding duplicate parts in the proper position to be machined, but it has no guides for the tools.

There are drills, taps, reamers, lathe tools, milling cutters, etc., and all of these may be properly classed as tools; hence a definition which I think covers the whole field is as follows: A tool is that mechanical device which comes in actual contact with the work, whether to cut, form or bend.

I am merely suggesting the above definitions and arguments and would like to hear the views of some of the other readers on the same subject. W. E. SHARKEY.

Middletown, Ohio.

[It is unfortunate that "die" should be the term used for such directly opposite tools as noted at (a) and (b). Also, jigs are often made on which no bushings are used, either of steel or any other metal, the guiding medium being a hole machined in the jig body.—Editor.]



The Metric System

My attention has been called to some articles and communications that have appeared in the *American Machinist* during the last few months, all bearing on the "metric agitation."

The subject is a very interesting one. The views so far expressed clearly indicate to me the limited viewpoints of some of the writers, who from their personal experiences in their own especial fields argue from the particular to the whole. I take it that these writers are sincere in their beliefs, that they argue for the good of the whole in spite of the fact that the universal adoption or rejection of the metric system would particularly benefit their individual cases.

I have also noticed, and this is what has prompted my letter, an article by Joel Tessitore in the issue bearing date of Aug. 10, 1916. This article is indorsed by C. W. Spicer under date of Aug. 31, 1916. I quote from the first-mentioned article: "I have noticed with disgust the comments on the metric system . . . Surely I hardly expect anything else from English speaking people, who have a limited knowledge of or are in total ignorance regarding the metric system."

The fact that Mr. Tessitore is "disgusted" and therefore probably impatient does not add to, but detracts from, his argument. The same may be said for his contempt of English speaking people and the ignorance he attributes to them. This is surely not the line along which this question should be argued; rather it must be judged from a broad point of view eliminating the partisan standpoint.

While I speak English, I hasten to add, lest a charge of ignorance be laid against me, that I also speak a few other languages, and my acquaintance with both the metric and the English systems can be judged by the following experiences I have had with them: I was brought up and educated abroad as a mechanical engineer under the metric system. Its use was thoroughly drilled into me by my shop experience while working as a machinist. I then came to the United States, where during 11 years I had a good chance to study and was

compelled to use the English system. I then returned abroad, where for nearly four years as chief engineer I was in charge of a well-known concern, not only guiding the designing and general work of a large engineering force, but also being responsible for and in direct control of the execution of all work in a shop employing 700 to 800 men. Here, needless to say, the metric system only was in use, because the business done did not extend beyond the seas. My experience here brought me into close touch with all the continental countries, including Russia, but to the exclusion of the Scandinavian countries and England. I then returned to the United States and to the use of the English system.

During the 30 years of very active work in the engineering profession, which covered an endless variety of subjects from small automatic machinery, machine tools, special machines—both very small and very large—for many purposes up to complete factory installations, I twice acquainted myself with the metric system and twice with the English system. I crave indulgence for the above lengthy recital of my experiences, which is only given as a basis for my belief that I am fairly well acquainted with both systems.

Nobody who looks in an impartial way at the merits claimed for the two systems can call either perfect. They both have merit, and the question is, Which has the greater merit? But, again, shall this question be answered by the scientist or the professor—the man who uses either system, so to speak, only in the abstract in his figures and calculations—or shall we hunt for our answer among the men who actually use the system and produce the millions of articles and things of our commerce?

I am for the basic standard of the inch. Well do I remember the difficulties I had in accustoming myself to the English system. Gradually and imperceptibly the handiness of this system took possession of me, and soon it seemed most natural. The reason why this should be so was forcibly impressed on me a few years later. On one of my trips abroad I sold to one of the largest and best-known machine-tool builders in Berlin an American universal grinder. The following year I visited this concern again, and imagine my surprise when the head of this firm invited me to the warehouse, where he showed me with every evidence of pride a row of 20 or 24 machines, true Chinese copies of the machine I had sold him the year before. Now these machines were built to the metric system, that being the only one in use at that shop.

Again, about 18 months later, I had occasion to study one of these machines, which stood in a shop in Switzerland alongside of an original American machine of the same size, which I had sold on the previous trip. In spite of all that has been said of "German efficiency," and I suppose this was a good example of it, I can only say that the American built machine really was a "grinding" machine, with all that this implies, while the German built machine was hardly more than a "roughing" machine.

At the time that I examined these two machines I was located in Europe, as stated above, in charge of a fair-sized shop. This shop had a reputation for accuracy, and I was supposed to maintain and extend it. Oh, yes, the engineering department did its share in giving dimensions in tenths and hundredths of a millimeter,

and many were the drawings coming from the outside that were similarly expressed. The rub came in the shop, where the execution of such instructions was attempted. I reorganized and extended the toolroom; I improved conditions for producing gages and tools; I put on overalls and worked alongside of the best workmen I had picked from the shop for this toolroom work; I fought the tendency of the engineers to specify low limits. I did all that was in my power to bring this shop up to the American standard for interchangeable work. I did fairly well, but the handicap imposed by the metric system was ever present.

At one time we built 200 silk-combing machines, each measuring over all about 18 in. wide, 24 in. long and 12 in. high, machines requiring the accuracy insisted on in the best grade of American sewing machines. With the best intention, while designing the machines, of so selecting the main dimensions as to avoid fractions, we soon landed into tenths and hundredths of millimeters. Then, with the addition of permissible limits, we arrived at decimal figures that were the despair of the men in the shop, due to the fact that the main dimensions were not as a rule divisible by two, four or eight.

I think I am safe in saying that to divide the limit of accuracy by two nearly doubles the cost of the part. This again means that certain limits are commercial (because they are easily attainable) while others are not. The result in the shop was that with the best intention the accuracy was indifferent and the interchangeability of parts suffered.

Another curious condition existing where small dimensions are used as units, such as the millimeter, is the fact that its subdivisions are taken as a matter of course, irrespective of how small they are. As an illustration may be mentioned the coinage of 0.01 franc, which is equal to $\frac{1}{50}$ c. To the scientist 1 mm. is as definite a dimension as 0.01 mm. The machinist who is told to lay out a hole of 75 mm. sets his calipers to $3\frac{1}{2}$ mm. and introduces an error, while his fellow workman who lays out a hole of 3 in. sets his calipers at $1\frac{1}{2}$ in. and avoids the error. I was once asked to produce a piece about 18 in. long with a 75-mm. hole through its length, ground true with 2-mm. taper. I asked the French artillery officer with whom I was discussing this matter to what accuracy he would want the piece. He calmly informed me that he would test it with a ray of light. Needless to say, I declined the job; still, 0.01 mm. evidently seemed big to him.

Such experiences and many others like it gradually made me realize thoroughly that the limits we work to in this country, be they one, two or more thousandths of one inch, are the practical, handy and logical dimensions of length for accurate and interchangeable work. The dimension 0.001 in. is a dimension to stick to and to swear by; 0.1 mm. is too large, 0.01 mm. is too small.

The system of interchangeable parts is distinctly an American production. It has given us advantages that other countries are trying to imitate. This is admitted even by advocates of the metric system in this country and has been admitted to me by engineers and manufacturers abroad. Nobody can deny that this work has been done upon the basis of the inch system. This is the important point I wish to bring home forcibly, backed up as it is by indisputable evidence of which my experience only forms a small part.

This system has been the key to our success, and we are asked to throw it overboard. One of the main reasons seems to be that by simply moving a decimal point in a row of figures we automatically change the name of the dimension represented by that figure.

This reminds me of another argument that was always considered unanswerable by the advocates of the metric system. Supposing, it was said, the standard yard kept at Greenwich is lost or destroyed, it cannot be reconstructed. Not so with the meter, because the meter is a definite subdivision of an existing unalterable dimension and can therefore always be reconstructed. Reference is here made to the French law of Nov. 2, 1801, legalizing the meter and defining it as the ten millionth part of the quadrant of the meridian, or the distance of the equator to the pole measured as along the surface of still water. Since then base lines have been measured again, and calculations have shown serious errors in previous computations. So this argument is not heard any more.

Its place has been taken by the argument of "foreign trade." Now, I have sold American machines abroad, and the best asset I had was my ability to speak the language of the country. I never lost a sale for the reason that the machines I sold were built on the English system. The machines took care of themselves, as I found out later when for the shops I mentioned above I bought and installed a number of American tools. We experienced no trouble in obtaining from them the proper output; on the contrary they were shining examples as to the accuracy of the work they turned out. I have never heard an advocate of the metric system suggest that a foreign country should adopt the English language in exchange for our adopting the metric system. When this is done, the foreign-trade argument will have some value.

Other reasons for maintaining the English system I will not dwell on. Most of them have been well presented by others, but one more observation I wish to permit myself.

In the last few years I have come in contact with scientists and professors, among them chemists and so-called chemical engineers. These men generally use dimensions and measures in the abstract only in their calculations and in the investigations of the many problems presented to them. Many of them have no conception of the mechanical limitations encountered in the development of their ideas into commercial propositions, and they therefore often become strong advocates of the metric system, which for their work has some advantages. It is only natural for them to think that what appears desirable from their point of view should benefit the whole structure of commercial activity, of which they have a very limited knowledge.

C. C. STUTZ.

Pittsburgh, Penn.

Under False Pretences

An imposter using the name of "Morris" has been falsely representing himself in this country as a representative of Charles Churchill & Co., London, England. His chief purpose has been to raise money under many of the guises to which such imposters usually resort. He judges his prospective victims and varies his story accordingly.

Forewarned is forearmed.

Economic War and the Machine-Building Industries

By LUDWIG W. SCHMIDT

SYNOPSIS—Statistics of the relative machine-building resources of the allies, central powers and neutrals. Industrial supremacy is conceded to the allies. The strength of an economic alliance is pointed out, and the belief expressed that after the return of peace the normal economic structure of Europe will be stronger than any alliance.

The decision of the allied nations of Europe to form an economic alliance, reached during the so-called Paris Conference, is of wider importance to the machinery trade of the world than is at present realized. Any doubts as to the seriousness of this intention have been removed by Italy, one of the parties to the conference, which abrogated her commercial agreement with Germany and followed this by a declaration of war. The possibility that a commercial war will follow the political war is therefore much increased. It is well known in this country that by far the largest part of the machines exported by European countries has been bought by the immediate neighbors of the selling nation. In fact the intercourse between the different markets has been so highly developed that several of the countries in question have relied almost entirely on the supply of such foreign machines the manufacture of which would have been unprofitable in their own country. This has been the case, for instance, with regard to certain machines used in the food industry in England. These machines are manufactured mostly in Germany, while English machines practically monopolize the German market.

According to the present state of affairs, we see in Europe united on the one side England, France, Russia, Italy, Belgium, Portugal, Roumania, Serbia and Montenegro. On the other Germany, Austria, Hungary, Turkey and Bulgaria. Also there are the neutrals—Norway, Sweden, Denmark, Holland, Spain, and as a doubtful quantity, Greece.

The neutral nations in Europe exert only a minor influence on the machinery market. Their position, however, is materially strengthened by having the United States in their midst, a machinery-producing country of the first class. Honors therefore would be divided fairly evenly.

With peace still far away, but with the possibility of decisive action in the economic field in the immediate future, it is not without interest to know what the machinery industry of Europe has at stake by venturing into an economic war; also to know what resources each of the countries has at its disposal, both for providing the machines used in its own industries and for building machines for the use of others.

INDUSTRIAL RESOURCES OF THE ALLIES—ENGLAND

The allies control larger and more powerful industrial resources than the Teutonic powers. Not only is the large industrial energy of England at their disposal, but when peace is restored France will regain her large iron districts in the northeast of the country. Belgium also

owns part of the richest industrial district of Europe. These three countries are successful producers of machinery. Italy possibly is of less importance, having until recently imported a large part of the machinery used in her own industries. Russia is in the same position, and Roumania, Serbia and Portugal are entirely dependent upon foreign sources.

The iron, steel and machinery producing industries of England before the war employed about 1,600,000 hands, mostly men. Since the war the percentage of female help has increased. Under normal conditions England needs approximately 600,000 hands to carry on the business of her heavy iron and steel industry, including the manufacture of armaments, steel plate and so on. The shipbuilding industry needs about 250,000 men, while 430,000 are employed in the general engineering trades, machine building, electrical machinery building, etc. The cycle and automobile industry employs about 60,000 men, while the tool-making and machine-tool industry gives employment to approximately 30,000 men. Changes in the composition of the various groups in consequence of the war are unavoidable. The shipbuilding industry most likely will come out of the war with a considerably larger force than it had before. It will continue to offer employment to a great number of workmen, owing to the necessary rebuilding of merchant shipping destroyed during the war.

The motor power used by the English industry at the beginning of the war reached about 2,800,000 hp., of which nearly 2,000,000 hp. was taken up by the iron and steel industries. Approximately 400,000 hp. was used by the engineering and allied trades, while 200,000 hp. was taken up by the shipbuilding yards. These figures are based on the last census, allowing for the natural increase of the industries, as also are the following, referring to the value of production and the cost of raw material. The \$900,000,000 spent by England for raw materials and partial manufactures in the year before the war will easily be doubled or trebled by present prices. The total value of the iron, steel and machine production of England has been estimated to be \$2,100,000,000. Allowing \$600,000,000 for wages, this would leave about the same amount for running expenses, amortization of capital and profit.

RESOURCES OF FRANCE AND RUSSIA

While in the case of England the recent census gives a fairly accurate basis for pre-war estimates of production, the value of raw materials and the number of workmen, figures for France are less reliable. France employed about 400,000 men, of which a large percentage were engaged in the minor metal industries. The industry in that part of the territory now occupied by German troops is a valuable asset to the French productive power, and \$500,000,000 as the pre-war value of the production of France is probably a fair estimate. Under these circumstances raw materials may have had a value of \$200,000,000. Russia is more or less an unknown quantity as regards her yearly production of machinery of all kinds and other material facts referring to the matter under

discussion. There is, however, one point with regard to Russia which is worth remembering: Russia during the last ten years has imported machinery of all sorts, approximately to a value of \$600,000,000 to \$700,000,000; a customer well worth having and a market that will play a considerable part in the rearrangement of the machinery trade of Europe after the war. This import in itself shows the fast growth of the engineering industries of Russia. In the group of powers formed at the Paris conference Russia will be the buyer of machines. She will have to rely on her present allies for supplies or she may have to turn again to Germany. The neutral producers of machinery, however, may be able to secure orders from Russia.

RESOURCES OF BELGIUM, PORTUGAL, ITALY AND ROUMANIA

Belgium, both in population and production, stands behind France. Belgium before the war had about 30,000 establishments engaged in the iron and engineering trades, employing 170,000 workmen. In the absence of more exact figures a total value of \$250,000,000 put on her yearly production is possibly a fair estimate.

Portugal is of small importance, producing for the home industry only and depending for practically all her machines on foreign markets. Italy also plays an unimportant part in the machine-producing resources of the allies. Her engineering and iron trades employed 120,000 men before the war. The country is seriously hampered by the lack of coal, which has to be imported from abroad. All Italy is able to produce under normal circumstances is possibly about \$150,000,000 worth of machines, raw materials and other metal goods.

Roumania, the leading Balkan nation on the side of the allies, is industrially well developed. Considering that the country is deriving most of its income from agriculture and the sale of agricultural products, the progress made in recent years is astonishing. When the war broke out 3,500 men were employed in railway repairing plants and like enterprises, and about 1,500 were engaged in the production of war material. Roumania is one of the few nations in Europe that have included in their census figures the number of establishments, the value of the capital employed and the worth of the machine equipment. A close estimate made from these figures shows that in the 80 establishments that fall under the heading Engineering Trades, there were employed about 8,500 workmen, while the capital value is \$7,400,000 and that of the machine equipment \$2,400,000. The pre-war production of Roumania can be covered by \$20,000,000, which was somewhat increased in the year 1915, owing to the fact that Roumania had to manufacture many articles which she formerly bought abroad.

The engineering industries of Serbia and Montenegro are confined only to repair shops for agricultural machinery and local industries, with the exception of the governmental plants for railway repair and arsenal work. Little value can be attached to it when reviewing the resources of the allied powers in their present struggle.

ECONOMIC ALLIANCE FIRST PROPOSED BY GERMANY

Whatever may have been the early intentions and aspirations of the economic experts of the allied nations, it is only fair to say that the idea of an economic alliance like that proposed in Paris was first expressed in Ger-

many. While it seems that priority of invention can be claimed by the central powers, there is no doubt that the allied powers have perfected the idea and seem to be the first to put it into working order. As our trade with Germany and her allies at present is interrupted, any problems arising for us out of the German combination most likely will be deferred until peace is restored.

The German iron, engineering and machinery industry is, in Europe at least, the strongest competitor of England. It is practically certain that this condition will continue after the war. Differences in the system of recording the census results make it practically impossible to say which of the two countries was stronger before the war. Workman for workman it seems that Germany has the larger productive power. But the fact that the greater population of Germany also necessitates a larger number of artisans, such as locksmiths, car builders, blacksmiths and others, suggests that the productive power of the industry in Germany per head of population possibly has been less than that of England.

This is also borne out by the fact that Germany employs less motive power than England. Germany before the war had approximately 220,000 establishments engaged in the industries in question. Many of these were one- or two-men establishments. About 250,000 men were employed in 400 plants in the heavy iron industry. The engineering trades, machine building and electrical engineering gave work to approximately 790,000 men in 19,000 establishments. The shipbuilding industry of Germany is naturally smaller than that of England, and in the 1,100 establishments of various sizes about 80,000 men found employment. As in the case of England, in Germany also their number will have increased largely. The German automobile and cycle industry at the beginning of the war had approximately 2,000 establishments with 44,000 men. The value of the production was about \$1,800,000,000, while wages were about \$600,000,000.

According to statistics and estimates, Austria employs in her machine-building industry about 160,000 men. These estimates and figures, based on the corresponding statistics in Hungary, would account for a production worth about \$150,000,000. Hungary has an iron and engineering trade that employed about 61,000 men before the war, with a wage roll of \$11,000,000 and a value of \$55,000,000 for production. Neither Turkey nor Bulgaria is a machinery producer of any importance.

INDUSTRIAL SUPREMACY OF ALLIES

Until now statistical and economic science has not discovered a satisfactory formula for carrying out such comparative economic measurements. A comparison of the figures given in the course of this article, however, does not leave much doubt that even when Germany and England measured against each other are fairly even, the total of the countries on the allied side gives these countries an industrial superiority. The future of Europe depends not alone on its industrial strength but also on its means of distribution. It is obvious that after the war great changes will take place in the industrial organization of all the countries concerned. A few of these changes have already been pointed out. Others will take place while the war lasts. England has added largely to her machine resources. France has possibly built up a new industry

(Continued on page 835)

Editorials

Which Should Be Done First?

A reader of the *American Machinist* writes as follows: "I claim that it is better to drill, bore or ream first, and mill or plane afterward. It has been the custom in some shops to do milling and planing first, and then follow by the boring operation. There is more chance of running out in the latter method than if the holes are pilot and line reamed, as the tendency is to force production in these days of high-speed steel. Of course, some parts actually have to be milled or planed first to get a locating surface, but how about machine parts where the order of the operations is optional? I should like very much to see discussion started on this subject in your journal."

This matter is of importance to tool designers and users, and we are glad to pass the request along and offer the opportunity to mix experiences. A hard and fast rule as to which should be done first—drill and bore, or mill and plane—cannot be set up. But it is possible that much machine-shop work can be classified, and for each class a statement formulated as to which in general is the better first operation.

The practice of different shops varies widely. In some you will find the jigs and fixtures designed to locate the rough casting or forging and at once drill or bore the principal holes. These are then reamed and serve as the locating surfaces for the following operations of planing and milling. In other shops you will find that the fashion is to work from a flat surface; that is, the first operations are planing or milling, then from the faces so produced the pieces are located in other tools, the holes are machined and the following operations performed.

But as in everything else, reason and not fashion should be followed. Accordingly, readers of the *American Machinist* are invited to discuss this question with the hope of so classifying a bit of machine-shop practice that some simple rule for guidance may be laid down as to which is better in certain cases—to machine circular or flat surfaces first.

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Three Instruction Cards

The name "instruction card" brings to the minds of most of us a more or less complicated form upon which are recorded all the detailed operations and elementary times used in the production of some machine part or for performing some individual operation on that part. It gives information as to what to do, how to do and how long it should take to do.

Is it not conceivable, however, that there may be other kinds of instruction cards than those that prescribe methods and quantity? It is at once obvious that quantity is not always the measure of the effectiveness of work done. Sometimes the quality of a flowing product is of greater importance in a series of manufacturing processes than the amount that is produced in a given length of

time. Again, it is easily conceivable that the intelligent carrying out of a series of operations may have a greater effect upon the final result than the building up of a great output in an hour, day or week.

In some industries this idea of setting up on instruction cards other standards than output has already been put into effect. In some processes in sulphite mills the quality of the output is the measure of the effectiveness of the operation and the workman. The bonus or increase in wages paid for effective work is figured upon the uniformity of the quality of the product turned out. This is a setting up of the standard of quality as opposed to that of quantity.

Further, in some operations in paper mills the wage increase or bonus is determined by the accuracy and care with which certain successive operations are performed. The final result is dependent upon this. Thus the standard set up is that of method rather than quantity.

It will of course be recognized that in such operations the quantity turned out in a given period of time has some relation to the amount of equipment that is in use; that is, a certain amount of material can be put through certain machines and processes in a given length of time, provided these are properly carried out. Thus the quantity factor is not entirely disregarded; but the standard set up before the workman is in one case the quality of a product that may vary considerably if it is not carefully handled, and in the other the effectiveness of a certain series of operations whose proper carrying out is essential to the production of a suitable product.

This practice, added to that which is so well known in machine shops, seems to give at least three kinds of instruction cards. The first specifies how much. The second specifies what quality. The third specifies how.

A striking example has recently reached our attention in regard to the second type. A large job of investigating and collecting information was undertaken. It was realized at the outset that this would extend over a period of many months and involve the labor of several men. It was impossible to specify in detail how or how much. It was, however, possible to outline in detail what. So the instructions that were prepared gave specific information as to what observations were to be made and just what information was to be gathered. Compared with previous records of similar work on a smaller scale, the output from this big job has been some six or eight times greater than ever before. In reality an instruction card was prepared telling what was to be done, and with this as a guide there has resulted the expected increase of output.

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Speed of New Construction in Navy Yards

The *American Machinist* has, from time to time, remarked on the mismanagement of the Government navy yards. These remarks can be substantiated by comparing the performance of the navy yards with that of private

yards. Such comparison is impossible with respect to repair work, because the navy yards do almost all the navy repair work, so that there is no basis for comparison. In the navy yards a considerable quantity of manufacturing work is done—small boats, cordage, furniture, chain, etc.—but a comparison of cost of such articles made in navy yards with similar articles made outside of navy yards is not possible, because of variations in quality and because of the peculiar methods followed in navy yards of locating expense charges. It is even impossible to compare costs of new construction, for this reason.

But an excellent comparison can be found in speed of new construction. Compare, for example, the progress made on the "New Mexico," "Idaho" and "Mississippi"—all three of which battleships were authorized at the same time, June 30, 1914. The "New Mexico," building at the New York navy yard, is now (Oct. 1, 1916) but 48.6 per cent. completed, whereas the "Idaho" is 64.8 per cent. and the "Mississippi" 55.9 per cent. completed, building at private yards.

Likewise, take the case of the torpedo-boat destroyers "Shaw," "Sampson" and "Rowan"—all authorized at the same time, June 30, 1914. The "Shaw," building at the Mare Island navy yard, is 72.5 per cent. completed, whereas the "Sampson" was delivered in June, 1916, and the "Rowan" in August, 1916, the latter ahead of her contract date of completion. The "Sampson" and "Rowan" were built by private contractors.

The submarine "L-8," building at the Portsmouth navy yard, is 90.8 per cent. complete, whereas the "L-9," "L-10" and "L-11," just like the "L-8" and authorized at the same time, but built by private contractors, have all been delivered. The "O-1" and "O-2" are building at the Portsmouth navy yard and Puget Sound navy yard respectively, and no appreciable progress has been made upon them, whereas on the other boats of this class, authorized at the same time, but building at private yards, the percentages of completion vary from 18.6 to 34.9.

Worse than any of these cases are those of the supply ship "Bridge" and the transport "Henderson," building at the Boston navy yard and at the Philadelphia navy yard respectively. These ships were authorized in March, 1913, and now, nearly four years later, are but 85 per cent. and 78.7 per cent. completed respectively. Both of these ships could have been completed in 24 months by private yards. The "Tennessee" and "California," assigned for construction to the navy yard, New York, and the Mare Island navy yard, had not been laid down on Oct. 1, 1916, although authorized Mar. 3, 1915; the orders were not placed with the navy yards until December, 1915, nine months after authorization.

The reasons for this condition are partly to be found in the navy yards and partly in the Navy Department. The navy yards themselves are not well managed. Their organization is faulty. With two or three exceptions, each yard is divided into two or more departments, which, to all intents and purposes, are separate and distinct, each with its own management, methods, etc. One of these departments is under a civil engineer, another under a naval constructor, another under a line officer. The department under the line officer has to do with the manufacture of machinery; that under the naval constructor has to do with the manufacture of ships'

hulls. Regularly the hulls are built more rapidly than the machinery, as a perusal of the department's report of progress of new construction will indicate. There is something lacking in the organization of the yard which, if provided, would bring about coördination and the consequent expedition of work.

Principally, however, the reasons are to be found in the Navy Department. At the time the orders for the construction of the "Bridge" and the "Henderson" were assigned to the navy yards at Boston and Philadelphia, there were no building slips on which to place them. How much more sensible it would have been to provide building slips and cranes for the construction of ships before placing orders there!

In the cases of the "Tennessee" and "California" these ships were assigned to navy yards that could not begin their construction for a year; and this action was taken at a time when private yards wanted to build them.

Bids have just been opened on four battleships, and the best delivery offered is 40 months. The navy-yard built ships will not be completed within that time, in all probability. Had the "Tennessee" and "California" been assigned to private yards for construction, they would have been ready at least a year sooner; and new construction from the present bill could have been assigned to navy yards if necessary.

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The Thousandth of an Inch

"Such experiences and many others like them gradually made me realize thoroughly that the limits we work to in this country, be they one, two or more thousandths of an inch, are the practical, handy and logical dimensions of length for accurate and interchangeable work. The dimension 0.001 in. is a dimension to stick to and to swear by; 0.1 mm. is too large, 0.01 mm. is too small." This is the positive testimony of C. C. Stutz, who, in the course of his article published elsewhere in this issue, relates his experiences with both the English and the metric systems, saying that he has twice acquainted himself with each. The thousandth part of an English inch and its double or treble and half or quarter give almost ideal limits for use in machinery building. By comparison, "0.1 mm. is too large, 0.01 mm. is too small."

The very existence of this practical measurement, 0.001 in., Mr. Stutz believes has had a profound influence upon the success of American machinery building. Quoting again from his article:

"The system of interchangeable parts is distinctly an American production. It has given us advantages that other countries are trying to imitate. This is admitted even by advocates of the metric system in this country and has been admitted to me by engineers and manufacturers abroad. Nobody can deny that this work had been done on the basis of the inch system. This is the important point I wish to bring home forcibly, backed up as it is by indisputable evidence of which my experience only forms a small part."

So the thousandth of an inch has played an important part in the achievement of American machinery building! Why should anyone suggest that it be thrown away? Simply to be able to multiply and divide by 10—to be able to move over the decimal point to the right or left as one figures on paper. What a paltry advantage for an irreparable loss!

Shop Equipment News

Vertical Surface Grinder

While the vertical surface grinder shown in the illustrations was designed especially for all classes of plain surface work, it is also adapted for circular grinding. The machine is the latest addition to the line made by the Reed-Prentice Co., Worcester, Mass.

The head of the grinder is practically integral with the large telescopic column, which is supported by a large

The wheel chuck has a composition soft-lined ring, the outside of which is tapered and concentrically closed on the outside periphery of the wheel. In addition to this, a vertical adjustment of the wheel in the chuck is provided so that the wheel may be used until it has been reduced to $\frac{1}{2}$ in. or less in thickness without any fear of crushing. This type of chuck has obviated the necessity of using a metallic band in the construction of the wheel. The loading of the chuck is simple and is easily accomplished by one man.

The wheel support is of a heavy gooseneck type, the telescopic part of which is supported in bearings in the base. The telescopic column is securely clamped or bound to the base when the wheel is actually performing its work, thereby making the entire support for the wheel practically integral with the base. A slight adjustment, however, is provided in the spindle, the sleeve of which tele-

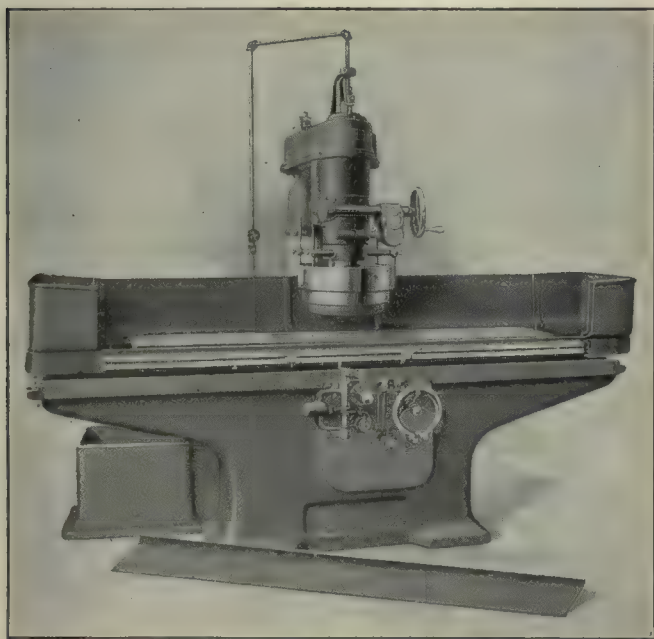


FIG. 1. VERTICAL SURFACE GRINDER

Table working surface, 12x78 in.; top of table to under side of grinding wheel, maximum (new wheel), 15 in.; table traverse, 78 in.; rectangular magnetic chuck, working surface, 12x60 in.; height, 4 in.; rotary chuck (plain), 16 in. in diameter, 7 in. high; rotary chuck (magnetic), 16 in. in diameter, 10 in. high; cup wheel, 14 in. in diameter, 4 in. high, $1\frac{1}{4}$ in. thick; spindle speed, 1,050 r.p.m.; driving pulley, 16x6 $\frac{3}{4}$ in.; belt width (driving from countershaft to machine), 6 in.; belt width (main line to tight and loose counter), 6 in.; floor space, 5x16 ft.; weight, 8,700 lb.

bearing in the main base of the machine and clamped into it while performing the work. When vertical adjustment of the head is required, the clamping device is released; and by means of a handwheel, worm and rack, or through power feed provided, the column and head are raised or lowered to the desired position and again clamped into place.

The lower sleeve or bearing for the spindle is lined with nickel babbitt and has the necessary adjustment for take-up. The bearing sleeve is tapered on the outside, and adjustment is obtained through locknuts at each end of the sleeve. The bearing is 3 in. in diameter by 8 in. long.

The upper end of the spindle is supported in a radial ball bearing. The end thrust or backlash of the spindle is taken by the use of a heavy coil spring and two ball thrust collars.

The driving sprocket of the spindle is mounted in independent bearings, so that there is no side strain to the wheel spindle.

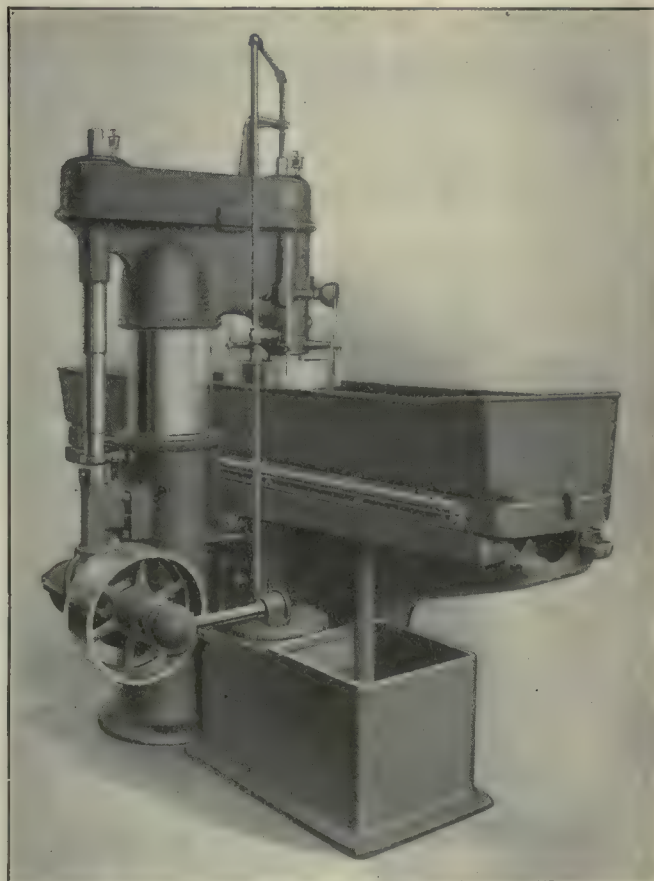


FIG. 2. REAR VIEW OF VERTICAL SURFACE GRINDER

scopes through the support for a very short adjustment, approximately 2 to 3 in. This adjustment will never permit any excessive overhang from the spindle support. The adjustment possible in the column and the vertical adjustment of the spindle, which latter adjustment is controlled either by hand or by power, enables a wide range of work to be taken care of, varying from thin disks to extremely thick or high pieces.

The table bed is braced and ribbed to insure permanent accuracy and alignment. The table is of rigid construction, being heavily ribbed and braced to prevent warping, to resist torsional strains and maintain alignment. The bed and table guides are made true and straight by master plates; the table being longer than the bed, the travel tends to keep both parts true. The ways and guides are automatically lubricated by reservoirs and rolls provided along the entire length of the table.

There are six feeds for the table, ranging from 2 to 12½ ft. per min., or from 0.021 to 0.142 in. per revolution of the spindle. These feeds are controlled by means of levers at the front of the base. Any feed may be instantly obtained while the machine is in motion.

The spindle sleeve or bearing is vertically adjusted in the head, either by hand or by power. The vertical adjustment in this machine is directly above the wheel, and with the counterbalance provided the adjustment is sensitive. The power feed is controlled by a ratchet wheel, provision being made for automatically disengaging the feed at a predetermined point. Twenty-five different feeds may be obtained, ranging from 0.0002 to 0.005 in.

An abundance of water is supplied to both the inside and the outside of the wheel at the same time. The inside supply is furnished through the spindle. Owing to centrifugal force and the use of a deflector, the wheel and the work are kept free from grit and dust. The outside supply is furnished through the ordinary flush system. Water guards control the splash of the water and assist in guiding the water to the large reservoirs or tank at the rear of the machine.

The rectangular magnetic type of chuck is readily applied to the grinder work table. These chucks are of

waterproof construction and therefore are not subject to dangers of short-circuit. The rotary chuck, similar to the rectangular chuck, is made dustproof and waterproof to prevent short-circuits. The driving mechanism is located outside the water guards. These chucks may be tilted for such work as cutters, circular saws, etc., which require slightly concave surfaces. The rotary chucks can be furnished either of the magnetic or of the plain type.

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Rifle-Barrel Drilling and Reaming Machines

By reason of the fact that an enormous quantity of military rifles was contracted for in this country during the first half of the year 1915 and also by reason of the demand abroad for rifle-making machinery, the regular makers of such tools in this country were entirely unable to meet more than a fraction of the demand.

This condition forced a considerable number of other people to design and build special machines for this purpose. A number of very novel and interesting designs have resulted from this pressure, some of them of high efficiency. The New England Westinghouse Co. was among those who had to produce machinery as best they could, from their own organization; among others they developed a new type of barrel-drilling machine.

It consists of 12 vertical-spindle drills, each driven by a single, independent, variable-speed motor. This 12-spindle machine, it is found, occupies exactly the same floor space as the old horizontal two-spindle drill. Each spindle is driven directly by an independent motor, which makes it possible to vary the speed of any spindle anywhere from 1,600 to 2,400 r.p.m.; this speed can be constantly changed to suit the steel that happens to be under any one of the drills at the time. The motor is supplied with an automatic switch, which is set to throw out if the power consumed exceeds a predetermined point; that is, if the drill becomes dull or sticks, the current is instantly thrown off, stopping the motor and feed, thus avoiding the breaking and bending of drills, which in the ordinary form of machines is a serious cause of delay and loss. The machine is compact, so that one operator can attend to 12 spindles. It is also found in practice that the vertical position enables the oil and chips to relieve themselves more readily, thus adding to the possible rate of speed. Another machine developed by the Westinghouse company is a mate to the drilling machine already described—namely, a vertical reaming machine with 12 spindles. The reamers are driven from above, and oil is fed to the reamer through its own hollow shank. The barrel is supported on a universal joint, so that it floats freely, enabling the reamer to follow truly and easily through the hole. The feed of this machine is by counterweights, thus automatically adjusting itself to the work being done. If more material is

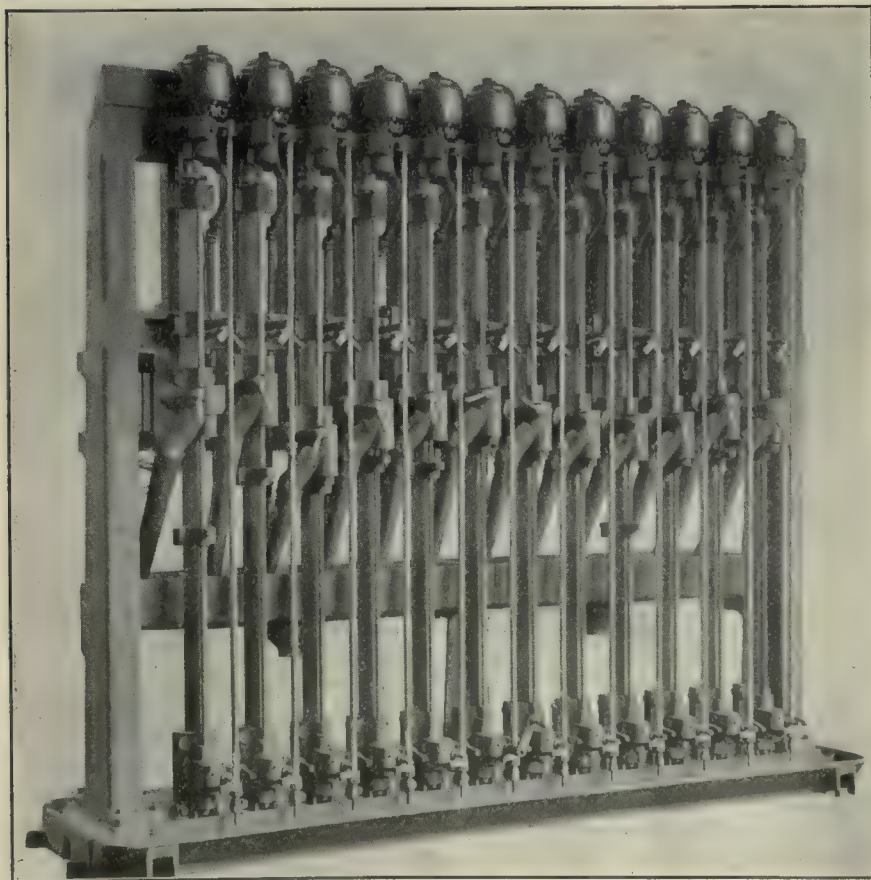


FIG. 1. RIFLE-BARREL DRILLING MACHINE

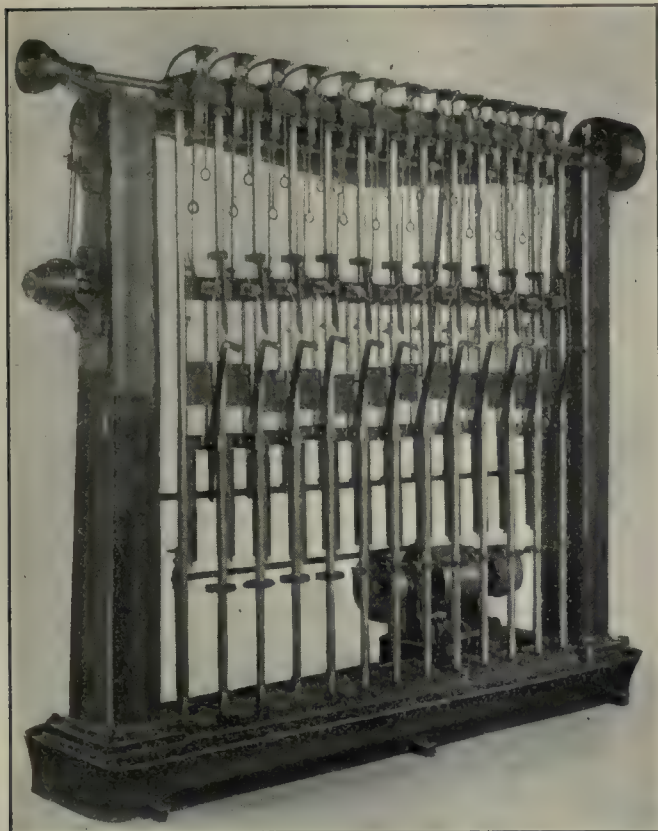


FIG. 2. RIFLE-BARREL REAMING MACHINE

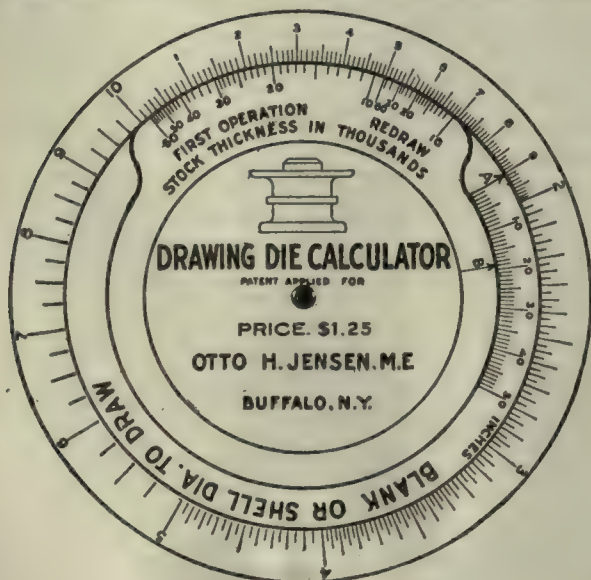
being reamed at one time than another, then the feed moves more slowly; if hard steel is encountered, this also slows up the feed without any attention whatever from the operator. From 90 to 100 rifle barrels per hour are regularly being reamed on this machine by one operator.

These machines are being put upon the market by Walter H. Foster Co., 50 Church St., New York City.

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Drawing-Die Calculator

To permit precise calculation in securing the maximum reduction in drawing sheet steel with double-action and combination drawing dies, O. H. Jensen, 44 Horton Pl., Buffalo, N. Y., has perfected the calculator shown.



DRAWING-DIE CALCULATOR

This drawing-die calculator was designed to permit ready determination of the correct reduction, allowing in the automatic calculation for variations in stock thickness and diameters of blanks and shells. The calculator indicates the maximum draw obtainable with a percentage of breakage that is claimed to come within a limit that is practically negligible.

The calculator is of the three-disk revolving type and has been founded upon exhaustive experiments originally charted and reduced to a slide-rule basis.

❧

Economic War and the Machine-Building Industries

(Continued from page 830)

in another part of France than that which formerly formed the main strength of the French machine-building industry. Italy is working hard to bring her industry to a higher standard, although she has been much hampered in her endeavors. The enormous orders for machinery reaching our country from Italy show that great changes have taken place. Russia has created practically a new industry.

When the war is over at least two countries will have been added to the machine producers in Europe—Russia and Italy. In consequence, they will buy less machinery and more machine tools than before. It is therefore certain that the countries of the allies, should they desire to do so, will be able to produce a large part of the machines they need. Germany also may build as much as possible for her own market, especially under the prospect of finding part of her old European markets closed against her.

But whatever happens there must be in each of the two groups a surplus of production. With the increased capacity peace cannot bring sufficient business to keep the shops busy. Under these circumstances the position of the neutral machinery producer becomes increasingly difficult. The United States most likely will feel little of this, but the neutrals of Europe have less power to resist, and with the exception of the Northern powers they have even no chance for effective combination.

THE SITUATION IN SWEDEN AND SPAIN

Sweden employs about 70,000 men in her machine building, engineering and iron and steel trades, and had a total output of \$64,000,000 before the war. Under the pressure put on the Swedish market since the outbreak of the war, and the necessity of extending the national output, this production has been much increased. The Norwegian industry is smaller, as is also that of Denmark. These three nations have had frequent intercourse since the war started, and it is likely that they will form a special economic group, possibly to be joined by Holland. The latter's engineering industry is not large, but it has a shipbuilding industry employing nearly 30,000 men.

Spain during the last few years has built up an important and active machinery-building industry. Owing to the rapid progress made by that country, expressed well by the fact that it has become an important customer for the American machine-tool industry, it is practically impossible even to estimate the size of its industries.

The present position of Switzerland is doubtful. The country had a well-developed machinery industry be-

fore the war, building not only for her own use but also for export. Since the war Switzerland has appeared in the American market several times as a large customer for machine tools, and after the war may become an important producer of certain special machines in the textile line and also of light explosion motors, the production of which has been greatly increased since the outbreak of the war.

STRENGTH OF ECONOMIC ALLIANCES

Economic alliances, when formed with the intention of mutual support, have so far proved to be of advantage to the participating countries. Such combinations tend to increase manufacturing activity and also allow of a better utilization of the mutual resources. The example of the German Zollverein, which was followed by the foundation of the present German empire, may be cited in this respect, so no immediate danger to the economic life of Europe would result from any economic alliance of several of the leading powers. We do not deplore the fact that European nations intend to combine for mutual economic support, but that this combination is contemplated on both sides with the avowed object of hurting the other. Economic alliances, such as proposed by the Paris con-

ference and also advocated in Germany and Austria-Hungary, can only be effective when they succeed in making the neutral states subservient to their interests. If this cannot be done, any other powerful and independent economic national unit can break up either of the combinations or both of them at will, provided it owns raw material or other resources, the supply of which is imperative to the combining countries. Neither of the groups of nations will be able to exist without American supplies, from the United States as well as from South America.

While the war lasts and normal intercourse between the European powers is interrupted, the ideas of the Paris conference may be carried into execution. But, fortunately, there is not always war, and when peace returns different counsels will guide the nations. It will then be shown that while there are no reasons why economic alliances should not exist, there are many that will make it desirable for the parties on both sides to start again the old commercial intercourse. The fine economic texture of Europe, woven during many years of peace, and the result of the economic development of centuries, will prove more durable than the diplomats in Paris and the scientists in Berlin expect.

Personals

William R. King, formerly with the E. S. Jackman Co., has joined the selling forces of William K. Stamets, Pittsburgh, Penn.

L. S. Devos, formerly purchasing agent for R. Martens & Co., New York City, has joined the selling forces of the Selson Engineering Co., Ltd., New York City.

L. L. Gisborne has become manager of the Toronto office of the General Supply Co. of Canada, succeeding G. B. Harlock, who has severed his connection with the firm.

E. W. Petters, chairman of Petters, Ltd., oil engine manufacturers, of Yeovil, England, is at present in this country for the purpose of securing a plant to take up the manufacture of his type of oil engine.

A. C. Lindholm, who is known to the readers of the "American Machinist" through his many contributions on punch and die practice, has become assistant superintendent of the Liberty Fuse and Arms Co., Long Island City, N. Y.

Donald Baker, assistant superintendent of the Liberty Fuse and Arms Co., Long Island City, and a frequent contributor to the "American Machinist," has resigned his position to become foreman of the toolroom of the Williams Mfg. Co., Montreal, Canada.

John V. N. Dorr, president of the Dorr Cyanide Machinery Co., New York City, has been awarded the John Scott Legacy Medal and Premium, by the City of Philadelphia, on recommendation of the Franklin Institute, for his inventions in hydrometallurgical apparatus.

H. A. Runge, for a number of years connected with the export department of Manning, Maxwell & Moore, has been elected vice-president, in charge of machinery and heavy hardware, of the Internations Commercial Corporation, New York City.

Obituary

Napoleon DuBrul, president, Miller, DuBrul & Peters Co., Cincinnati, died at his residence in that city on Oct. 26, aged 70 years. He was the inventor of a number of machines, chief among which was an automatic machine for making cigarettes. He is survived by his widow and four sons. The sons are all associated with the business.

William Cooper Cuntz, managing director of the Goldschmidt Thermit Co., New York City, died Nov. 2 at Auburndale, Mass., in his 45th year. He was born and educated in Hoboken and started his business career with the Pennsylvania Steel Co. of Stockton, Penn., and later went to Boston, Philadelphia, and London, England, for the company. He became connected with the Goldschmidt Thermit Co. in 1910.

Theodore Newell Ely, engineer and retired chief of motive power of the Pennsylvania Railroad Co., died at his home in Bryn Mawr, Penn., on

Oct. 28. Mr. Ely retired from active engineering work in 1911. Mr. Ely was born in Watertown, N. Y., and was educated in the Rensselaer Polytechnic Institute, where he received the degree of C. E., in 1886. In addition, he received the honorary degree of M. A. from Yale University in 1897, and that of Sc.D. from Hamilton College in 1904. He spent his entire active life in the employ of the Pennsylvania R.R., whose engineering department he joined in 1888. During 1893-1910 he was chief of motive power of the lines east and west of Pittsburgh and Erie, and at the time of his retirement was chief of the whole system.

Arthur C. Eastwood, president, Electric Controller and Manufacturing Co., Cleveland, Ohio, died on Oct. 17. Mr. Eastwood received his early education in Louisville, Ky., and his technical training at the Rose Polytechnic Institute. As a young electrical engineer at the mills of the Tennessee Coal, Iron and Railroad Co. his work attracted the attention of S. W. Wellman, who induced him to take up work in Cleveland as electrical engineer of the Wellman-Seaver Engineering Co. and chief engineer for the newly formed Electric Controller and Supply Co. As a result of Mr. Eastwood's inventive ability, the growth of the latter company was so rapid that he was soon forced to give the business his entire attention under the title of general manager and chief engineer. About 1905 Mr. Eastwood and his associates reorganized the company, and the name was changed to the Electric Controller and Manufacturing Co., with Mr. Eastwood as active head. He was the patentee of nearly 100 inventions, covering all phases of electrical control and power generation. The lifting magnet, development of which was entirely his own work, was in his own opinion his greatest inventive accomplishment.

Business Items

The Wahlstrom Tool Co. has moved to 5520 Second Ave., Brooklyn, N. Y.

A. P. McCulloch Machine Co. has moved its shop from Chelsea, Mass., to 216 High St., Boston, Mass.

Latrobe Electric Steel Co., Latrobe, Penn., has opened a sales office in Cincinnati, Ohio. Edwin M. Oug, manager.

Burton-Griffiths Co., London, England, has moved its American office, in charge of W. W. Gibbons, from the Grand Central Terminal Building to 110 West 40th St., New York City.

The Wolverine Machinery and Supply Co., 813 Dime Bank Bldg., Detroit, has been organized to handle a general line of machine tools. W. C. Kettenring is president. J. M. Blount, vice-president; G. G. Whitney, secy. and treasurer.

Trade Catalogs

Ball-Bearing Hangers. Gurney Ball Bearing Co., Jamestown, N. Y. Catalog H-2; pp. 40; 8½x11 in.; illustrated.

"Barnes-Made" Springs, Screw-Machine Products, Cold-Rolled Steel and Wire, Washers, Etc. The Wallace Barnes Co., 38 Wallace St., Bristol, Conn. Catalog 7-A; pp. 28; 6x9 in.; illustrated. A chart of decimal equivalents and tables of wire and steel stock gages are included.

Cold Saw Cutting-Off Machines. Newton Machine Tool Works, Inc., 23rd and Vine St., Philadelphia, Penn. Catalog No. 21; pp. 72; 6x9 in.; illustrated. This includes supplement, showing other machines built by this company, including milling, slotting, planing machines, etc.

Automatic Gear Cutting and Milling Machines. etc. The Standard Manufacturing Co., Housatonic Ave., Bridgeport, Conn. Loose Leaf Catalog No. 10; 9x11 in.; illustrated. This also shows the drilling machines formerly made by the Dwight Slate Machine Co. and riveting machines made by Harvey Hubbell and a new cutter and tool grinder.

Forthcoming Meetings

American Society of Mechanical Engineers. Annual meeting, Dec. 5-8, Engineering Building, New York City. Calvin W. Rice, secretary, 29 West 39th St., New York City.

American Society of Mechanical Engineers. Monthly meeting, first Tuesday. Calvin W. Rice, secretary, 29 West 39th St., New York City.

Boston Branch National Metal Trades Association. Monthly meeting on first Wednesday of each month, Young's Hotel. W. W. Poole, secretary, 40 Central St., Boston, Mass.

Providence Association of Mechanical Engineers. Monthly meeting, fourth Wednesday of each month. J. A. Brooks, secretary, Brown University, Providence, R. I.

New England Foundrymen's Association. Regular meeting, second Wednesday of each month. Exchange Club, Boston, Mass. Fred F. Stockwell, 205 Broadway, Cambridgeport, Mass.

Engineers' Society of Western Pennsylvania. Monthly meeting, third Tuesday; section meeting, first Tuesday. Elmer K. Hiles, secretary, Oliver Building, Pittsburgh, Penn.

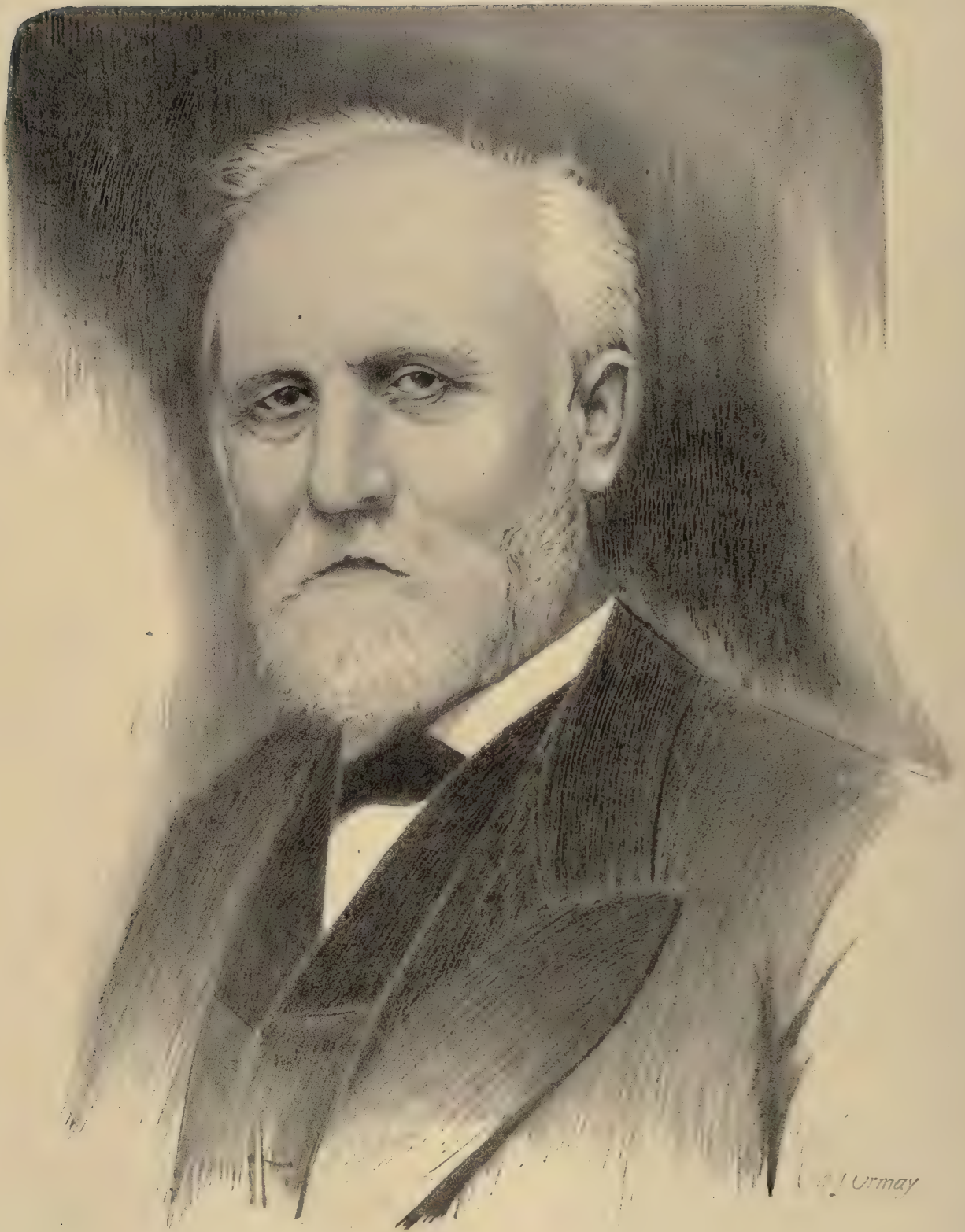
Rochester Society of Technical Draftsmen. Monthly meeting, last Thursday. O. L. Angeline, Jr., secretary, 857 Genesee St., Rochester, N. Y.

Superintendents' and Foremen's Club of Cleveland. Monthly meeting, third Saturday. Philip Frankel, secretary, 310 New England Building, Cleveland, Ohio.

Western Society of Engineers, Chicago, Ill. Regular meeting, first Wednesday evening of each month, excepting July and August. J. H. Warder, secretary, 1785 Monadnock Block, Chicago, Ill.

Philadelphia Foundrymen's Association. Meetings first Wednesday of each month. Manufacturers' Club, Philadelphia, Penn. Howard Evans, secretary, Pier 45 North, Philadelphia, Penn.

Technical League of America. Regular meeting, second Friday of each month. Oscar S. Teale, secretary, 35 Broadway, New York, N. Y.



John E. Sweet.

John E. Sweet--Reminiscences and Characteristics--I

By J. E. JOHNSON, JR.*

SYNOPSIS—One of John E. Sweet's "boys" shows us that "Professor's" character was more than his achievements, that his being was greater than his doing. At his death, Professor Sweet left a brief autobiography written in his own modest way. This is published here for the first time. It tells of his boyhood home, his early life and some of the incidents of his mature years.

A people who have well met the task of reducing half a continent from an aboriginal wilderness to civilization in little more than a century are necessarily utilitarian and should not be unduly reproached for that fact; but as the task of reducing the wilderness to a home of civilization approaches completion, those engaged upon it have more leisure to cultivate the gentler side of life and in so doing must recognize that sentiment in the broad, brave sense of that word has had much to do with technical development. Accordingly, all right-thinking readers will not disapprove of the comparatively new departure of the *American Machinist* in publishing a biographical notice and appreciation of the great men of the mechanical-engineering profession.

In the eyes of his friends and, they hope, in the opinion of the profession at large no man has better earned that honor than John E. Sweet. It is therefore eminently fitting that an adequate record of his life and character should appear here. But when it came to having such a record prepared, the editor found himself in serious difficulty. Professor Sweet lived to a great age, eighty-three and a half. Few, indeed, of his contemporaries are left, and of his "boys," in spite of the fact that new ones were coming along even to the last years of his life, most have long since grown gray and taken on weighty responsibilities. Two or three there were who were well fitted by intimate friendship and close association with Professor Sweet, since the Cornell days of almost forty years ago, as well as by professional distinction and literary training, to prepare a notice that historically and sympathetically would have done credit to the task. Unfortunately, the help of these gentlemen was unavailable, so the writer has undertaken the work in the belief that it were better done inadequately than not at all.

MY CONNECTION WITH "PROFESSOR"

My own connection with "Professor," as we always called him and as I shall call him in these reminiscences, began in February, 1893. I had taken my degree at Cornell a few months earlier and was casting around for an opening in the steam-engine business. I had seen a good deal of Professor's writings in the *American Machinist* and some in the "Transactions" of the American Society of Mechanical Engineers. I wrote to him and asked for a job. I received a characteristic reply, calculated to encourage, not to depress, as so many such replies are, especially in dull times like those. He was

looking for a man to make the designs for a special compound engine and, subject to certain conditions, I could have the job if I wanted it. Of course I wanted it, and a few days later I was ensconced at a drafting board close beside Professor's desk.

For the next several months I received intensive education in the highest grade of mechanical knowledge and in commonsense to the nth power. I also saw an example of the highest ideals of human conduct being followed by a man completely unconscious that there was anything praiseworthy or even noticeable about such a course.

The panic of '93 and changes in the plans of the customer for whom the engine was being designed led to my transfer after a few months to another concern in Syracuse, where I kept in close touch with Professor. A year later I left Syracuse and never returned there to live, but always maintained a correspondence with Professor, not by any means frequent, but full enough to keep him in intimate touch with what I was doing, while he on his side wrote to me very fully as to his work, his travels and the things that he was interested in and thought about. Added to that, whenever I could arrange it, after 1901, we met at least once a year at the dinner given by "Professor Sweet's boys." Once or twice he came to visit me for a few days. In this way, while my association with Professor was not as long by many years as that of a number of the other "boys," it was fairly intimate and gave me a good knowledge of his character.

THE POWER OF CHARACTER

The opening paragraphs of Emerson's wonderful essay on "Character" are as follows:

I have read that those who listened to Lord Chatham felt that there was something finer in the man than anything which he said. It has been complained of our brilliant English historian of the French Revolution that when he has told all his facts about Mirabeau, they do not justify his estimate of his genius. The Gracchi, Agis, Cleomenes, and others of Plutarch's heroes, do not in the record of facts equal their own fame. Sir Philip Sidney, the Earl of Essex, Sir Walter Raleigh, are men of great figure, and of few deeds. We cannot find the smallest part of the personal weight of Washington in the narrative of his exploits. The authority of the name of Schiller is too great for his books. This inequality of the reputation to the works or the anecdotes is not accounted for by saying that the reverberation is longer than the thunder-clap; but somewhat resided in these men which begot an expectation that outran all their performance. The largest part of their power was latent. This is that which we call Character—a reserved force which acts directly by presence, and without means. The purest literary talent appears at one time great, at another time small, but character is of a stellar and undiminishable greatness.

This is obviously not intended as disparagement of Washington or any of the others—rather the reverse—but to bring out Emerson's view that character involves something more than accomplishment. He might almost have said that character consists in being rather than in doing. Nevertheless, we must not forget that these two modes of existence merge into one another more or less, and being which does not translate itself, at least to some extent, into some useful form of doing is worthless.

*Consulting Engineer, Metallurgist.

Sometimes it has seemed to me that one reason why we do not always have a great estimate of the accomplishments of great men is that their achievements have passed into and become a part of the common life. Washington, for instance, declined to be made king of the Colonies and indirectly forced the formation of representative and republican government. Later he declined to be president for more than two terms, as he thought that a bad tradition would be established by his doing so. These two concepts that there shall be no king in America and that the continuous reelection of any one man shall be forbidden by public sentiment have passed into and become a part of our political life. It is but seldom that we refer them back to that great character who gave them to us. To choose a later and more technical illustration, one of the greatest inventions in the metallurgical field during the last half of the nineteenth century was the three-high rolling mill. Everyone who desires to do so, now uses it freely, but it is probable that not one man in ten knows that it was invented by John Fritz, though he died only a year or two ago, one of the great figures in the metallurgical development of our country.

In the same way the subject of this sketch was greater than anything that he did, and many of the things he pioneered were adopted after years of missionary work by him and have passed into the world's fund of mechanical knowledge with never a thought as to their origin or to the deplorable conditions that would exist if we did not have them.

PROFESSOR'S FAMILY AND PEOPLE

Professor came of people who were farmers and mechanics in the best sense of those words. I asked him once whence came the mechanical ability that the family had to such a marked extent, and he replied that it was from his mother's people—the Avery's—who, he said, "were all born mechanics."

There were several brothers, of whom one other achieved considerable distinction. This was William A. Sweet, deceased some ten or fifteen years ago, who differed from Professor in the marked way that brothers so often differ; in character and in manner he was the very antithesis of John E. He was a fighter, as rough as a bear if crossed, fond of display, especially of jewels—all things that Professor abhorred. William A. became involved in fights in regard to public questions in Syracuse, and on these occasions his methods were more characterized by directness rather than by gentleness. He angered many people by his outspoken attacks on objectionable things, and it is said that these people would sometimes end up a tirade against him with the words, "and they say that he's got a brother who is one of the finest men who ever lived on earth," implying that it was a contradiction of the laws of nature for William A. Sweet to have a brother answering that description.

The two brothers were just as different as this remark implied, but were alike in possessing marked mechanical ability. Professor's own powers of observation and his ability to digest what he saw were remarkable; but he once told me that if he and "Bill" walked through a shop or industrial plant together, his brother would see more of what the plant contained than he did. While the two brothers were associated in earlier years when mechanical and metallurgical activities had hardly become differen-

tiated from one another, as time went on William A. developed along the lines of the steel industry, while Professor became more and more closely identified with refined mechanical work and the conditions necessary for its production.

Professor's life, as a whole, may properly be divided into two portions—that previous to his becoming professor of mechanical arts at Cornell, and the portion subsequent to that important event.

Owing to the urging of some of us, Professor Sweet prepared within quite recent years an outline of an autobiography. This has the defect that Professor's incurable modesty did not permit him to put the emphasis upon the important things of his life, or even to describe them fully. Nevertheless, it is the best information we have in regard to his early life and is quoted here almost in full:

PERSONAL REMINISCENCES WRITTEN BY PROFESSOR SWEET

I was born in Pompey, and Pompey was a good place to come from, because a good many pretty good people have come from there: Horatio Seymour, who ran for President; Grace Greenwood, the author of "Fifty Years Ago"; Charles Mason, patent commissioner; and later, Holland Duell, also commissioner; William Avery, the inventor of the Avery engine and many other useful inventions; besides many other noted people.

Pompey generated some comedians and liars—one man who had two yoke of oxen drawing interest, and a liar who could give Baron Munchausen hearts and spades and beat him on inventing stories. As an example, he built himself a log house and it was so tight that the fire would not draw, so he bored a gimlet hole through the sash and it was all right. Old Strickland had a wonderful dog that could run like streaked lightning. It was chasing a fox, and the fox swerved past a sapling. The dog, always aiming for the fox, struck his nose squarely against the sapling, which split him from end to end; and as the two halves passed the sapling, they came together and welded, and the dog kept on and captured the fox.

The thing that I remember that dates back the farthest must have been when I was perhaps three years old. I had my knee on a stick across my little chair, trying to saw the stick with a compass saw. My father said, "That boy will make a mechanic." That I remember as distinctly as I do anything that happened yesterday. How near that prophecy came true, others may guess.

I believe the next event that I call to mind was when I was four years old. Our people moved to a farm at Britain Settlement, now Collamer, north of Messina Springs. I only remember that Jim Terwilliger (I remember him particularly, as he challenged my first vote) attended the same country school, but not long, as I do not think I went over two days.

When we were returning to the Pompey farm, we stopped at Messina Springs Hotel. My mother was taken sick and asked my father to get her some wine, and I was horror stricken. It would seem from this incident that I inherited my temperance notions. I don't know what became of me from that time until I was seven years old, probably nothing, for when I was four years old my youngest sister was born and from that time until I went to school I existed and kept out of the way. I was always tinkering and was dubbed "Johnny Tinker."

I don't remember about my great achievements during my school life, as that was mostly in the old stone schoolhouse. I cannot remember that I ever studied—not that I was the bad boy in the school or out, or made any trouble, as I was never punished or had a fight. My best hold was in arithmetic and geography, the latter because I could draw the maps better than the others, and the arithmetic was easy for me. There were three schoolhouses, each a mile and a half away, and it was getting an education at long range. My last teacher was a Miss Bridgman, who found out my weak points in schoolwork when the study of grammar came up, for I got no farther than the one rule, "A noun is the name of something." When she attempted to start me on algebra she said, "Let *A* stand for 300," or something of that sort. I asked why three and two naughts wouldn't do just as well. She then gave it up as a bad job.

BEGINNING OF MY MECHANICAL EXPERIENCE

My mechanical experience started simultaneously with my schoolwork, as the first day was only a half-day in school. I went home at noon, and in the afternoon I made a model of a plow. With one of my left-hand improvements, I made the moldboard very long and explained to my brother that I made it that way because it would draw easier. So my mechanism began to show itself early, as did my disposition to do things better. I cannot call to mind ever starting on a job without thinking out how to make it better than it had been done before.

When I was about twelve years old I made a small fiddle. My parents likely thought I made the fiddle because I wanted to play it, so I was sent over to Mr. Sutherland's to take lessons and came home at the end of two weeks with about a dozen tunes to my credit, which would indicate that I was an apt scholar. Perhaps I was, in a way, but no musician, as I did not learn how to tune my fiddle for twenty or thirty years, and then not as musicians tune theirs. I make a distinction between a fiddler and a musician: The fiddler plays one note at once and the musician two, and when I learned to tune my fiddle it was in a new way. When the string of a stringed instrument is slightly touched in its middle, both halves vibrate alike, and the result is a harmonic; if touched at a point one-third of its length, it divides into three parts and all three vibrate, making a harmonic of a higher key. This harmonic on the *A* string is the same when the instrument is in tune as the first harmonic on the *E* string, so I discovered that I could tune the instrument by bringing these two together. I could tell when the two notes were at the same pitch, but never could tell when two notes of different pitch harmonized.

It was during this period of my life that I first began my graphic method of solving problems. I had noticed the unequal spacing of the frets of a guitar and learned from Mr. Sutherland that the true *A* sharp and *B* flat were not the same, but that in a guitar, piano, etc., the same note was used. He said, too, that the violin and trombone were the only true instruments, as by those the true flats and sharps could be produced. I devised a graphic method to lay out the frets, making the best compromise for all keys. I made a guitar and so placed the frets, and Mr. Sutherland said it was the best guitar he had ever seen. Likely the way the stand-

ard instruments are made is the best for some one key—*C* perhaps—and worse for some other.

About these days our people had a stone cistern made, and the masons were two of the Fargoes. The founder of the express business was one, and he appeared a little too well dressed for a mason; but when my mother mentioned it, he said he would never wear poorer, and during his later life he didn't have to.

MY FIRST LESSON IN MECHANISM

I distinctly remember my first lesson in moving mechanisms. In those days our grain was at first threshed by a complete horsepower machine erected in our barn, and later by the portable machine that circulated during the fall from farm to farm. In the case of the latter the horses and gearing operated outside the barn, and a belt conveyed the power to the machine in the barn. I told one of my brothers that I couldn't see why the cylinder of the machine went faster than the band-wheel of the power, as certainly one end of the belt could not travel any faster than the other. I expect he set me right, and it is mighty few times I have ever had to be set right in that respect.

I was always at making something, had a turning lathe in the second story of our horse barn. It was turned by a crank, and my sister-in-law used to climb the stairs and turn the crank. We had, in the years of my idle life, a good deal of building and repair work in which I took a hand, and this led to my going, on the first of April, 1850, to learn the carpenter's trade. I worked seven months as an apprentice, for \$7 a month. This money went for tools and board at \$2 a week here in Syracuse, when I began to spend my money to the best advantage. By the favor of a neighbor living here, he got me the opportunity to build the fires and sweep the office of Deacon Hayden, who was then the only architect in the city, so then from the early winter till carpenter time in the spring I was learning something about drawing and architecture as that existed at that day.

At that period of my life I was fortunate to become associated with two of the best men possible, John Pinkerton and Deacon Hayden. The first week of my apprenticeship I helped make two planes, one of which I still possess.

My mechanical life ran into architecture, and there are a number of buildings in this city from my designs, and my architectural career ended at the breaking out of the Rebellion, when I was building from my own design at Selma, Ala., a hotel that would have been the second-best hotel in the South. It was stopped, and the plans were destroyed during the Rebellion. I was called down there afterward to make the plans over, and now, as a monument, I should not be ashamed of it if erected in this city.

MY FIRST VISIT TO EUROPE

After returning from the South, where I left one rainy day, I became acquainted with William B. Cogswell, who was a partner with my brothers. He left there for the Central R.R. shops and from there took a position in the Government shop at Port Royal. I took his place at the railroad shop and completed the drawings in detail for locomotive No. 108. The Government at the seat of war at that time was giving jobs to those who wanted to stand up and be shot at, which was a job that

I did not hanker for. Besides, I had cultivated a desire to see Venice and other cities, and so, early in 1862, I went to the London Exhibition of that year, and from there to Paris, Switzerland and Italy, as far as Rome.

A good deal of this trip was alone and, remember, traveling fifty years ago alone in foreign countries was not the simple job it would be now. There were events along the journey worthy of notice; but I can only mention a few. In going over the St. Gothard Pass it was in a two-horse box, with four of us jammed inside with our limbs ship-lapped together—two Russian women, a German and myself. It was a jolly party. We were allowed to disembark at the Devil's Bridge, where the noise of the boiling water was so deafening that it would not have made any difference what language we spoke; nothing could have been understood. It took all night to get over to Como, and from there we went by train to Milan. During the night on the mountain, we stopped at the hospice, where we exchanged money for bread.

From Milan to Venice, then a half-day's journey, we went over the line to that part of Italy that was then under Austrian rule, through the forts and battlefields, through Verona and into Venice, which was one of the scary times of my life. It was midnight, and instead of getting into the gondola omnibus two gondoliers got me in a single gondola and made a short-cut of a couple of miles or so through the narrow, dark canals to the hotel. It makes me shudder now, fifty years later, to think of it. Venice was a gem to me, and it has grown brighter and brighter each of the three or four times I have seen it since.

SOME INCIDENTS OF THE VISIT

On a Saturday afternoon I went with a gondola-omnibus load out to the Adriatic bathing ground. A young gentleman, recognizing me as an American, came over and started an acquaintance. He asked me to come and take dinner with him Sunday. It turned out to be William Dean Howells, then consul at Venice, and later one of America's greatest authors. On Sunday evening, while in the depot to leave for Florence, another gentleman made himself known to me. He proved to be the general agent of the Wheeler & Wilson Sewing Machine Co. We traveled together until we returned to Paris.

Through Florence, Pisa and Rome I made myself so conversant with the make-up of all the sights that when I visited them fifty years later it seemed to me as easy to travel there as in our own cities. I will not bother to enumerate the various sights further than to mention St. Peter's, the Coliseum, Pantheon, the Capitoline Hill and Museum, Trajan's Forum, St. Paul's outside, the Gates, the Pincian Hill, the Museum, the Vatican, the statue of Moses and that of Pauline Borghese. At the visit fifty years later, about the only notable addition was the statue of Garibaldi. In the thirty-six hour return trip from Civita Vecchia to Marseilles I learned what it was to be seasick for thirty-five hours.

EXPERIENCES IN LONDON

After returning to London, where I first saw Dickens, I secured a position as draftsman in the International Patent Office, a big name for two of us—Dr. Hazeltine as the company, and I assistant. It was pretty hard sledding sometimes. I got a job one time making the patent drawings of a machine for making envelopes, and

the last dinner before I got my pay was made out of a halfpenny loaf of bread eaten beneath a railway arch—a halfpenny loaf is *not* the best bread made in England. My first knowledge of Charles T. Porter [of Porter-Allen engine fame] was in making the patent drawings for the Richards indicator for him. At that time patent documents, including the drawings, were all on parchment.

I had invented a nail machine to make two nails where one was made before, and at Mr. Hazeltine's instigation I took out an English patent. He interested the proprietor of the Patent Nut and Bolt Co. to undertake the construction and introduction of my machine at its works at Smethwick, near Birmingham, and there I spent the remainder of the two years I was away in making two or three machines and in trying to make them go. Returning home, where I had sent the drawings, I found that a machine was being made from improved drawings, and the patent attorney had taken an interest. When the machine (which didn't work any better than the English one) was done, we went with it to New York as joint owners. The attorney sold out my half of the patent to some of the sewing-machine men for \$10,000. Eventually he got half of it and two or three years at a good salary to make two or three more machines that didn't work, either.

Out of the money I built another machine and exhibited it at the Paris Exhibition of 1867, where I saw Napoleon III and his wife, the Empress Eugénie, one of the most noble and beautiful women I ever saw; King William, who later became Kaiser William I of Germany; Bismarck and other notables; the kings of Austria, Spain, Portugal; the shah of Persia; khedives of Egypt and Turkey; and the Prince of Wales, who later became King Edward VII and father of the present King George V. Later, at the Centennial, I saw Dom Pedro, ruler of Brazil, and had the honor of meeting the King of Belgium in Brussels; that is, he was going one way in the street and I was going the other.

A MACHINE TO SUPERSEDE MOVABLE TYPE

The machine I invented is in the museum at Cornell, a relic now, but a masterpiece of ingenuity and workmanship executed by William H. Craig, a master mechanic. It was an attempt to supersede movable type and was the forerunner of the linotype.

For a time I was superintendent for Whitman & Barnes, then at bridge building for Howard Soule—the man I used to say I had as lief carry my pocket-book as to carry it myself. While building a bridge at Ithaca, President White and Mr. Cornell came around one afternoon and asked me to meet the Cornell Board, which I did and talked over what to do in the Sibley shop. This was soon after building the first Straight-Line engine, and some months after this I was engaged to take charge of the Cornell shop.

The engine was purely an experimental one. Almost every element differed from common practice. The frame was straight instead of crooked; the cylinder had a jacket cast around it; the piston had a length equal to the diameter; the piston rod was ground round and straight and ran through a reamed bush; the crank between two flywheels; the valve a mechanically fitted balanced valve; engine resting on three points; end play to shaft and crank bearings; and many other features. Explaining this and the notion of making perfectly flat plates and

straight-edges and a measuring machine, etc., and suggesting these things in the shop are probably what got me the position, and doing these things is what kept it. We speak of the engine as an invention, while, in fact, the engine in its various forms and the different devices devised for its manufacture likely would foot up to nearer a hundred than one.

WORK IN THE CORNELL SHOPS

At Cornell we were constantly developing new things—absolutely perfect surface plates, straight-edges, squares and angles, standard gages by the use of the measuring machine (which we built, the first ever built in this country, and which read to the ten-thousandth of an inch and enabled us to judge to the forty-thousandth of an inch). Visitors to the university were always shown our shop, and the wonders of the work we were doing interested the greatest of them all. Mr. Cornell was a constant, interested visitor while he lived; General Grant, Henry Ward Beecher, John Hay and hundreds of others came. In conversation with Henry Ward Beecher I casually remarked that an ordinary college graduate was of not much use in a machine shop, and he said he guessed I had never seen one in a pulpit.

Measuring hairs was one of the things to show off. The fact that all the hairs of one's head are of the same size was a discovery, and the various sizes was another. Every hair of my head, and I measured hundreds, is twenty-four ten-thousandths of an inch, and the finest one I ever measured was fifteen ten-thousandths. I remember one incident: We built certain lathes, and among other new things all the bolts and nuts that had to be changed to meet conditions were made to be operated by the one wrench. Showing it off to a friend, he said, "What in the world would you do if you lost that wrench?"

FOUNDING THE STRAIGHT-LINE ENGINE CO.

The best thing we made, or helped make, at Sibley, I suppose—or hope, at least—was a lot of valuable men. A train of circumstances compelled me to abandon my post, a lamentable thing for both, I think. I returned here, remodeled the engine and made it so good that five of us put in a thousand dollars each and organized the Straight-Line Engine Co. With the aid of a company of able and devoted assistants we built up during the third of a century a moderate business and an extra-good reputation. During the life and death of the engine business four of the five founders—David Hotchkiss, George Barnes, Anson A. Sweet and Henry Stevens—have died; and by the combined elements of gas engines, electric motors and other and more profitable business for the shop the engine business has died. A few months before the Chicago World's Fair, where I spent six months as a judge, I designed a steam separator; and at the instigation of some of our associates the separator was patented and the Direct Separator Co. organized. At first it seemed like the tail of the Straight-Line Engine dog, and later it looked as if the tail was going to wag the dog. Anyway, under the management of some of the engine company's lieutenants it has prospered wonderfully.

Some three or four years ago the manufacturers in the city joined in building a trade school. While it had to be abandoned, it was not because of any fault of

the plan. It was undertaken because of my advocating it, so it naturally fell to my lot to father it; and the cause of the failure was my age. I was twenty-five years too old when the school was started, and it was wearing me out. It is lamentable that the engine business failed, and it is far more lamentable that the school failed.

Such are the little events of my life, because there were no big ones. I have never been drowned, burned to death, shot or dynamited; in fact, I have never been killed, in jail, arrested or sued. Likely the most important thing I have done was to set the ball rolling for the organization of the American Society of Mechanical Engineers, of which there are between four and five thousand members scattered throughout the inhabited surface of the world; that which is the most pleasing is the annual meeting of my "boys," who gather to honor me on my birthday, and have for a dozen years. A year ago the American Society of Mechanical Engineers, through a committee, made a great splurge, and in the large assembly room seated 250 to honor my eightieth birthday. It was a great occasion and a great honor.

I have traveled a good deal, likely nearer two hundred thousand miles than one, and never met with but one accident. That was from jumping out of a buggy when ordered out by the driver. I struck on my head, which knocked me out for a couple of hours and knocked my eyes out of focus. I have crossed the Atlantic fifteen times, have been in ten seas and twenty-two countries.

I have recently been honored by the degree of doctor of engineering. In response to the committee I said I could not understand how I deserved it, and I see no way to justify it, except to use the remaining years of my life in inventing a way to get electricity direct from the coal, or a way to burn the coal in the mines.

(To be concluded)

Allowances for Fits

BY J. A. POTTER*

The following table gives the actual size of hole that a reamer will cut, the proper allowance for a close running fit and the size to which studs should be ground to mate with the holes. The nominal range of sizes listed is from 0.250 to 1 in.

Nominal Diameter of Reamer, In.	Actual Size of Hole Produced, In.	Allowance for Close Running Fit, In.	Size To Grind Studs, In.
0.250	0.2503 0.2501	0.0003	0.2497
0.500	0.50047 0.50027	0.00047	0.49965
0.750	0.7506 0.7504	0.0006	0.7496
1.000	1.00075 1.00055	0.00075	0.9995

Another short table gives the decrease in diameter necessary to permit a dry part to pass through a standard ring. Three kinds of finish are specified. From the screw machine; unhardened and ground; hardened and ground.

Nominal Size, In.	To pass through a standard ring (dry) parts finished on screw machine must be small as specified below, In.	To pass through a standard ring (dry) unhardened ground parts must be small as specified below, In.	To pass through a standard ring (dry) hardened and ground parts must be small as specified below, In.
1/16	-0.0005 -0.0006 -0.00075	-0.0004 -0.0005 -0.0007	-0.00035 -0.0004 -0.00065
1/8	-0.0009 -0.0013	-0.00085 -0.0012	-0.0008 -0.0011

*Chief tool designer, Becker Milling Machine Co.

Tools Used in a Small Trade-School Shop

BY ROBERT MAWSON

SYNOPSIS—In this article are shown some tools used in a state trade-school shop. Most of these tools were made by students of an average age of 16 years and have features of interest that enable elements for machine tools to be manufactured quickly and economically.

The State Trade Education Shop, Bridgeport, Conn., in one of its branches devotes its energies to training young men to become machinists and draftsmen.

In this article are shown some tools designed and made by students whose average age is 16 years. The pupils to a large extent use small tools—jigs and fixtures—illustrations and descriptions of which have appeared in the jig and fixture data pages of the *American Machinist* during the past two years and which have covered a sufficiently wide variety of work to permit an easy choice.

On the fixture used in milling the base of the tailstock the casting is located in a fixed cup bushing at one end. Another cup bushing operated by a screw is at the other end. These bushings fit over hubs on the piece, in order to locate it centrally. Adjustable screws hold the casting in alignment. The fixture used to bore the headstock is fitted with long guide bushings at each end to keep the bar in alignment during boring. The steadyrest planing fixture is arranged with an indexing finger for holding the tool in position at each cutting operation.

It will be observed that the uprights carrying the bushings in the headstock boring fixture are tied together at the top similarly to the method employed in the design of some of the well-known lathe heads. This method results in accuracy and high production of the elements under manufacture. The locating screws on all of the jigs are of large size and hold the parts rigidly and accurately against the cutting stresses and vibration.

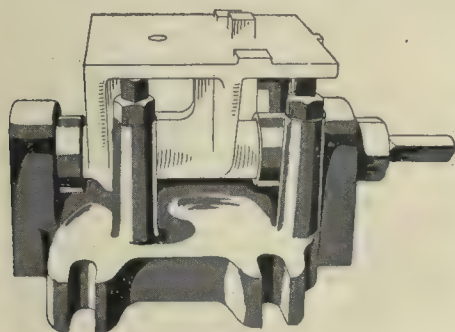


FIG. 2

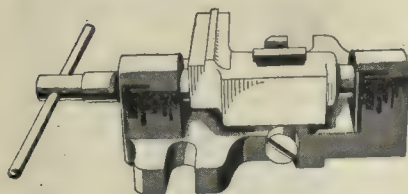


FIG. 2-A

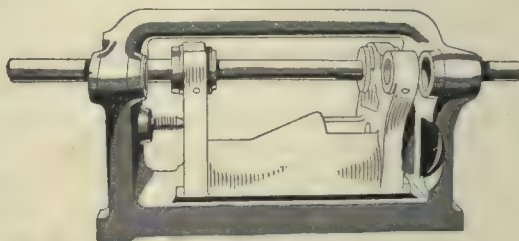


FIG. 4

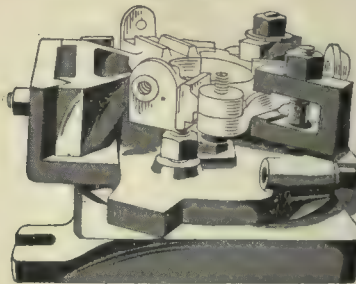


FIG. 4-A

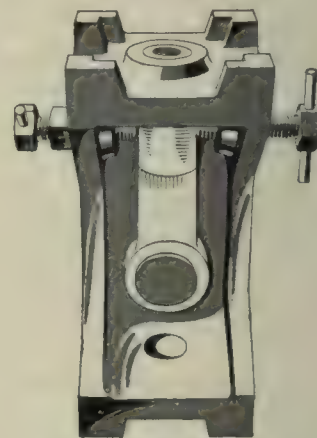


FIG. 6

JIGS AND FIXTURES DESIGNED AND BUILT BY STUDENTS OF A SMALL TRADE-SCHOOL SHOP

FIGS. 2 AND 2-A

Operation—Milling tailstock, Fig. 1. The casting is located by two cap bushings—one fixed, the other operated by a screw. A chuck nut prevents the moving screw from slacking back. Four adjustable screws fit under the flange of the casting to hold it in alignment.

Surface Machined—Base of casting, using $3\frac{1}{4}$ - and $3\frac{1}{2}$ -in. gang cutters operating at 68 r.p.m. with a feed of 0.032 in. per revolution.

FIGS. 4 AND 4-A

Operation—Boring headstock, Fig. 3. The casting is located in the fixture on a V and a finished pad, which fit into the surface already machined in the base. The casting is pushed back against an adjustable screw for a stop. The bars are guided in slip-fitting bushings at each end.

Surfaces Machined—Two $1\frac{1}{8}$ -in. holes bored and two $1\frac{1}{2}$ -in. holes bored. The caps are then put on the headstock and the bearings bored to $\frac{7}{8}$ in.

FIGS. 6 AND 6-A

Operation—Drilling pull-knob lever for reverse gears, Fig. 5. The casting is located by a pin that fits into a $\frac{7}{8}$ -in. hole

previously machined. The lever is then pushed back against an adjustable screw by a pin-head screw. The locating pin is then tightened back with a thrust nut. A shoulder on the pin holds the casting in position.

Holes Machined—One $\frac{7}{8}$ -in. and one $\frac{1}{2}$ -in. drilled.

FIGS. 8 AND 8-A

Operation—Milling worm-gear bracket, Fig. 7. The casting is located by a $\frac{3}{4}$ -in. pin that slides into a hole in the casting previously machined and into an arm on both ends of the fixture. The projecting arm of the piece rests on an adjustable screw to obtain the correct height.

Surface Machined—Base of casting, using $1\frac{1}{4}$ -in. gaged cutters operating at 60 r.p.m. with a feed of 0.032 in. per revolution.

FIGS. 10 AND 10-A

Operation—Planing steadyrest, Fig. 9. The casting is located in a machined V and on a pad. Adjustable posts hold it in proper alignment. The fixture is provided with an index finger that allows the sub-base to be swung around and locked in the correct location for the machining operation.

Surface Machined—Three jaws, the operation being performed on a planer.

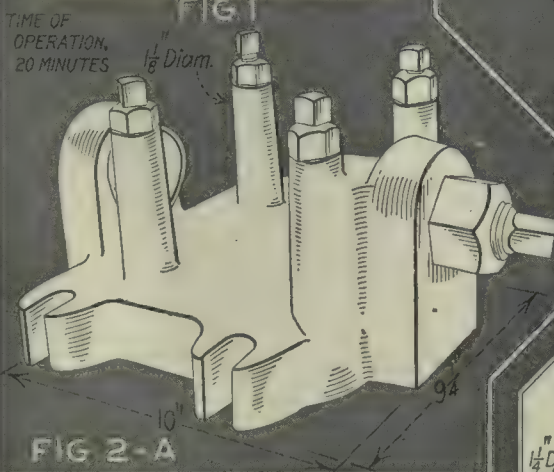
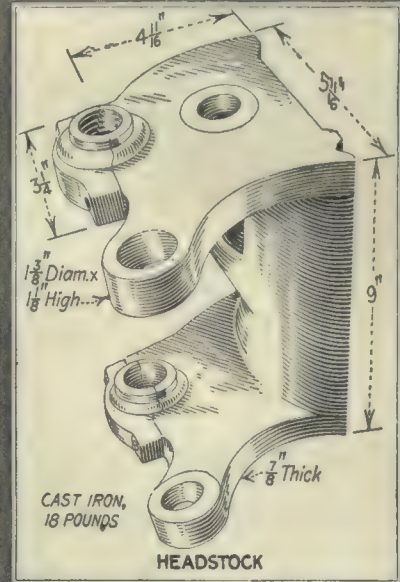
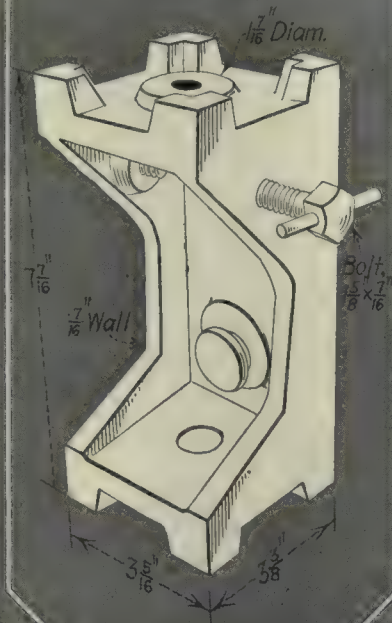
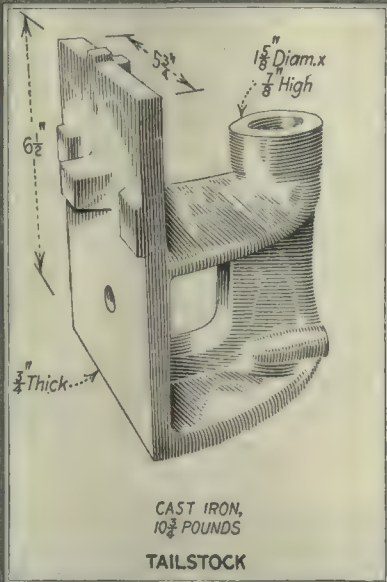


FIG 6-A

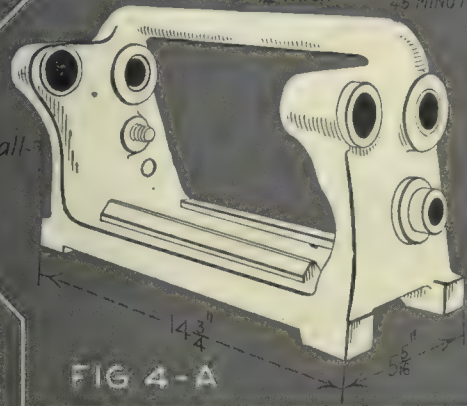
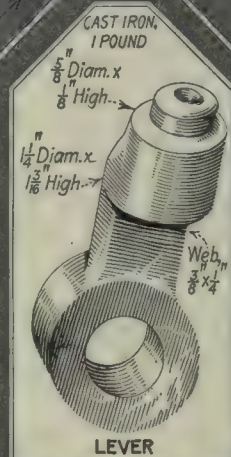
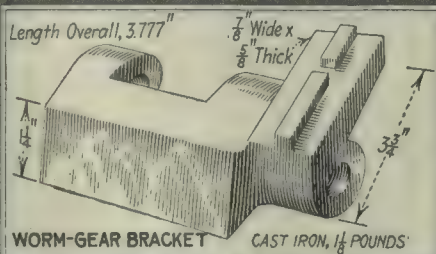
TIME OF
OPERATION,
10 MINUTESTIME OF
OPERATION,
45 MINUTES

FIG 5

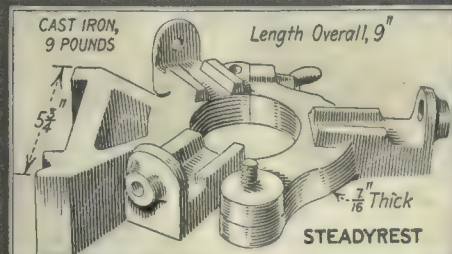
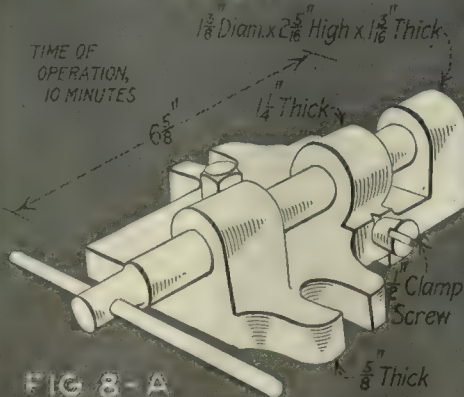
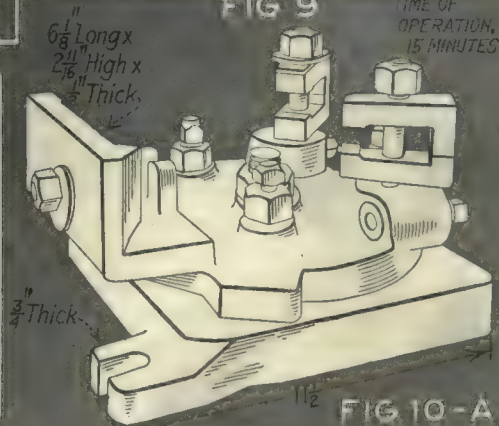


FIG 9

TIME OF
OPERATION,
15 MINUTES

NOTE

ALL BUSHINGS USED FOR
GUIDING TOOLS ARE BLACK-
ENED. ALL JIG AND FIXTURE
BODIES ARE CAST IRON,
STRAPS AND FASTENINGS,
MACHINERY STEEL; GUIDE
BUSHINGS ARE TOOL STEEL
HARDENED AND GROUND



Hawaiian Railroad Repair Shop

SPECIAL CORRESPONDENCE

SYNOPSIS—General features of the shop, and a few machine methods and special machines. A bumper planing job is shown and also the planing of a switch rail. A home-made shear and a set of hand-power rolls are described.

The railway out of Honolulu, Hawaii, is owned by the Oahu Railway and Land Co. This line follows the shore of the island for some 60 mi. to Kahuku, where connections are made with the Koolau Railway Co., which carries

The railroad is narrow gage—that is, 3 ft.—and the locomotives for passenger service weigh 50 tons without tender.

Fig. 2 is another view inside the shops, showing one of the road's standard locomotives blocked up over the pit ready for the drivers and truck wheels to be replaced. The truck wheels are shown suspended by the sling from the crane hook ready to be slipped under the forward end.

This view, together with the other interior view (Fig. 1), gives a good idea of the construction features of the shop. Fig. 1 in particular shows clearly the concrete



FIG. 1. GENERAL VIEW OF OAHU R.R. SHOP AT HONOLULU, HAWAIIAN ISLANDS

passengers 15 mi. farther. Beyond this point travelers journey by automobile and stage to various points on the Island of Oahu.

On several other islands in the Hawaiian group, there are railways reaching the principal towns, and in most cases these lines are supplemented by plantation trains running to smaller towns and villages. Each of these railroads has its repair shops, and some views in the Oahu shops at Honolulu are shown in the accompanying illustrations.

A general view in the main shop is shown in Fig. 1, where in the foreground a locomotive is seen in the process of being overhauled, while at the right and in the background are a number of the larger machine tools employed on various operations.

building with its heavy columns, liberal lighting facilities and deep craneways for the overhead crane, which traverses the main bay. It will be noticed from this view that the big lathe, several planers and other tools are so placed as to be served directly by the crane.

Fig. 3, taken from a point directly in front of the locomotive seen in Fig. 2, shows this piece of equipment pretty well stripped and with the four sets of drivers on the track, immediately in front. This view also shows the column and overhead construction features of the shop and incidentally brings out a number of machining operations carried on with different tools.

Figs. 4 and 5 illustrate two typical planer jobs occasionally handled in this shop. The first of these represents the method of planing a locomotive bumper, which

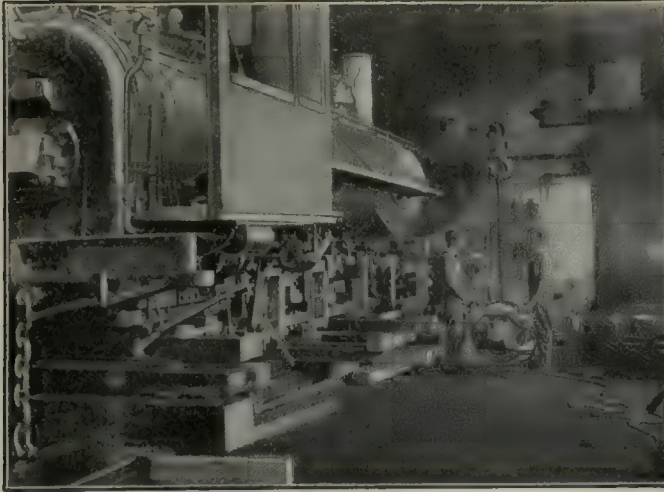


FIG. 2. OVERHAULING LOCOMOTIVE TRUCKS

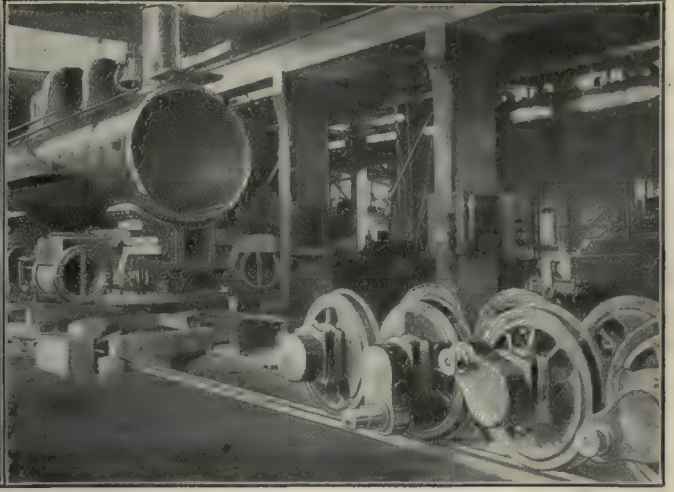


FIG. 3. LOCOMOTIVE AND PIT



FIG. 4. PLANING A LOCOMOTIVE BUMPER



FIG. 5. PLANING A SWITCH RAIL

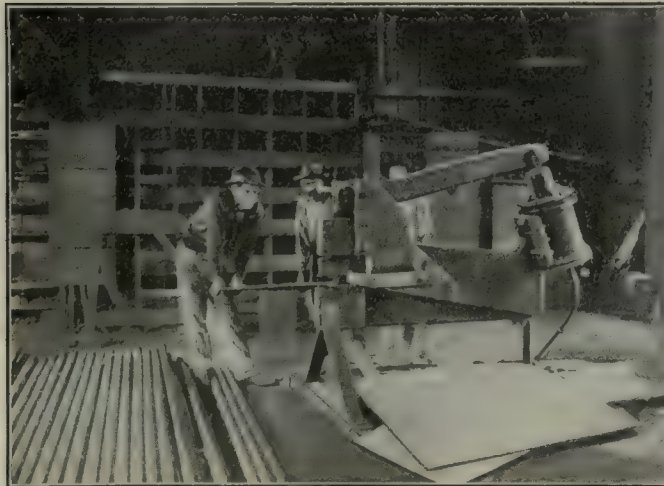


FIG. 6. HOME-MADE SHEAR FOR PLATES



FIG. 7. HOME-MADE PLATE-BENDING ROLLS

is practically a solid casting from end to end, weighing about two tons. The casting is held on the planer by straps at the sides and end, and the thrust is taken by a strap backed up by two plugs at the end of the planer platen, although the weight of the work is such that with the shallow cut necessary to true up the surface there is little tendency on the part of the casting to move under the cutting action of the tool.

Fig. 5 shows a switch-rail job on a planer, where the long rail to be surfaced and tapered at one end is strapped down on a deep parallel at the rear end of the platen, while the forward end is gripped by the planer chuck. The projecting outer end of the rail extends many feet from the end of the platen base over a suitable support to prevent sag and consequent bowing of the face of the rail, which is being planed.

There are a number of machines in the plate shop alongside the main locomotive shop that were built on the premises and which are in constant service on boiler plate. One of these machines is seen in Fig. 6. This is a home-made shear for cutting and splitting all thicknesses of boiler plate. It is built up of flat sections and carries a slide for the shear knife, which is operated up and down by a long, pivoted lever connected at the rear end to a piston in an air cylinder taken from an old locomotive. The air is supplied to this cylinder from the pipe shown passing up from the floor, and pressure is applied to the piston by a controlling lever at the front of the machine.

The whole shear is mounted upon wrought-iron legs, or angle irons, forming a pair of A legs at the front and a straight leg at the rear, which is bent at the top and bottom to provide a flat base for bolting to the under side of the shear frame, and a similar foot below for securing it to the floor.

Fig. 7 shows a set of plate-bending rolls made in this shop and designed to be operated by the big pilot wheel at the side of the machine. This pilot has a number of long arms, enabling several men to work together.



Handling Machined Parts

By P. G. LITTLE

During my experience as inspector for a foreign government I have been impressed by the large amount of finished material that it has been necessary to reject during final inspection, on account of careless treatment during transportation from one department to another.

In many cases this is due to the fact that suitable trucks or carriers are not provided and also because the men doing this work do not understand and have not been instructed in the handling of various materials. I have noticed that at some factories it is the practice to fill common wooden barrels with machined parts for transportation to the stock and assembly rooms. No matter whether the parts are rough castings or ground parts, like piston pins, the same barrels are used. Perhaps the parts are placed carefully in the barrel by the machine hand and at the time of leaving the machine shop are in good condition; but when they reach the other departments and are dumped out to be used or counted, it can readily be seen what the results are.

The piston pins mentioned could be transported in simply constructed wooden racks, with holes cut in the boards to fit each part, or in shallow steel trays, both methods making for speed in counting and inspecting and also serving as a protection. In certain cases, if pieces are packed immediately after completion, a saving will result.

Recently, I had a quantity of roller bearings to inspect. The bearing was composed of a cone, a cup and the retainer with rollers. The parts were all carefully made and interchangeable, but were sent to the shipping room separately for the packers to assemble as units and pack. It was found that, due to careless handling, rollers had come apart from the retainers, cups and cones were rusty and badly marred, and the retainers were bent out of shape. The number of rejections of pieces that had left the machine room in perfect condition convinced the officials at that factory that it pays to pack these parts as units, immediately after completion.

Had not a buyer's inspector rejected this material, it certainly would have been shipped in defective condition, yet the factory does careful machine work and spends much money on inspecting parts, which because of careless handling, are spoiled before reaching the buyer. I have seen at other plants automobile gears, worth \$12 each, piled on trucks just as raw material would be heaped, and dumped from the truck to cement floors.

It is costly enough to spoil work during production; but when parts are spoiled because of the foregoing methods, it is far more costly, because it is preventable.

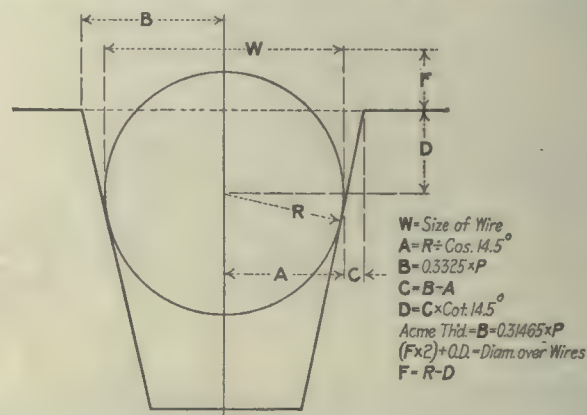
The conditions commented upon do not exist at one plant only, but have been noticed at a dozen or more factories that have come under the writer's observation. This matter should be investigated in every plant.



Measuring B. & S. or Acme 29-Deg. Threads

By KARL FENNELL

The formula given below permits the use of any size of wire that will touch the sides and project above the top of the thread. The only difference between B. & S. and Acme threads is that in the B. & S. thread, $B =$



MEASUREMENT OF B. & S. OR ACME 29-DEG. THREADS

$0.3325 \times$ pitch, while in the Acme thread, $B = 0.31465 \times$ pitch.

Example: B. & S. thread two per inch, 2-in. outside diameter.

Wire = 0.3 in. in diameter;

$$A = 0.15 \div 0.96815 = 0.15494;$$

$$B = 0.3325 \times 0.5 = 0.16625;$$

$$C = 0.16625 - 0.15494 = 0.01131;$$

$$D = 0.01131 \times 3.86671 = 0.04373;$$

$$F = 0.15 - 0.04373 = 0.10627.$$

$$\text{Over wires} = 0.10627 \times 2 + \text{outside diameter} = 0.21254 + 2 = 2.21254.$$



Importance of Uniformity of Spelter in brass manufacture was emphasized in a report of the Committee on Nonferrous Metals and Alloys at the last meeting of the American Society for Testing Materials. As lead segregates badly, and more markedly the higher the proportion, the lead limit of the average sample is made low enough to allow for this tendency without injurious effect on the product. Even when the brass manufacturer adds lead, he does so in known amounts and thus obtains a uniform alloy from the different pots, which would not be possible if all the lead needed were contained in the spelter. Selected spelter carrying the maximum 0.8 per cent. of lead and 0.04 per cent. iron is used by brass manufacturers for making alloys to which lead is added in order to secure free-cutting qualities.

Lubrication of Bearings

By WILLIAM KNIGHT*

SYNOPSIS—A brief review of the principles of journal lubrication, with special reference to recent investigations. Formulas are given for coefficient of friction, bearing pressure, rubbing velocity, heat removed, cooling water required, temperature rise and horsepower and specific losses.

Our knowledge of the laws of lubrication of bearings is quite recent, and is yet far from being complete. We know, from a number of experiments already made, some of the relations that exist between the several physical factors affecting the coefficient of friction and load-carrying powers of a lubricated bearing, but more experiments are needed before we will be able to establish a rational basis for bearing design.

The necessity of having future experiments conducted along some definite lines, in order to gain the knowledge that we need, is forcibly illustrated by M. D. Hersey in a paper, "On the Laws of Lubrication of Journal Bearings," presented at the meeting of the A. S. M. E., June, 1915, of which a good recapitulation is given in an editorial in the *American Machinist*, Vol. 43, page 81.

Mr. Hersey in his paper deals with the physics of lubrication, and he deduces by dimensional reasoning certain general relations that may be taken as a guide in the planning and interpretation of experiments.

The importance of the dimensional theory in planning experiments and deducing from them some reliable empirical equations unfortunately is not appreciated as much as it should be. To Mr. Buckingham goes the credit of having illustrated the dimensional theory in connection with model experiments and the form of empirical equations, in an elementary way, with worked-out examples (see 1915 "Proceedings" of the A. S. M. E.; "Smithsonian Miscellaneous Collections," Vol. 62, No. 4; *The Electrician* of Jan. 15, 1915, and *Engineering* of March 13, 1914).

By following the scheme outlined by Mr. Hersey in planning future experiments there is no doubt that we will be able to acquire a complete knowledge of the phenomenon of bearing lubrication.

In this article I will attempt to make a rapid survey of the main principles established in the laws of lubrication of journal bearings derived from the first classical experiments made by Beauchamp Tower (see "Transactions" of the British Institution, 1885), followed by the mathematical analysis of bearing lubrication of Professor Reynolds (see "Philosophical Transactions," Vol. 177) and the experiments of O. Lasche, of Berlin (English translation in "Traction and Transmission," London, 1903). Mr. Illmer (see *Power*, Feb. 22, 1916) gives a complete comparative analysis of the results obtained by different experimenters and derives from them some useful designing formulas giving the coefficient of friction and load-carrying power of journal bearings, which will be given here in an abstracted form.

Some still more recent experiments made by Messrs. Thomas, Maurer and Kelso (see "Proceedings" of the

A. S. M. E., 1913) on lineshaft bearings have furnished us some sort of connecting link between Tower's and Lasche's experiments on bearings heavily loaded and the conditions that we have in the actual service of bearings subjected to moderate loads.

TOWER'S AND LASCHE'S EXPERIMENTS

Tower's experiments were made on a 3x6-in. steel journal, using various grades of oil maintained at a temperature of 90 deg. F.; maximum journal speed 500 ft. per min. bearing pressure between 100 and 500 lb. per sq.in.

Lasche's experiments were particularly made on a 4 $\frac{3}{8}$ x 9 $\frac{5}{8}$ -in. steel journal and a babbitt-lined oil-ring journal box, bearing pressure between 15 and 225 lb. per sq.in., and rotating at a maximum peripheral speed of 3,500 ft. per min.; bearing temperature between 85 and 210 deg. F.

Tower's experiments showed that up to 500 ft. per min. the coefficient of friction is directly proportional to the square root of the speed and is inversely proportional to the bearing pressure and to the square root of the virtual temperature head of the oil (temperature of oil —60 deg. F.).

Lasche's experiments showed that for speeds between 500 and 3,500 ft. per min., the coefficient of friction is independent of the speed and is also inversely proportional to the bearing pressure and to the square root of the virtual temperature head of the oil (temperature of oil —60 deg. F.).

At 500 ft. per min. both Tower's and Lasche's formulas give the same results.

That, from a certain speed up, the coefficient of friction is independent of the velocity, can be explained by considering the change in viscosity of the oil. When the shaft is just started up from rest, the oil is cold and has a relatively high viscosity. By increasing the speed, the rate at which the oil film is sheared increases, and the coefficient of friction also increases. The increase of the coefficient of friction means increase of lost work that is transformed into heat which is radiated into the surrounding air, increasing the temperature of the bearing and of the oil film. The increase in temperature reduces the viscosity of the oil, and the coefficient of friction drops. Thus the two actions are opposing each other, and it is conceivable that, up to a certain speed, the tendency to increase of the coefficient of friction, due to the increase in velocity, predominates over the opposite tendency to decrease the frictional force due to the drop in viscosity of the oil; and it is also conceivable that, from a certain speed up, all the other conditions remaining the same, one action offsets the other, and the coefficient of friction proves to be independent of the speed.

Thus the results of Tower's and Lasche's experiments are perfectly consistent, as far as the influence of the velocity on the coefficient of friction is concerned; and the latter's experiments have established the very great importance that is to be attached to the knowledge of the viscosity of a given oil at different temperatures, if we want to be able to judge of its lubricating qualities.

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The best lubricant for a given service is the one having the least viscosity that will maintain the necessary film between the rubbing surfaces; and R. L. Ellis (*Metallurgical and Chemical Engineering*, Sept. 1, 1912), in order to discover a law representing the relation between temperature and viscosity of lubricating oils, likely to be met with in practice, made a large number of tests covering oils of widely different characteristics and over a wide range of temperatures. As a result of these investigations it was established that if T' is the temperature rise of the oil above its point of complete solidification, and V the corresponding viscosity relative to water (water being considered as unity), the rate of change in viscosity corresponding to the change in temperature is such that it is represented by the equation $TV^n = C$, where n and C are two constants depending upon the particular oil tested.

The practical application of the law is that, given the point of complete solidification of the oil, and two determinations of viscosity (preferably at rather wide variations of temperature), or else three viscosity determinations, it is possible, by plotting them on logarithmic paper, to determine with substantial accuracy the viscosity at any other temperature at which the oil is likely to be used for lubrication. In this way the relative value of different oils can be obtained, and an intelligent choice can be made of the best one to use for a given service.

Lasche's formula for the coefficient of friction of bearings heavily loaded has been found to be satisfactory in practice. When, instead, it has been applied to bearings subject to pressures up to 50 lb. per sq.in., actual measurements of friction losses showed a coefficient of friction about one-half of what Lasche's formula gives. For bearings working under heavy pressure, a viscous oil is generally used; and both Tower and Lasche, who made their experiments over a wide range of pressures—from low pressures up to very high pressures—in order to be able to impose on the bearings these high pressures used in their experiments a heavy engine oil and, naturally, the results obtained at low pressures cannot be expected to agree with the results obtained in practice, when a lighter oil having a lower viscosity is more likely to be used.

The influence of the specific gravity of the oil and the bearing pressure on the coefficient of friction has recently been emphasized by a set of tests made by A. L. Westcott (see Bulletin No. 4 of the University of Missouri on "Friction Tests of Lubricating Greases and Oils," Vol. 4, December, 1913) on oils of different specific gravities. The coefficient of friction was found to vary directly as the specific gravity (the higher the gravity number in degrees Baumé, the less the coefficient of friction for a given load and temperature), and the relation found by plotting the coefficient of friction against bearing pressures (varying from 65 to 240 lb. per sq.in.) for each grade of oil at a constant temperature (several tests made for each grade of oil between 80 and 160 deg. F.) is such that the several curves representing tests made with the oil at different temperatures tend at high pressures to converge to a common point; and if the load on the bearing had been carried far enough, a point would have been reached where the curves for the higher temperatures would have crossed those representing the lower temperatures. In every case it was found that, for an oil at a low temperature, the coefficient of friction varies

with the bearing pressure at a higher rate than for an oil at a higher temperature, with a tendency to reach a constant value, independent of the bearing pressure, at an average temperature of about 150 deg. F. For instance, it was found that with dark-yellow engine oil (specific gravity 20 deg. Bé., flash point at 348 deg. F.), at a temperature of 81 deg. F., the coefficient of friction is about 0.045 at 65 lb. per sq.in., and 0.015 at 240 lb. per sq.in. bearing pressure; and at a temperature of 142 deg. F. the coefficient of friction is 0.006 at 65 lb. per sq.in., and 0.005 at 240 lb. per sq.in.

From tests made on three different qualities of engine oil with a specific gravity varying from 32 to 19.4 deg. Bé., the coefficient of friction varies inversely as the square root of the bearing pressure, approximately.

That the coefficient of friction in a well-lubricated bearing varies inversely as the square root of the bearing pressure (and not inversely as the first power of the bearing pressure as derived by Tower's and Lasche's experiments) is further confirmed by Woodbury's experiments ("Transactions" A. S. M. E., Vol. 6, 1884), by Thurston ("Friction and Last Work in Machinery and Mill Work," 7th edition), by Thomas, Maurer and Kelso ("Transactions" A. S. M. E., 1913), and is not contradicted by Lasche's experiments if we keep in mind that his formula is based on tests made with heavy oil in the bearings, in order to stand very high bearing pressures, and cannot be expected to give the same results as obtained from tests in which more moderate pressures and lighter oils were used.

ILLMER'S FORMULA FOR COEFFICIENT OF FRICTION

From Thomas' experiments Illmer derives the following formula which, as he states, may be taken as representative of the coefficient of friction that may be expected in the practical operation of well-designed bearings such as are generally used for engines, generators, turbines and like machinery:

$$f = \frac{0.4}{\sqrt{PT_0}} \quad (1)$$

where f = coefficient of friction, P = bearing pressure in pounds per square inch and T_0 = virtual temperature head of oil in degrees Fahrenheit (temperature —60 deg.). I would suggest, on the strength of Mr. Westcott's experiments, that the above formula be modified thus:

$$f = \frac{0.4s}{\sqrt{PT_0}} \quad (2)$$

where s is the specific gravity of the oil as compared to water taken = 1. This would give a better agreement with Lasche's experiments between 120 and 240 lb. per sq.in.—that is, such a range of pressures for which we would expect a close check with the results of the investigations of Tower and Lasche.

A point which has caused a good deal of confusion in analyzing results of tests on lubricants and lubrication is the misconception of the importance attached to the external friction of a lubricating oil (resistance opposed to being squeezed out of the bearing under heavy pressure). The distinction between external friction and internal friction in bearing lubrication was first made by Petroff ("Neue Theorie der Reibung," Hamburg, 1888) who developed the hydro-

dynamic theory of lubrication; but when he derived the general formula for the moment of friction, he showed that the influence of the external friction is of very little importance, and the only dominating factor in determining the coefficient of friction is the viscosity or internal friction (resistance opposed by a film of oil to be sheared off).

Mr. Ubbelohde, in "Petroleum" (see English translation in the *General Electric Review* of November and December, 1915) denies that the external friction has anything to do with the lubrication of bearings, and the property of capillarity appears for the first time in connection with the problem of bearing lubrication. A nonwetting fluid (like mercury) when pressed between two surfaces tends always to flow toward the larger space and out. A wetting fluid instead, like oil (or even water provided that the surfaces are completely free from fat so as not to prevent the water from wetting them), tends always to flow to the narrowest point with a force, under certain conditions, sufficient to prevent the coming in contact of the two surfaces, even when very high pressures are used. Mr. Ubbelohde proves (and his statement is confirmed by a large number of experiments made by others) that all fluids adhere to all solid substances, and that the external friction should be neglected when analyzing the lubricating qualities of a given oil. Viscosity only is to be considered for the behavior of lubricating oil between bearing and journal, and the analysis of a number of tests made on a large variety of oils proves that all oils of the same viscosity have the same coefficient of friction and, with increasing viscosity, the coefficient of friction also increases.

Another very important factor affecting the coefficient of friction of bearings, first pointed out by Professor Reynolds in his article "Concerning the Theory of Lubrication and Its Application to the Researches of Tower," and further developed by Sommerfeld (*Zeitschrift für Mathematik und Physik*, 1904) is the clearance between shaft and journal box, or the thickness of the oil film.

INFLUENCE OF OIL FILM THICKNESS ON LUBRICATION

Professor Upton, in the *Sibley Journal of Engineering* (1916), gives a very good analysis of the conditions affecting the thickness of the oil film and its influence on the lubrication of bearings. He points out that in any bearing, when started from rest, the oil tends to stick to both the journal and the bearing and, due to this tendency, the resulting action will be a relative sliding of one moving layer of oil adhering to the shaft on another stationary layer of oil adhering to the bearing. Before the motion starts, both the journal and bearing are in contact. As soon as the motion starts, a film of oil is formed, which will act like a wedge between the journal and the bearing, and the wedging force, tending to lift the journal and bring it to a central position, will be directly proportional to the viscosity of the oil and to the speed of rotation, and will be inversely proportional to the bearing pressures. The thickness of the film, evidently, will also depend on the product, $\frac{\text{viscosity} \times \text{velocity}}{\text{load}}$. The load being a constant, and the

viscosity being practically a constant when the motion starts, if there were no high spots on the surface of journal and journal box, the film thickness would increase directly as the speed. At a certain critical value of the

velocity, metallic contact ceases entirely, and the thickness of the oil film on the loaded side of the bearing begins to build up rapidly until it reaches a maximum value. By further increasing the velocity, the temperature of the oil goes up and the viscosity of the oil drops. If the rate of increase in velocity is equal to the rate of decrease in viscosity, the thickness of the oil film does not change. If, instead, the viscosity decreases at a higher rate than the speed increases, the thickness of the oil film decreases and we may again have metallic contact between journal and journal box.

An oil of high viscosity will present less danger of seizing; but it will provide a less efficient lubrication on account of the coefficient of friction being high. The highest efficiency is obtained by approaching seizing as much as is consistent with the safety of the bearing, and by avoiding hand scraping of the journal boxes such as to minimize the danger of metallic contact with the high spots when the oil film becomes very small.

BEARING PRESSURE AND OIL FILM THICKNESS

The bearing pressure has also possibly some influence on the viscosity of the oil and, consequently, on the thickness of the oil film; but I do not know of any conclusive tests embodying their interrelation. The coefficient of friction is evidently inversely proportional to the thickness of the oil film, and either a smaller clearance or a lighter oil can be used with reamed bearings as compared with hand-scraped bearings, with which we are confronted with more danger of seizing on account of the thickness of the oil film becoming too small when the temperature reaches a certain limit.

Evidently there must be a minimum value of the coefficient of friction in film lubrication, and this minimum value, as derived by Sommerfeld from the hydrodynamic theory of Petroff (suitably modified according to Reynolds' idea on the influence of the variable thickness of the oil film), is only 0.94 of the starting coefficient of friction, which, according to Sommerfeld theory, is equal to the ratio of half the clearance between journal and journal box and the radius. According to Striebeck's experiments (*Ztschr. des Vereins Deutscher Ingenieure*, 46, 341, 1902) the starting coefficient of friction = 0.14 and the minimum coefficient of friction = 0.0038.

This minimum value is reached at different speeds by bearings working under different loads. The higher the load, the higher is the speed at which this minimum value is reached.

In designing bearings, evidently, we cannot exactly integrate all the factors entering in the predeterminations of the coefficient of friction and load-carrying power of the bearing, and it is obviously necessary to recur to some empirical formulas derived from experiments and expressed in a form well in accordance with the theory of lubrication.

FORMULAS FOR BEARING PRESSURE AND VELOCITY

Formulas (1) and (2), given before, will give us the coefficient of friction. The following formulas given by Illmer and derived from the experiments of Tower, Lasche, Thomas, Moore, Thurston and others give us the critical bearing pressure, $P_{(crit.)}$, beyond which the oil film breaks, and the maximum allowable velocity, $V_{(max.)}$, based upon an ample supply of suitable lubri-

cant at the rate of feed of about 350,000 sq.ft. of surface per gallon of oil.

$$P_{(crit.)} = 140 \sqrt{\frac{V}{T_0}} \text{ lb. per sq.in.} \quad (3)$$

$$V_{(max.)} = 2.5HT \sqrt{\frac{T_0}{P}} \text{ ft. per min.} \quad (4)$$

where P and T_0 have the same meaning as before, V = journal speed in ft. per minute, T = temperature rise of the rubbing surfaces over the temperature of the cooling medium (atmospheric temperature in case of naturally cooled bearings) in deg. F., and

$H = \frac{PVf}{T}$ = specific radiating capacity in foot-pounds per second of the bearing per square inch of projected area of rubbing surface, at 1 deg. F. temperature head.

The foregoing formulas apply especially to a steel journal running in a rigid babbitt-lined journal box.

The value of H depends on the mass of iron involved in the construction of the bearing. A massive construction will provide for the dissipation of the heat more liberally than a small bearing. The conditions of the surrounding air have also a good deal to do with the specific radiating capacity of a given bearing.

According to A. K. Pedersen (see *American Machinist*, Vol. 39, page 1017), a bearing made out of a large mass of iron and located in a place where the surrounding air is easily moved can carry off 77 per cent. more heat than a bearing of small mass located in still air.

From experiments made by the General Electric Co. on oil-ring bearings, the results of which were published in Mr. Alford's book,¹ is derived $H = \frac{(T + 33)^2}{A}$, where $A = 1,150$. Mr. Pedersen suggests to use for designing purposes for "still air" bearings and small masses $A = 1,860$.

Mr. Illmer finds that for heavy-duty commercial engines $H = 6$ ft.-lb. for main bearings, and is equal to between 4 and 5 ft.-lb. for outboard bearings. In small motor ring-oiler bearings substantially built, $H = 4$ ft.-lb. and for bearings of small masses can be as low as 2 ft.-lb. The above data apply only to the natural radiation of the bearing into the atmosphere. In case of water-cooling the value of H may be four times as large.

From Lasche's experiments H equals 3 ft.-lb., and from Thomas' experiments $H = 2$ ft.-lb. In a paper read in 1912 before the Rugby Engineering Society J. C. K. Balfry has collected some useful data on the present design of high-speed bearings, and these afford good evidence that designers have in the past been unnecessarily cautious in the load they allowed per square inch on the projected surface of such bearings.

The following figures are given by Mr. Balfry as representing the practice of the General Electric Co.:

Peripheral Velocity of Journal, Ft. per Sec.	Bearing Pressure in Lb. per Sq.In.	Peripheral Velocity of Journal, Ft. per Sec.	Bearing Pressure in Lb. per Sq.in.
20.0	167	60.0	229
30.0	190	73.5	235
40.0	208		

WATER-COOLING OF BEARINGS

High-speed bearings must be water-cooled, especially in the case of large bearings. The heat generated in a bearing for a given peripheral speed of the journal increases as the square of the dimensions of the bearing,

and the radiating surface from which it may be dissipated increases practically at the same rate. However, necessity for water-cooling arises sooner in the case of a large bearing than in the case of a small bearing.

Water-cooling protects the bearing during the instant of start or stopping when, on account of the oil film being broken, metal contact occurs with a consequent momentary high coefficient of friction and, in case of forced lubrication, if due to accumulation of dirt or scale at the inlet of the oil supply, the quantity of oil admitted becomes insufficient, or some solid particles get into the oil film. Water-cooling will prevent the temperature of the bearing from rising high enough to melt the babbitt and, outside of a few scratches left, the bearing will ordinarily recover itself after the particles of dirt have been forced out again.

DEDUCTION OF FORMULAS

If v_1 = peripheral speed of journal in feet per second, and v_2 = the maximum speed at which the journal could be run without any provision made for water-cooling, calling l and d the length and the diameter of the bearing in inches, P and f having the same meaning as before, the number of gallons of water per minute which must be provided for water-cooling (water at about 10 deg. C) is

$$Q = \frac{Pf(v_1 - v_2)ld}{1,940} \quad (5)$$

The product Pf is indicated sometimes as the "specific loss" of a given bearing and can be obtained from formula (1) or (2).

The temperature rise of a given bearing at a speed V , provided that the bearing pressure does not exceed the value of $P_{(crit.)}$ given in formula (3), is

$$T = \frac{0.4V}{H \sqrt{\frac{T_0}{P}}} \quad (6)$$

and

$$HP = \frac{PfVld}{33,000} \quad (7)$$

will give us the horsepower losses at a given speed V in feet per minute.

PERFECT AND IMPERFECT FILM LUBRICATION

According to A. K. Pedersen (see *American Machinist*, Vol. 37, page 599) the specific losses of a given bearing with a perfect film lubrication, for speeds above 500 ft. per min., are given by

$$Pf = \frac{51.2}{t - 32} \quad (8)$$

and for speeds below 500 ft. per min.

$$Pf = \frac{2.3 \sqrt{V}}{t - 32} \quad (9)$$

when t = temperature of oil film in deg. F.

Mr. Pedersen makes a distinction between perfect film lubrication and semiperfect film lubrication, and he puts oil-ring bearings among the semiperfect type. Evidently in the case of both forced lubrication and flooded lubrication we have types of perfect oil film. However, I believe that in the case of a ring-oiled bearing properly designed, constructed and lubricated we have as good a film as in the case of forced lubrication.

¹"Bearings and Their Lubrication."

Construction of Machinery for Laundries--II

BY FRANK A. STANLEY

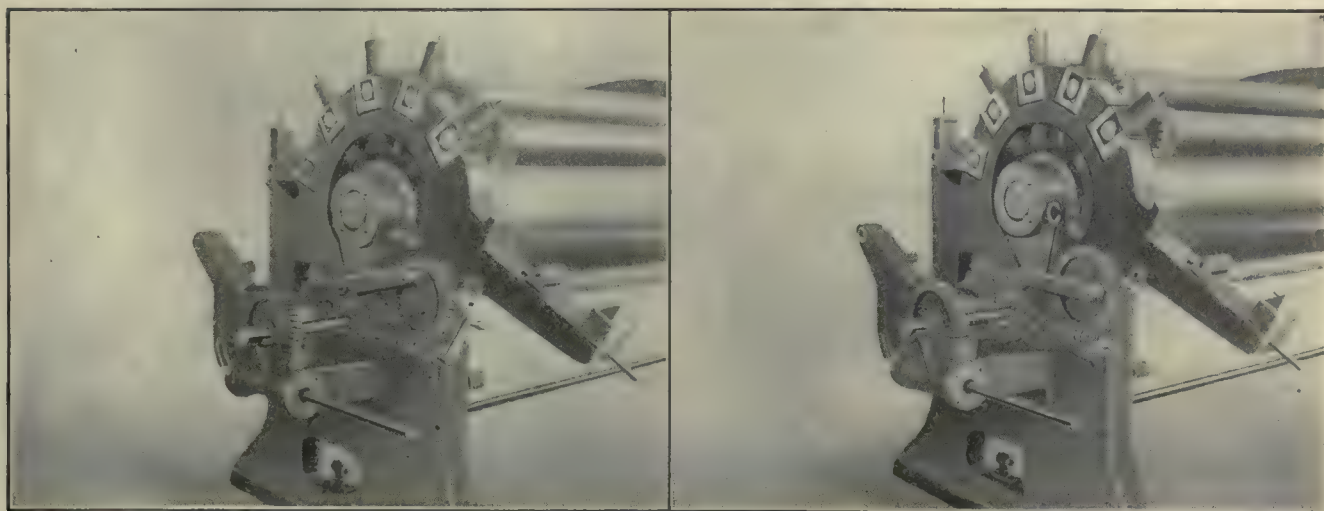
SYNOPSIS—Construction and operation of a clothes ironer and machining operations on the main frame. The production of smaller parts in fairly good-sized lots permits the use of special methods.

As mentioned in the first installment on this subject, one of the important points about the Watts ironing machine is the fact that the pressure is varied from that required for flat work to that for body work—miscellaneous articles with or without buttons—almost instantaneously by the simple moving of a lever. This is an easy operation, and there is no excuse for leaving the machine

The wormshaft, with the inner bevel gear for operation from the main driving shaft and the worm for operating the controlling wormwheel which lifts or drops the roll boxes, will be seen lying on the floor in Fig. 3 at the left-hand end of the machine. A clutch connection for drawing in or disconnecting the power drive for this wormshaft is controlled by a simple lever at the side of the gearing.

CHANGE IN ROLL POSITION

In Figs. 1, 2 and 3 the bearing boxes for the rolls are illustrated dropped to position for the pressure suitable for ironing the usual run of flat work. To lift these rolls sufficiently to admit what is called body work, operating disks *A* and *B*, Fig. 3, are rotated to the left by revolving



FIGS. 4 AND 5. A CONTROLLING DEVICE FOR PRESSURE ROLLS

with the heavy pressure needed on flat work when it should be changed for body-clothes ironing.

The arrangement of this mechanism as shown in the previous section is as follows: The five pressure rolls on top of the drier will be seen in Figs. 1 and 2, and their supporting boxes and the supporting boxes for these rolls are shown also in Fig. 3. These boxes are carried under adjustable spring control in brackets that are turned up with a cylindrical shank to pass down through the circular upper portion of the main housings of the laundry-machine frame. The lower ends will be seen projecting well down toward the bearing box for the drier neck, and it will be noticed that they are slotted fork-shape to receive short links whose lower ends are mounted on studs passing through an operating disk something like the wrist-plate of a Corliss engine.

An operating disk is placed at each end of the machine, and the two are connected to work in unison by suitable gearing and a long through-shaft with a connecting-rod passing from the crank side of the operating disk to the case of the worm gear, which is actuated by power from the bevel gear on the central driving shaft of the machine and by hand through a crank placed on the outer end of the wormshaft when desired to lift or drop the pressure rolls from the mangle.

the worm-operating mechanism to the position seen in Fig. 4. This shows a quarter-turn of the wormwheel from the original position, with the operating crank end of the links of the connecting-rod *C* in uppermost position. Here the short links *D*, Fig. 3, are swung into their radial position, thus lifting the boxes to the utmost extent possible at this setting. To drop the boxes and the rolls to original position, the operating worm gear is given another quarter-turn, bringing the connecting-rod *C* into horizontal position again, as in Fig. 5. The short links *B* then assume the same angle of position as shown in Fig. 3, but on the other side of the center, due to the fact that in the complete cycle of movements of the wormwheel at the side of the disks, *A* and *B* are operated to and fro instead of being turned directly around.

The top of each of the shoes or brackets for carrying the roll bearing boxes is capped with a spring cage in which the tension of the spring is adjusted by the screws clearly shown projecting from the top. The under side of the supporting brackets carries a spring also under the box. Each pair of roll boxes is thus independently adjustable to apply the desired degree of pressure to each individual roll, and of course the adjustment in each case is made in relation to the angle of position of the rolls in relation to the vertical center line of the machine, the

position by the weighted rocker-arm *D*, which carries crosswise of the shaft a conical wooden roller *E* bearing at all times upon the edge of the working apron passing over the rolls.

The upper surface of the block or base plate for the roll bearing block is provided at each end with a series of ratchet teeth sloping up from the center toward either end. With the apron traveling through at its proper position upon the rolls, the sole action of this double-ended pawl is to float back and forth without crowding the roll bearing either direction from normal. However, if the

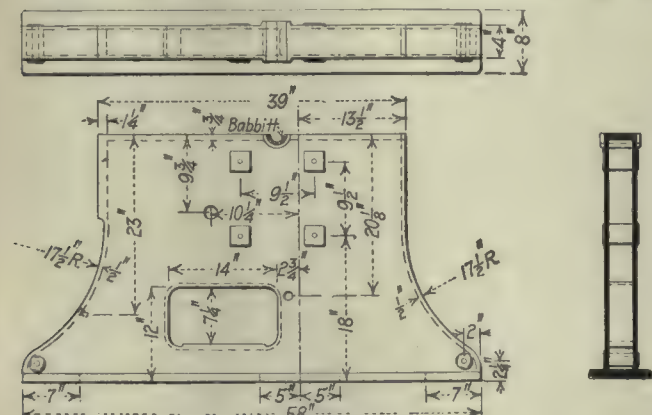


FIG. 9. BOTTOM MAIN FRAME

traveling apron begins to move toward either end of the roll, thus running out of its proper track, the crossarm of rocker lever *D*, on the other hand, allows it to drop, dependent upon which way the belt runs out of alignment.

The corresponding pawl *C* or *C'* in the floating action back and forth drops sufficiently to engage with the inclined ratchet teeth *F* at the corresponding end of the block, forcing the floating bearing for the roll either forward or back to produce the necessary condition of alignment with the other rolls to cause the apron to travel back into its normal path. This take-up and adjusting action is going on perpetually and is controlled from one edge,

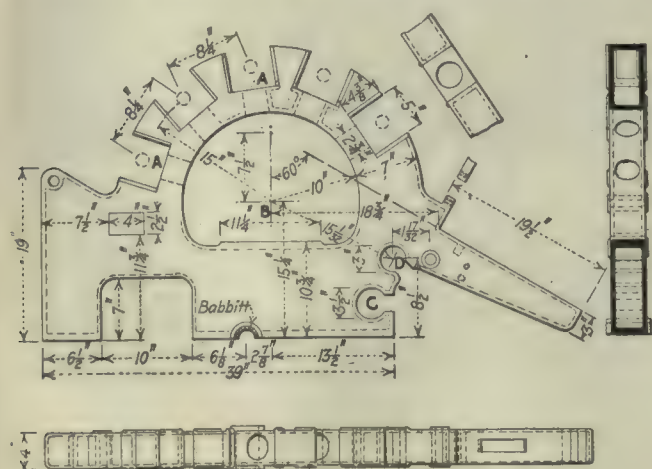


FIG. 10. TOP MAIN FRAME

where the mechanism operates without injuring the material in any way.

The importance of the proper tracking of this apron will perhaps be more clearly recognized when it is realized what a great number of rolls the apron passes over. This is best understood by looking at Figs. 7 and 8, where all the rolls with the exception of the side-pres-

sure ones above the top of the drier are shown in position, either by dotted or full circles.

This outline drawing is of value, as it also gives some hint of the method used in laying out the two members of the housing—the base and the upper portion of the frame—for boring the bearings, fitting up the boxes, etc.

FRAME DETAILS

The detail of the bottom main frame is given in Fig. 9 and of the top main frame in Fig. 10. These castings, while heavy in appearance, are cored out all the way around, leaving a wall about $\frac{3}{8}$ in. thick, so that the total weight is not excessive, although the metal is so disposed as to provide a rigid, substantial casting. These detail drawings give a better idea also of the operation of the machine and the manner in which the bearings are fitted up.

As is the case with some other lines of machinery, including certain textile machines, some classes of farm

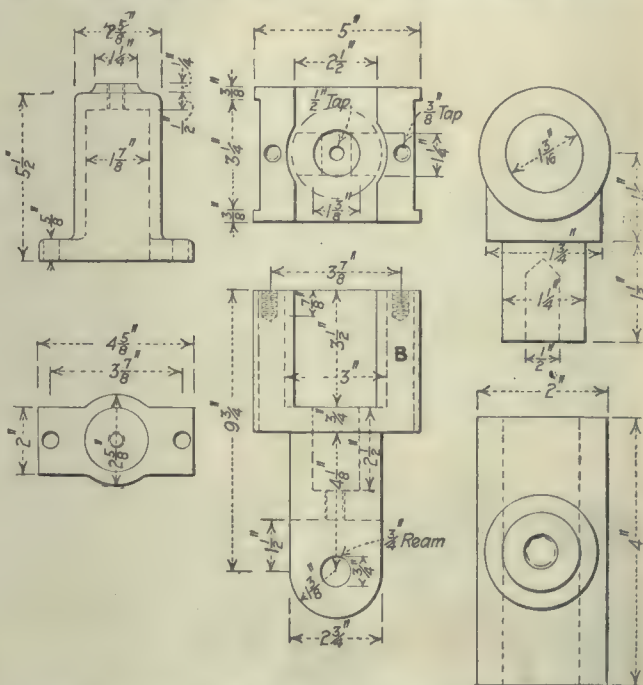


FIG. 11. DETAILS OF ROLL BEARING AND BRACKET

implements and other apparatus that might be mentioned, a number of surfaces on these laundry machines do not require any finishing other than cleaning up with chisel and file, the fit of the internal member being determined simply by casting it sufficiently small to enter freely into the corresponding opening in the carrying member. There are, in fact, aside from the immediate bearings for the journals of driers, driving shafts and rolls, few fits that have to be close, and in such cases it is often more a matter of having the parts so cast that they will go together without interference than of trying to establish a fairly accurate fit between corresponding surfaces which may seldom if ever come in contact with one another in operation.

In Fig. 10 at *A* are five pockets to receive the five brackets for carrying the roll bearings or boxes, one of which is shown assembled in Fig. 6. The detail parts are seen more clearly in Fig. 11, inspection of which will indicate the nature of certain of the surfaces to be fitted and placed. Thus the narrow ribs on the four vertical cor-

ners of bracket *B* in this detail are merely filed to smooth them off, as these brackets depend for the fit of the shank in the bored hole in the top frame for general support, this fit being a nice, free, sliding one, to admit proper adjustment of the boxes up and down, as required.

After the top and bottom of the lower main frame and the bottom of the top main frame have been planed, ready for putting together as in Fig. 8, center lines are laid off the right distance from the edges of the castings.

have also to be bored at certain points for bearing purposes.

A front view of this machine is given somewhat more conspicuously in Fig. 13, which represents clearly the method of setting up the job on the table of the machine and the type of tool used in boring the holes. Although these holes are shown open to the rear wall of the casting, they are actually cast with the wall integral. After the operation of boring, the intervening tie wall is cut out.



FIG. 12. FRAMES AND OTHER HEAVY WORK

Working lines are established from these so that all holes are in the right position to the center lines or may be struck at a given radius to some center, such as shown in Fig. 10, where the two box openings at *CD* are represented at a certain radius from the main center *B*. The center referred to is in this case a given distance above the base line of the top main frame, and the seat for the bearing for the drier neck is laid out from the same surface, so that the center will be accurately established. It remains, after laying out, to bore out the numerous holes through this frame and finish such surfaces as need to be fitted up for carrying corresponding parts.

The general view, Fig. 12, which gives an excellent idea of one department in this shop, shows among other things one of the top main frames mounted upon the bed of a boring machine for machining the two holes *C* and *D*, Fig. 10, just referred to. At the back of this machine will be noticed two of the bottom main frames, which

With other settings on the same machine all the other bearing openings are similarly bored.

Fig. 14 represents the method of setting up the work to bore the five radially located openings in the top main frame for carrying the brackets for the pressure roll boxes. To set the work for this operation, the bearing for carrying the drier neck is secured to the seat in the opening in the top main frame. The whole affair is then slipped over a large post secured to the bed of the boring mill. The angular spacing between these five holes is not required to be accurate enough to make it necessary to index the job by any precision method. It is important, however, that each hole should be closely centralized in the cored jaw openings on the inside, as these must receive freely the corresponding bracket for carrying the roll box. A position at one side of the center would make it necessary to do too much filing and fitting of the jaws to receive the bracket. The latter, as already explained,

is required to enter the radially bored holes with a nice sliding fit for the shank, which is turned up on a special fixture on an engine lathe.

After the frame casting has been swiveled about the supporting post until by testing with the single-point boring tool the cored opening is closely centered, it is readily bored with the power-feed motion of the spindle, and the work is then reset for the next hole. This is a fairly heavy job for so small a machine, but it is handled easily, the process being facilitated by the portable crane shown at the left in Fig. 14.

Some idea of the character of the different parts on such laundry machines can be gathered from examination

Constructing a Die for a Matted Surface

By EDWARD J. BESSOM

Recently I was confronted with the job of matting sheet steel in such a manner that articles made from it would present a firm grip to the hand. The metal to be used was 0.025 in. thick, and large production was expected. Therefore it was strictly a job for the power press.

For the die a piece of tool steel 6 in. square and 2 in. thick was obtained. This was planed all over and ground on one large surface. It was then clamped on the table of a slotter, and a punch ground to 60 deg. was made to

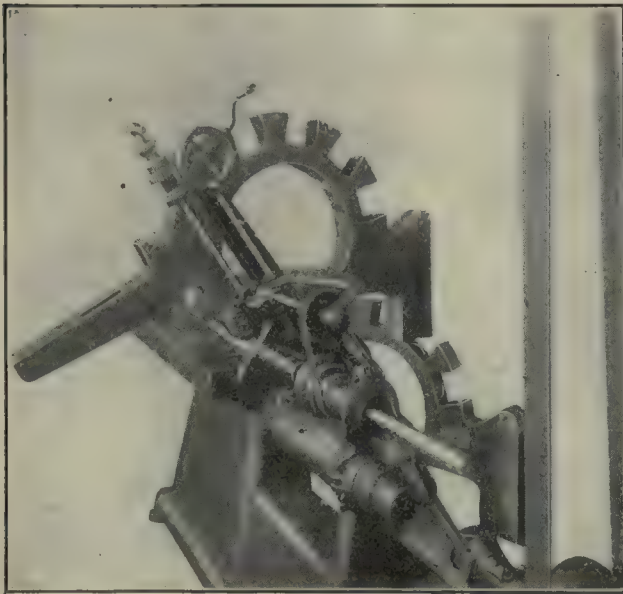


FIG. 13. BORING A SEAT FOR A BEARING IN THE



FIG. 14. BORING THE TOP FRAME

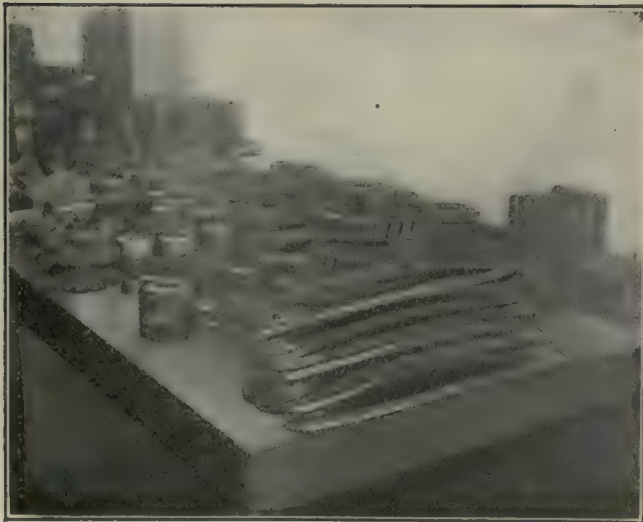


FIG. 15. SMALL PARTS TO BE MACHINED

of Figs. 12 and 14, which show more or less of the stock of rolls, levers, gears and castings required in the work of construction. A group of smaller parts, such as short links and levers, worm gear, boxes, sprocket wheels, collars and the like, will be seen on the bench illustrated in Fig. 15. Most of the latter work, except the chucking jobs, is handled in fairly good-sized lots, with simple fixtures to enable them to be grasped and machined properly, after which they may be quickly released for the admission of new work.

fit the tool holder. This punch was used to make small indentations on the surface of the die.

The automatic feed on the slotter was adjusted to feed about 0.025 in. per stroke. By this means the holes were spaced longitudinally, while transversely the spaces were kept even by using the graduations on the transverse feed and setting the table over 0.025 in. for each line of indentations.

The ram of the slotter was set for a long stroke, so that it would deliver a sharp, quick blow, as would a hammer, to the punch.

The rows of indentations were each stopped after passing a circle scribed on the face of the die. Then after the die was taken from the slotter, it was faced in the lathe until the center with the matted surface in it was $\frac{1}{64}$ in. higher than the rest of the die and $2\frac{3}{16}$ in. in diameter.

The die was made in about 12 hr.; the punch, or force, took less time and was made flat. This same method can be used for making the background for embossing dies.

Water Power in the United States, according to revised figures of the United States Department of Agriculture, is placed at the minimum of 27,493,000 hp. and maximum of 53,905,000, the minimum representing the amount of power that could be developed from the use of the average annual minimum stream flow for the lowest two consecutive seven-day periods of each year, while the maximum represents the amount that could be developed from the use of the average maximum continuous stream flow available for six months during the year. The national forests are stated to contain 30.4 per cent. of this minimum and 31.3 per cent. of the maximum, while over 72 per cent. of the country's total is found in the mountain and Pacific states.

System of Special Holders with Inserted Cutters

By EARL L. LIDDELL

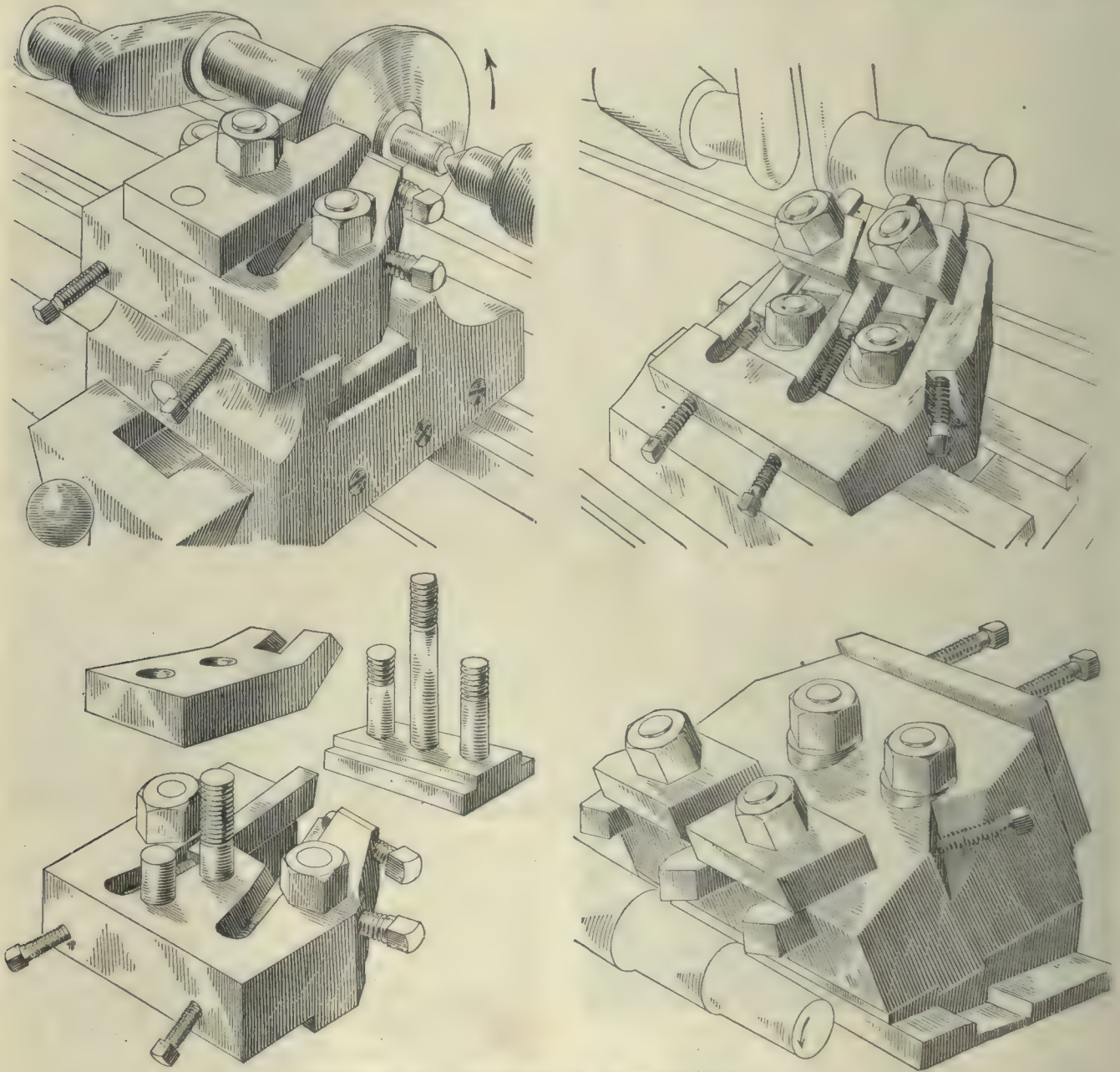
I have been assisting in the installation of a department producing special tool holders for use in the factory. This department has grown from a hazy idea to a complete smooth-running system. Each detail was added as the necessity presented itself. There was no effort to fit a system to the plant.

It started with the effort to install a tool-grinding system for making and grinding all lathe and similar

different operator cannot clamp it in an unsuitable position and then blame the tool shape for poor work.

We have found it necessary to keep in stock and use at least three times as many tools of each tool number as are needed for one day's supply. In some cases this requires a large number of tools on hand, so that, from the first, forged tools were quite impracticable. With but few exceptions, $\frac{5}{8}$ -in. square tool bits have been found large enough, and this size, with $\frac{1}{2}$ -in. and $\frac{3}{8}$ -in. square, covers most of the tools we use.

The design of the tool blocks and tool holders is the basis of this description. Instead of making a plain block



FIGS. 1 TO 4. APPLICATIONS OF MULTIPLE TOOLS

tools. In order for a workman to grind a tool with the use of which he is entirely ignorant it is necessary to have a drawing showing every detail accurately. The design must be such that an indefinite amount can be ground off the cutting end, grinding all angles each time, without changing the shape from the original.

The tool holder must be made to hold the tool to a certain set angle and height, so that a careless or in-

with wide slots for forged tools of indefinite shape, held perhaps by a plate with heavy setscrews in it, the small cutting tool is carefully designed, first, with reference to many points formerly never considered. For instance on the drawings of the small tools are shown the best shape for the material machined, feed and depth of cut and ease of grinding to uniform shape with least waste of the tool.

One thing which I never saw employed much before, but which we use universally, is a negative top rake on the cutting point. The top of the tool is ground on an angle of 5 or 10 deg. down (the ideal angle would be about 30 deg.) instead of high at the cutting edge. This makes it possible to remove pits and chipped spots from

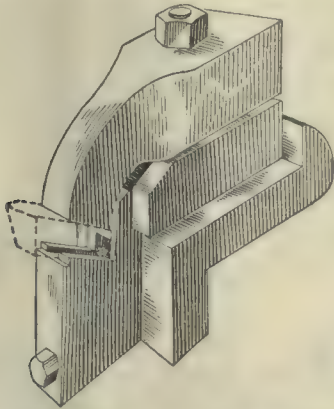


FIG. 5. METHOD OF HOLDING SINGLE TOOL

the top of the tool and preserve the proper length on the cutting edge without removing an excessive amount from the end. By grinding back to a fixed dimension from the end, the cutting edge is always the same height from the bottom. The same principle applies to grinding

the proper height and to form the correct angle with the work. When using a tool with negative top rake, it can either be raised enough above center, in a parallel position, to have the right cutting rake, or the rear end can be dropped down to secure the same result.

When a comparatively frail tool must have some adjustment sidewise in its slot, it is always provided with a setscrew or similar support out at the end where needed.

The method of holding that has been adopted almost universally, is to provide clamps as large and heavy as possible (within reason, of course) to bear on the top of the tool close up to the cutting end, for a length of 1 to 2 in. With a clamp of this nature and the bottom of the tool ground flat, with the side of the tool either bearing against the side of the slot or supported with an adjusting screw, the strength and rigidity of a very small tool are almost equal to that of the holder itself. When the tools are dropped down in the rear at more than a 10-deg. angle, it is necessary to support them with setscrews in a plate across the back of the block or holder.

The underlying principle is that tool blocks can be made to use small cutting tools, just as Armstrong and other holders have replaced many forged tools.

The results have justified the expense. Many hundreds of pounds of forged tools have been released from service, and much of this steel has been hammered down to small-

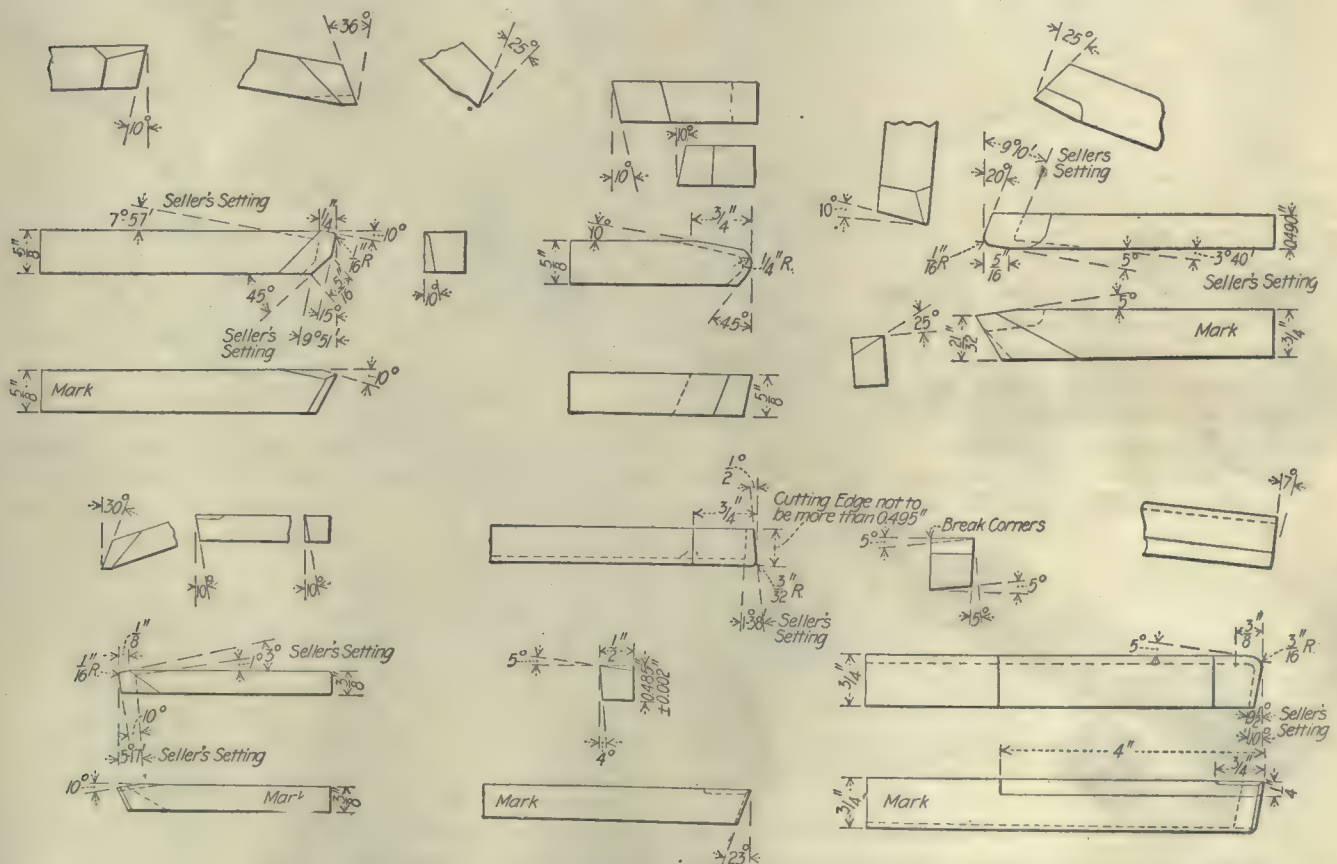


FIG. 6. LAYOUT AND NECESSARY INFORMATION REGARDING THE BITS

the side of the tool on the cutting edge. The size of the tool depends only partly on the severity of the cut. The room that there may be for building the holder around the point of the tool is an important feature.

When the tool itself has been drawn and approved, the tool holder is built around the tool, to hold it at

sized bars. Instead of having a very limited supply of stock on hand we have all that will be needed for some time to come, at the comparatively small expense of forging. The grinding department can sharpen tools at less cost than could the individual machine operators. The actual production time of each machine has been

increased a little for every day. The high-speed scrap amounts to but little, for when a tool is too short for one job it is used somewhere else, and there is no prospect of being held up by lack of high-speed steel.

The tools are all machine ground on the angles—a method that has proved to be cheap and fast and that insures accuracy; the radii are ground both by hand and by machine. The machines we use are one small Seller's grinder for forged tools, which we have adapted to grinding small tools, and several small cutter grinders. We have a special radius-grinding fixture of ingenious design, which not only grinds the radius on the end of a tool, but any angle, with any clearance, on each side of the radius. The work can be handled on this attachment with great accuracy and faster than it can be done in any other way and held to drawing.

Making Simple Dies and Templets

By W. J. WELLS

After seeing several simple dies spoiled in the making, owing to inexperience or nervousness on the part of the makers—young fellows trying to advance in this line of work—I am prompted to show an easy and simple method of making templets and dies that may be of interest to some of the younger mechanics.

The dies referred to were of the simple piercing and blanking type commonly known as follow dies, which were to produce blanks similar to the templet shown in Fig. 1. Any dimension could vary 0.004 or 0.005 in., but a variation $\frac{1}{64}$ in. would be too great.

Several blanks $\frac{1}{16}$ in. thick were wanted for experimental purposes, one to be used as a templet. The blanks were laid out with dividers and filed by guess, and the guessing was very poor as there were no two alike and all were far from what was required.

About the best way to make the first lot by hand is to cut several pieces of material to the proper length and width and clamp them together. Lay off the $\frac{1}{4}$ -in. holes 2 in. apart and drill and ream them. Large holes should not be drilled in *single* thin pieces when a *round* hole is required.

The next step is to make the gages shown in Figs. 2 and 3. The gage shown in Fig. 2 is for the $\frac{3}{8}$ -in. radius at the ends, and the flat shown on one side is for establishing a line $\frac{3}{8}$ in. each side of the center, which is half the width of the straight part of the link. The gage shown in Fig. 3 is a $\frac{1}{16}$ -in. washer $\frac{1}{16}$ in. thick with a $\frac{1}{4}$ -in. hole that fits over the stem of the templet, Fig. 2, which should be $\frac{7}{64}$ in. long. It requires only a few minutes to make these pieces and saves a lot of bother later. They should be casehardened in cyanide and used as templets in filing the ends of the work shown in Fig. 1.

In Figs. 4 and 5 is shown the proper way of holding the work to be filed. This finishes the model, and if we have worked with reasonable care up to this point we are ready for the die.

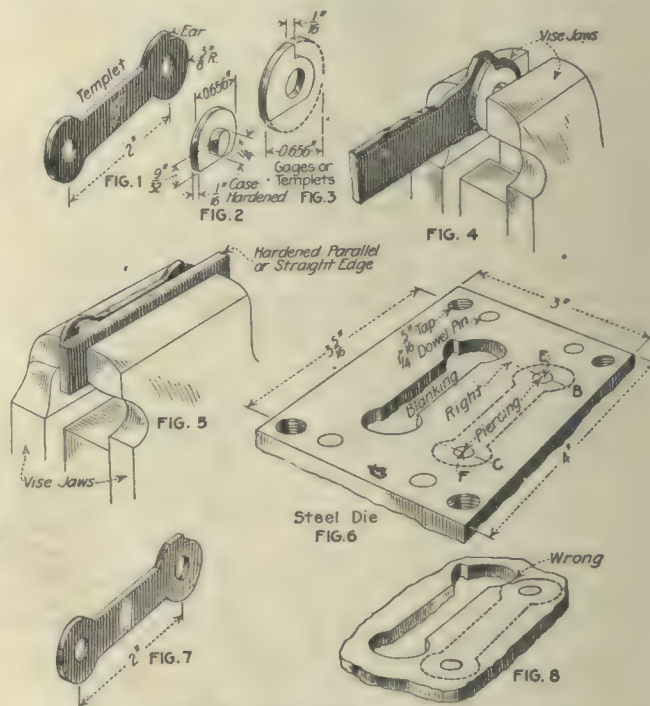
After the steel die block has been surfaced and squared, the face should be treated by heating until a dark-blue color is obtained, or by rubbing with a little clean waste dampened with sulphate of copper solution. Another good surface for a layout is obtained by filing or grinding off all tool marks and rubbing with emery cloth.

The rubbing should not be done straight across, but around and around, covering only a small portion at a time. Layout lines are easily seen upon this dull finish.

In Fig. 6 is shown the proper layout for this die.

With a very fine scriber draw the lines *B* and *C*, 2 in. apart, crosswise of the steel 1 in. from the center, and a line lengthwise about $\frac{1}{4}$ in. from the center. With the dividers set to $\frac{3}{8}$ in., which is the width of the templet at the large end plus $\frac{1}{16}$ in., which we allow for scrap, lay off *E* and *F*, using as centers the intersection of *B* and *C* with the lengthwise line. The layout should always be reckoned from the large end of the blank. Fig. 7 shows a blank with a clipped ear, the result of the layout shown in Fig. 8.

We could bore this die on the miller without a layout, but we would have to put the clearance in later, so it



SIMPLE DIES AND TEMPLETS

is best to do it in the lathe, using the compound rest set for $\frac{3}{4}$ -deg. clearance for the $\frac{3}{4}$ -in. holes, and taper-ream the $\frac{1}{4}$ -in. holes. The straight part in the middle can be drilled out and finished in the miller or shaper with an extension tool, and the $\frac{1}{16}$ -in. radius also. When the screw holes are drilled and tapped, and the dowel pin-holes drilled, the die is ready for hardening, after which it is ground on both sides and fitted to the shoe.

A templet should be marked "Die" on one side and "Punch" on the other, as an irregular punch will not fit the die if laid out from the same side of the templet. In laying out the die the surface marked "Die" should lie next to the steel, using the other side for the punch. As there are several styles of die shoes and punches, the workman should be governed largely by the material furnished. The piercing punch holes in the punch holder are located by drilling through the die from the back, with the blanking punch in place. The most important thing in a follow die is to place the piercing holes in proper relation to the blanking. Then the die becomes a master by which to make and align the punches.

The dotted outline of the blank on Fig. 6 is for the purpose of showing the proper layout.

United States Munitions*

The Springfield Model 1903 Service Rifle

Operations on the Receiver --II

SYNOPSIS—This article continues the detailed description of manufacturing operations on the Springfield rifle receiver, outlining many interesting milling operations and showing full details of the milling cutters and fixtures. The method of locating the receiver in the various jigs or fixtures is clearly shown.

OPERATION 11. MILLING RIGHT SIDE TO FINISH

Transformations—Same as Fig. 281. Machine Used—Pratt & Whitney Lincoln type belt-drive miller. Number of Operators per Machine—One. Work-Holding Devices—Work clamped to block, using bottom as working points, Fig. 291. Tool-Holding Devices—Cutters held on standard arbor. Cutting Tools—Similar to Fig. 283. Number of Cuts—One. Cut Data—Speed, 50 r.p.m.; $\frac{1}{2}$ -in. feed. Coolant—Cutting oil, drop at a time. Average Life of Tool Between Grindings—2,000 pieces. Gages—Similar to Fig. 296; the fingers show if form is right; other gages same as operation 9. Production—20 pieces per hour. Note—Stops A and jaws B, Fig. 291. Side gaged by straight-edge across top of mandrel.

OPERATION AA. REMOVING BURRS AFTER OPERATION 11

Number of Operators—One. Description of Operation—Scraping burrs left on edges from operation 11. Apparatus and Equipment Used—File and scraper. Production—280 per hr.

*Copyright, 1916, Hill Publishing Co.

OPERATION 13. MILLING LEFT SIDE TO FINISH

Transformation—Fig. 292. Machine Used—Pratt & Whitney Lincoln type belt-drive miller. Number of Operators Per Machine—One. Work-Holding Devices—Special vise, Fig. 293, located by bottom. Tool-Holding Devices—Cutters held on arbor. Cutting Tools—Form cutters, Fig. 294. Number of Cuts—Two. Cut Data—Speed, 50 r.p.m.; $\frac{1}{2}$ -in. feed. Coolant—Cutting oil, drop at a time. Average Life of Tool Between Grindings—2,000 pieces. Gages—Stand and form, Figs. 295 and 296. Production—20 pieces per hour.



FIG. 297

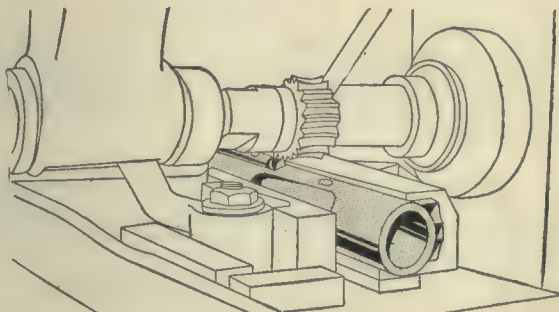


FIG. 298

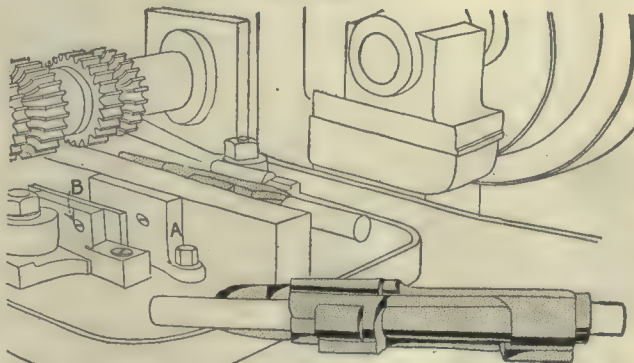


FIG. 293

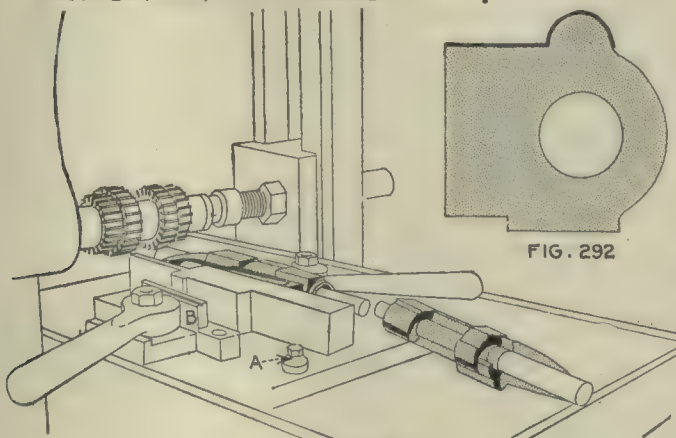


FIG. 292

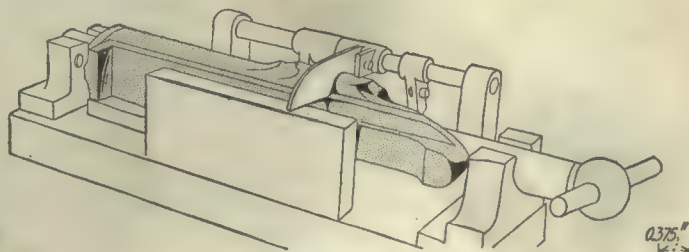
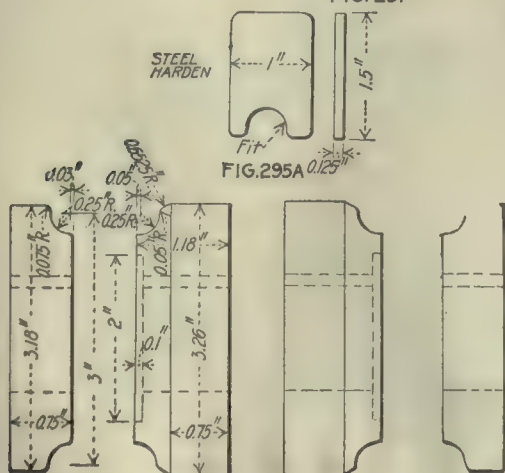
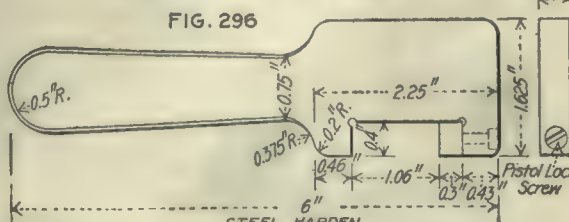


FIG. 296



Fit to Gage. 24 Teeth, Straight, L.H.

FIG. 294



STEEL HARDEN

FIG. 295B

OPERATION BB. REMOVING BURRS LEFT BY OPERATION 13

Number of Operators—One. Description of Operation—Filing burrs from edge after operation 13. Apparatus and Equipment Used—Cut, file and scraper. Production—250 per hr.

OPERATION 14. MILLING LEFT SIDE, FRONT END

Transformation—Fig. 297. Machine Used—Standard No. 41½ Universal. Number of Operators per Machine—One. Work-Holding Devices—Fig. 298. Tool-Holding Devices—Held on arbor. Cutting Tools—Hollow radius cutter, Fig. 299. Number of Cuts—One. Cut Data—Speed, 270 r.p.m.; feed, 3 in. per min. Coolant—Compound. Average Life of Tool Between Grindings—200 pieces. Gages—Fig. 300. Production—40 pieces per hour. Note—Side and bottom are working points.

OPERATION 15. MILLING LEFT SIDE OVER CUTOFF- SPINDLE HOLE

Transformation—Fig. 301. Machine Used—Whitney Manufacturing Co. hand miller No. 6. Number of Operators per Machine—One. Work-Holding Devices—Work held as in Fig. 303, working from hole and bottom. Tool-Holding Devices—Cutters held in holder, taper hole. Cutting Tools—Form cutter, Fig. 304. Number of Cuts—Two. Cut Data—Speed, 300 r.p.m.; hand feed. Coolant—Compound, ¼-in. stream. Average Life of Tool Between Grindings—200 pieces. Gages—Stand gage and templet, Fig. 305; A, distance gage; B, form gage of finger type. Production—40 pieces per hour. Note—Machining diagram, Fig. 302.

OPERATION CC. REMOVING BURRS AFTER OPERATION 14

Number of Operators—One. Description of Operation—Filing burrs left by cutter. Apparatus and Equipment Used—File and scraper. Production—250 per hr.

OPERATION 17. MARKING BARREL

Transformation—Fig. 306. Number of Operators—One. Description of Operation—Stamping "draw" line on receiver for thread milling to match with that on barrel. Apparatus and Equipment Used—Fixture with stamp, operated by hand lever, Fig. 307. Gages—Gaging from side of lug, Fig. 308; also shown in place at A, Fig. 307. Production—350 per hr. Note—Working points, hole and bottom.

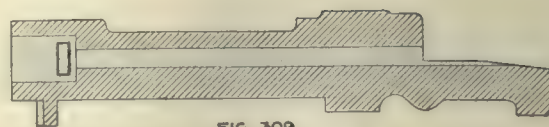


FIG. 309

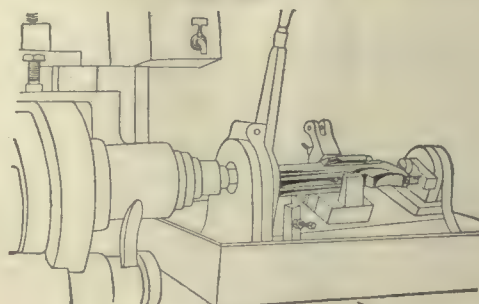


FIG. 310

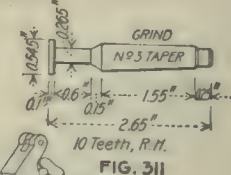


FIG. 311

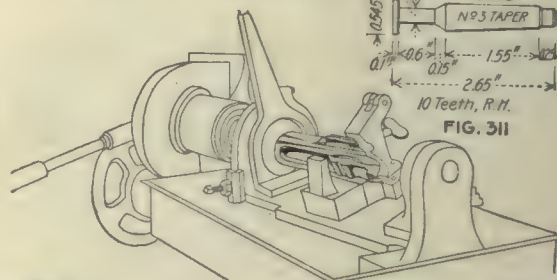


FIG. 310



FIG. 312A

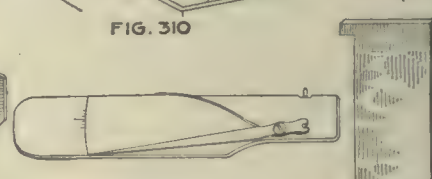


FIG. 312B

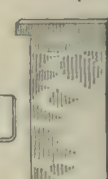


FIG. 312C

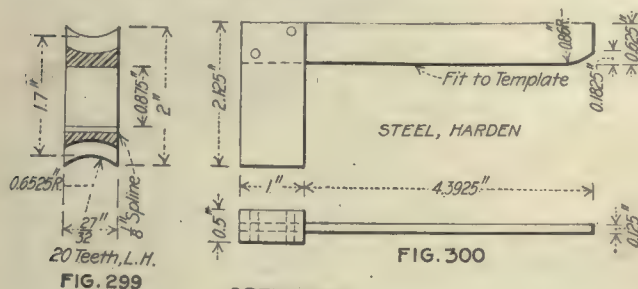


FIG. 299

OPERATION 14

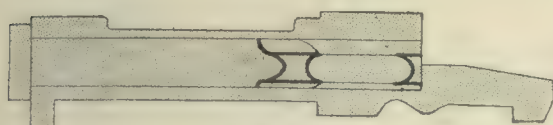


FIG. 301



FIG. 302

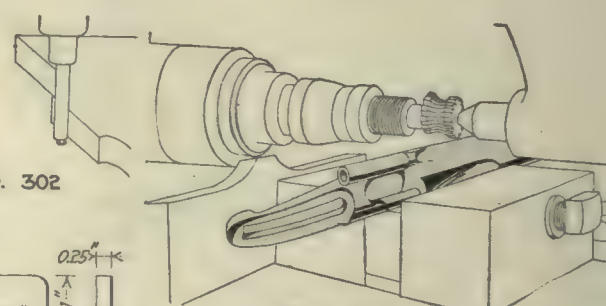


FIG. 303

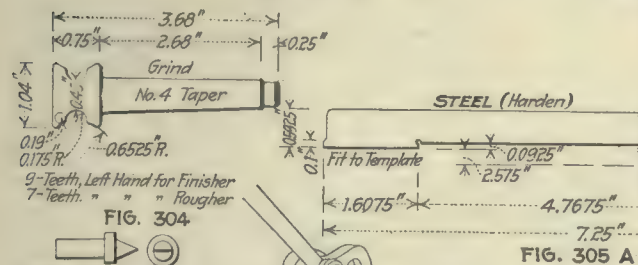


FIG. 304

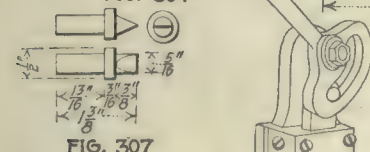


FIG. 307

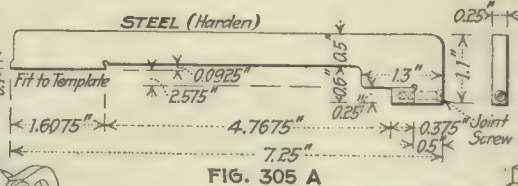


FIG. 305 A



FIG. 306

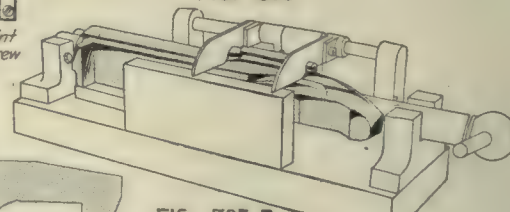


FIG. 305 B

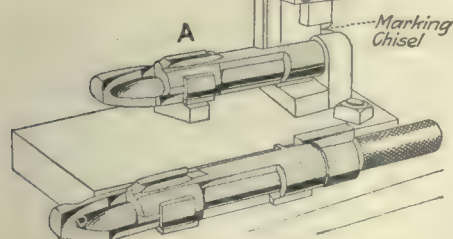


FIG. 307

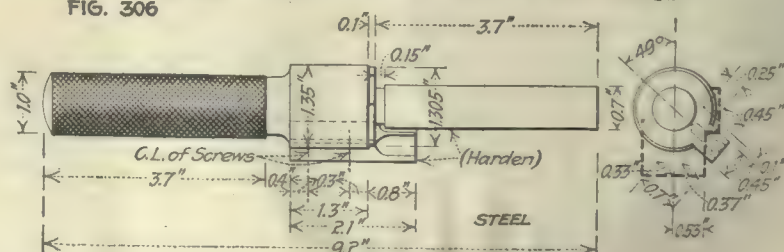


FIG. 308

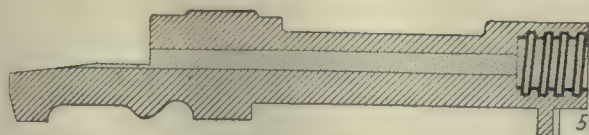


FIG. 313

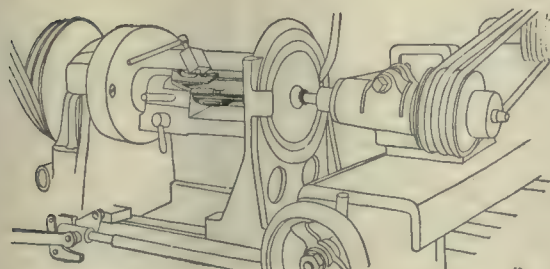
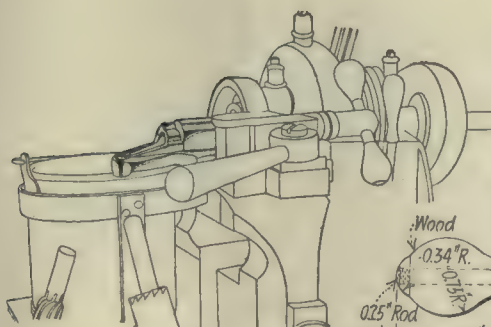


FIG. 314



315-D

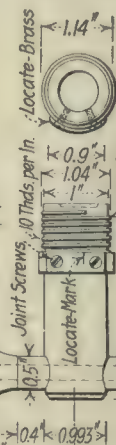


FIG. 316

OPERATION 18

OPERATION 16. HAND MILLING FOR END OF THREAD

Transformation—Fig. 309. Machine Used—Whitney hand miller No. 6. Number of Operators per Machine—One. Work-Holding Devices—Work held in a hand, rotating fixture, Fig. 310. Tool-Holding Devices—Taper shank. Cutting Tools—Taper-shank cutter, Fig. 311. Number of Cuts—One. Cut Data—Speed, 600 r.p.m.; hand feed. Coolant—Cutting oil, $\frac{1}{16}$ -in. stream. Average Life of Tool Between Grindings—About 200 pieces. Gages—Distance, 0.572 in., Fig. 312-A; depth, Fig. 312-B; width of slot, 312-C. Production—About 100 per hr. Note—Working points, outside of front end and bottom.

OPERATION 18. THREAD MILLING FOR BARREL

Transformation—Fig. 313. Machine Used—Pratt & Whitney 14-in. thread miller. Number of Machines per Operator—

In manufacturing the Springfield rifle receiver, the Lincoln type miller, the plain miller and the profiler are much in evidence. Some of the operations are performed in fixtures which hold a single receiver while at other times, when the cutting capacity of the machine permits, it will be noted that two receivers are machined at once. Examples of single milling are shown in Figs. 293, 298, 303, 342, 350 and 366. Examples of milling in pairs are not as frequently found in the operations illustrated in this particular section but one good example of this practice is shown in Fig. 318 in which the top of the receiver is being milled to its finished form.

The use of gang milling cutters on the receiver is evident in the illustrations accompanying this article and will be further emphasized as the description proceeds. A good example is shown in Fig. 342 in which the top of tang and overwell are milled to remove the rough stock. The machine used in this case is a Pratt & Whitney No. 3 Lincoln type miller with belt drive. The fixture used to hold the work for this operation is of a type very generally used at the Springfield arsenal and consists of a vise with a sliding jaw actuated by a cam with a handle, the work itself being first accurately set

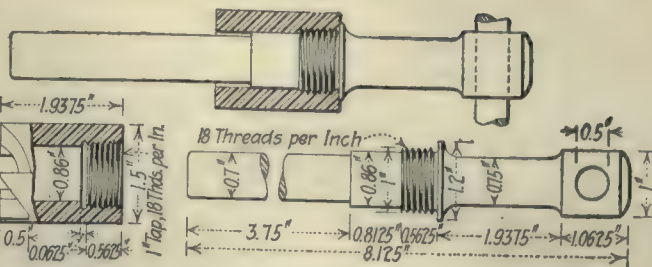


FIG. 315 B

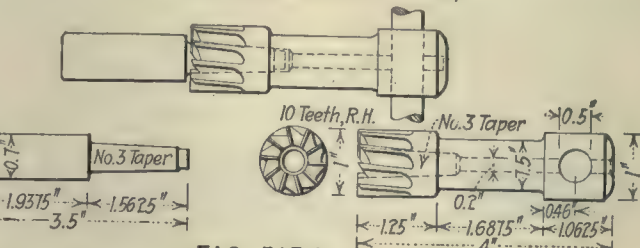


FIG. 315 C

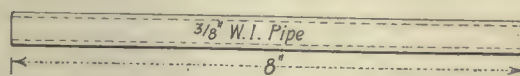


FIG. 315 A

Two. Work-Holding Devices—Work held in fixture, using front end and tang as guiding points, Fig. 314; Fig. 315-B shows use for hand reaming, the tools used and the thread gage in place. Tool-Holding Devices—Pratt & Whitney arbor, 315-A. Cutting Tools—Standard thread cutter, Fig. 315-A; hand facing and counterboring tools, Figs. 315-B and 315-C. Fig. 315; A, milling cutter; B, hand facing tool; C, hand counterbore; D, use for handwork and gaging. Number of Cuts—One. Cut Data—30 r.p.m. for the work; cutter, 450 r.p.m. Coolant—Cutting oil, $\frac{1}{4}$ -in. stream. Average Life of Tool Between Grindings—200 pieces. Gages—Plug thread, Fig. 316. Production—35 per hr., two machines. Note—Fig. 315-D also shows plug thread gage in place. The thread is milled with a single cutter to insure an accurate duplication of threads, which is quite necessary to prevent gas leakage.

upon an arbor before being gripped in the vise jaws. Sliding-jaw fixtures of this type are not only quick in action and allow the easy removal of the work but also hold the piece rigid against a heavy cut which is particularly essential on roughing operations.

Another case of duplex milling is shown in Fig. 322 which is the set-up for operation 20, milling the underside of the tang. It will be noted that the same type of sliding-jaw vise fixtures is used for this operation.

Among the interesting profiling operations is the one shown in Fig. 327 in which the underside of the tang on the right hand side of the receiver is being profiled. This illustrates another convenient form of holding device, also cam actuated, which has a quick release and also sufficient leverage to resist the comparatively light strain of profiling, although it would probably not have holding power enough if applied to a heavier milling operation.

The thread miller comes into play in cutting the internal thread which fastens the receiver to the rifle barrel. Each operator on this work runs two machines while the work is held in fixtures using the front end and the tang as guiding points. A production of 35 pieces per hour for two machines and one operator is obtained.



FIG. 330

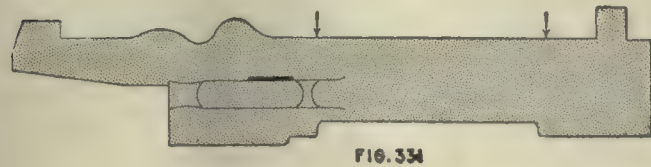


FIG. 334

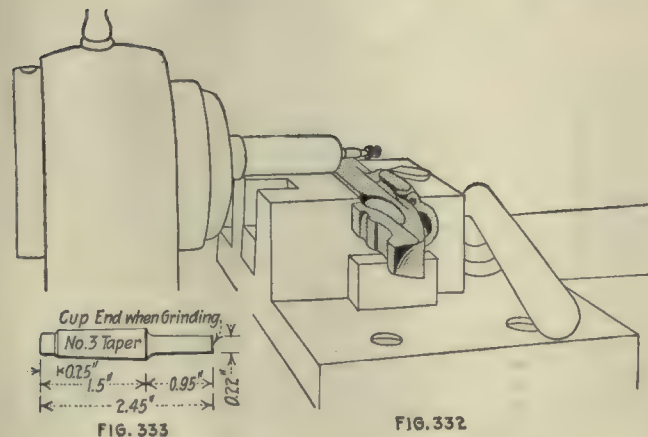
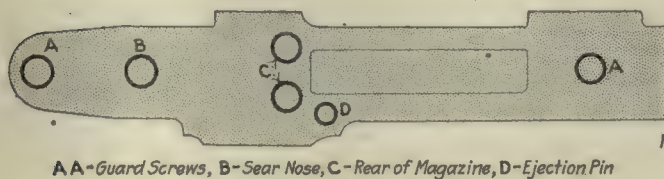


FIG. 333

FIG. 332



AA-Guard Screws, B-Sear Nose, C-Rear of Magazine, D-Ejection Pin

FIG. 334

Operation 22

OPERATION 21. PROFILING UNDER SIDE OF TANG, RIGHT

Transformation—Fig. 325. Machine Used—Pratt & Whitney profiler No. 2. Number of Operators per Machine—One. Work-Holding Devices—Work held on mandrel, clamped in fixture, Fig. 327; note the pivoted, swinging clamp with cam; working points, hole and bottom. Tool-Holding Devices—Taper shank. Cutting Tools—Round-nose profile cutter, right hand, Fig. 328. Number of Cuts—Two. Cut Data—Speed, 1,200 r.p.m.; hand feed. Coolant—Compound, $\frac{1}{4}$ -in. stream. Average Life of Tool Between Grindings—200 pieces. Gages—Form, Fig. 329. Production—65 per hr. Note—Machining diagram, Fig. 326.

OPERATION DD. REMOVING BURRS LEFT BY OPERATION 21

Number of Operators—One. Description of Operation—Filing burrs left on edge after operation 21. Apparatus and Equipment Used—Flat file. Production—300 per hr.

OPERATION 22. PROFILING UNDER SIDE OF TANG, LEFT

Transformation—Fig. 330. Machine Used—Pratt & Whitney profiler No. 2. Number of Operators per Machine—One. Work-Holding Devices—Same as operation 21. Tool-Holding Devices—Same as operation 21. Cutting Tools—Two, same as Fig. 328, except left hand. Number of Cuts—One. Cut Data—Speed, 1,200 r.p.m.; hand feed. Coolant—Compound, $\frac{1}{4}$ -in. streams. Average Life of Tool Between Grindings—200 pieces. Gages—Fig. 329, gages both sides. Production—65 per hr. Note—Machining diagram, reverse of Fig. 326.

The intricate shape of the receiver and the many cuts made upon it conspire to render the design of testing fixtures rather difficult. It is interesting to note the way in which these different things have been overcome and the resulting fixtures which are used in gaging the various out of the way surfaces. A good example of this is shown in Fig. 334 for testing the milling of the underside of the tang and also in Fig. 337 where the alignment of the guard screw, ejector pin and sear nose is tested. It will be noted from the construction of this

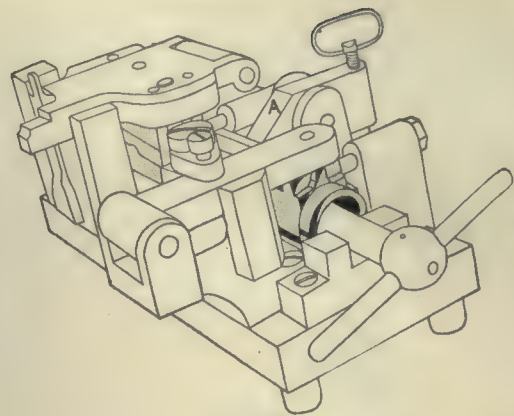


FIG. 335

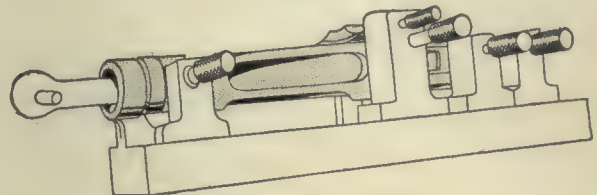


FIG. 336

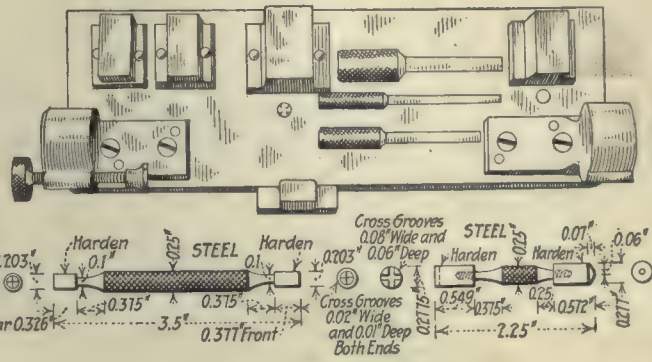


FIG. 337

OPERATION EE. REMOVING BURRS LEFT BY OPERATION 22

Number of Operators—One. Description of Operation—Filing burrs off tang left by operation 22. Apparatus and Equipment Used—Flat file. Production—300 per hr.

OPERATION FF. HAND MILLING TO REMOVE STOCK FOR OPERATION 23

Transformation—Fig. 331. Machine Used—Brainard hand miller. Number of Operators per Machine—One. Work-Holding Devices—Work held in vise jaws, locating from hole and bottom, Fig. 332. Tool-Holding Devices—Taper shank. Cutting Tools—End mill, Fig. 333. Number of Cuts—One. Cut Data—Speed, 900 r.p.m.; hand feed. Coolant—Cutting oil put on with brush. Average Life of Tool Between Grindings—2,500 pieces. Production—175 per hr. Note—This simply mills a flat spot for starting drill.

OPERATION 23. DRILLING GUARD-SCREW, EJECTOR-PIN AND SEAR-NOSE HOLES

Transformation—Fig. 334. Machine Used—Pratt & Whitney four-spindle upright drilling machine. Number of Operators per Machine—One. Work-Holding Devices—Work held in drill jig, Fig. 335; located by mandrel, held by clamp A; bushings in swinging leaves. Tool-Holding Devices—Drill held in drill chuck. Cutting Tools—Twist drills. Cut Data—400 r.p.m.; hand feed. Coolant—Cutting oil, $\frac{1}{4}$ -in. stream. Average Life of Tool Between Grindings—From 300 to 400 pieces. Gages—Stand, Fig. 336, and plug, Fig. 337. Production—20 pieces per hr.

inspecting fixture or stand that a very slight discrepancy between the centers of these holes may be instantly detected. It should also be noted that the inspection fixtures as far as holding the work is concerned, follow in principle the jig illustrated in Fig. 335 which is a good point to follow in shop practice in general.

This principle is often overlooked, especially in shops where designing of tools and gages is not handled under a central organization. In such cases one man is likely to design the jig or holding fixture for the work and

OPERATION 24. DRILLING SEAR-JOINT PIN HOLE, ETC.

Transformation—Fig. 338. Machine Used—Dwight Slate Co. three-spindle upright drilling machine. Number of Operators per Machine—One. Work-Holding Devices—Work held in drill jig, Figs. 339-A and 339-B, located by mandrel A held



FIG. 338

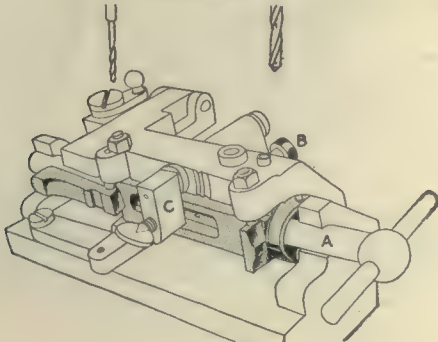


FIG. 339A

OPERATION 25. MILLING TOP OF TANG AND OVERWELL

Transformation—Fig. 341. Machine Used—Pratt & Whitney No. 3 Lincoln type, belt drive. Number of Machines per Operator—Two. Work-Holding Devices—Special fixture, Fig. 342. Tool-Holding Devices—Cutters held on standard arbor

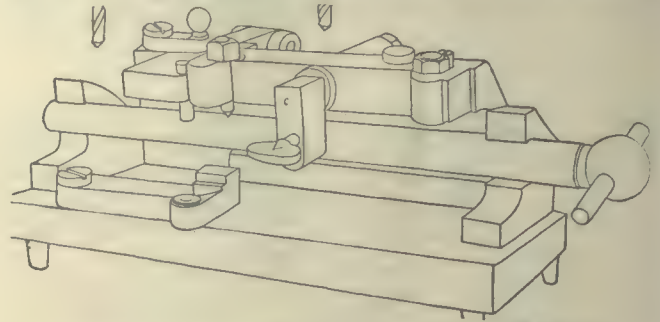


FIG. 339B

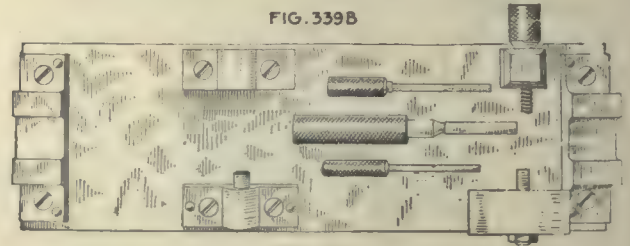
FIG. 340
OPERATION 24

FIG. 341

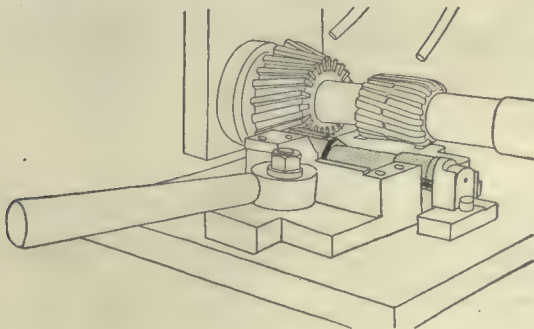


FIG. 342

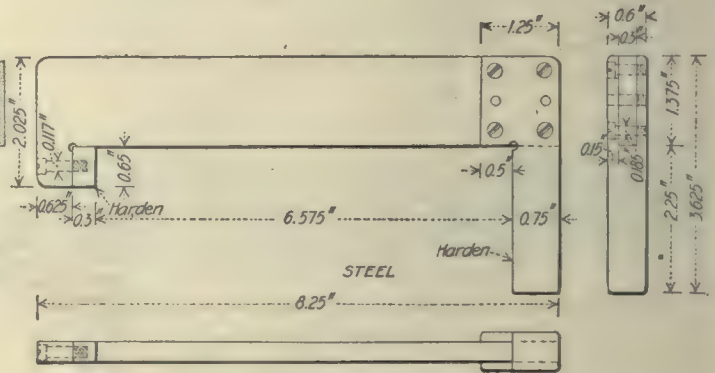


FIG. 344A

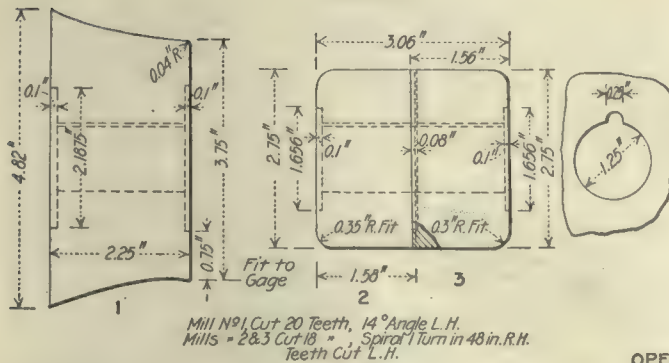


FIG. 343

Mill No. 1, Cut 20 Teeth, 14° Angle L.H.
Mills = 2 & 3 Cut 18°, Spiral 1 Turn in 48 in. R.H.
Teeth Cut L.H.

OPERATION 25

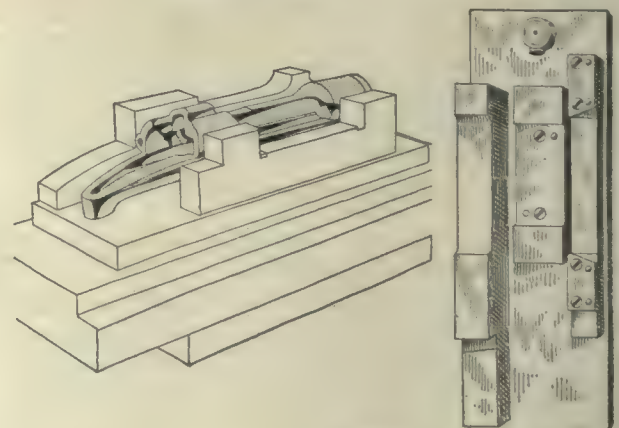


FIG. 344B

against stops B by thumb-screw in swinging clamp C; Fig. 339-B shows jig empty, with mandrel in place. Tool-Holding Devices—Drill chucks. Cutting Tools—Twist drills. Cut Data—Speed, 600 r.p.m.; hand feed. Coolant—Cutting oil, 1/2-in. stream. Average Life of Tool Between Grindings—200 to 400 pieces. Gages—Stand, Fig. 340. Production—35 pieces per hr.

OPERATION GG. BURRING OPERATIONS 23 AND 24

Number of Operators—One. Description of Operation—Scraping burrs left by drill in operations 23 and 24. Apparatus and Equipment Used—File and scraper. Production—300 per hr.

Cutting Tools—Two form cutters, Fig. 343. Number of Cuts—One. Cut Data—50 r.p.m.; 1/8-in. feed. Coolant—Compound, two 1/4-in. streams. Average Life of Tool Between Grindings—1,000 pieces. Gages—Fig. 344: A, rear shoulder from front end; B, contour and sides; use straight-edge resting on side. Production—20 pieces per hr. Note—Working points, side and bottom.

OPERATION HH. REMOVING BURRS LEFT BY OP. 25

Number of Operators—One. Description of Operation—Milling burrs that are thrown up around well in operation 25. Apparatus and Equipment Used—Hand mill with pilot Gages—None. Production—Burrs as they come from operation 25, 40 pieces per hr., two machines.

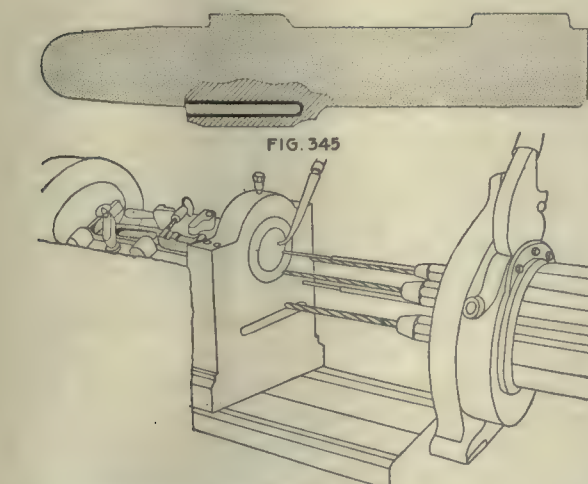


FIG. 345

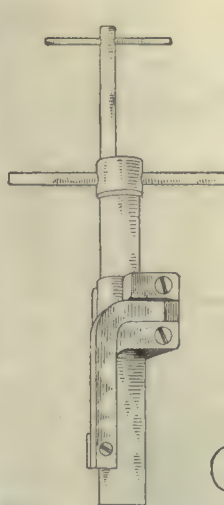


FIG. 348B

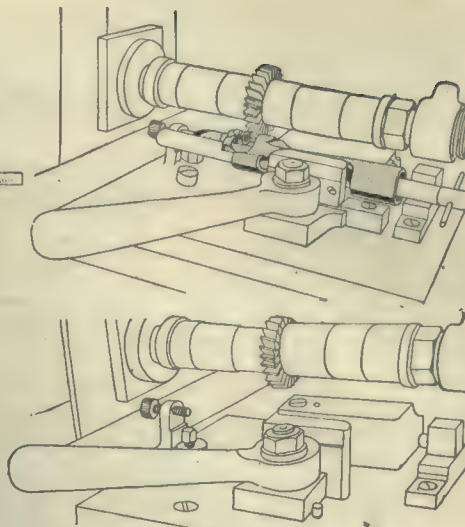


FIG. 350

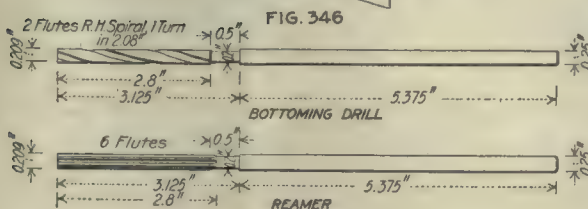


FIG. 347

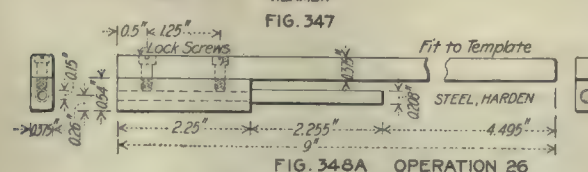


FIG. 348A OPERATION 26

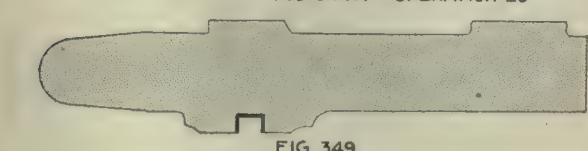


FIG. 349

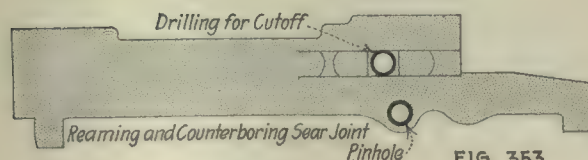


FIG. 353

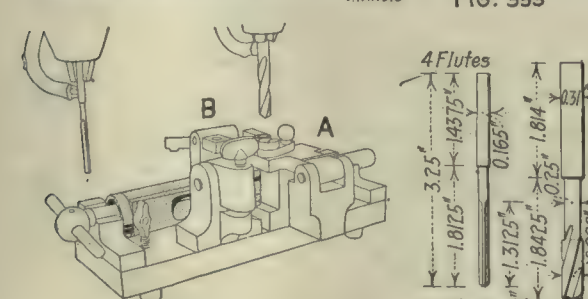


FIG. 354

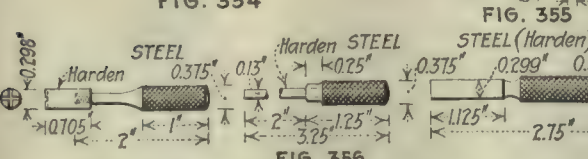


FIG. 355

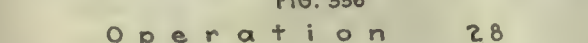


FIG. 356

Operation 28

another man, possibly in another department will design the testing fixture for this same piece. Under such circumstances, where the inspection is at all complicated, there is likely to be a large number of rejections due to the springing of the piece in the gaging fixture. If,

OPERATION 26. DRILLING AND REAMING CUTOFF HOLE AND BOTTOMING HOLE

Transformation—Fig. 345. Machine Used—Pratt & Whitney hand screw machine, 16 in. Number of Operators per Machine—One. Work-Holding Devices—Work held in mandrel in fixture bolted to head of machine; Fig. 346 shows general view with details of holding fixture. Tool-Holding Devices—Drills held in chuck in turret of machine. Cutting Tools—One $\frac{13}{64}$ standard twist drill, two $\frac{13}{64}$ in. and reamer 0.209 in.; Fig. 347. Number of Cuts—Three. Cut Data—Speed, 60 r.p.m.; hand feed. Coolant—Cutting oil, $\frac{1}{4}$ -in. stream. Average Life of Tool Between Grindings—350 pieces. Gages—Fig. 348; A, depth of hole; B, location with well hole. Production—20 pieces per hr. Note—Working points, bottom and hole; first drill spots hole for following drills.

OPERATION 27. MILLING FOR CUTOFF

Transformation—Fig. 349. Machine Used—Pratt & Whitney No. 2 Lincoln type belt drive. Number of Machines per Operator—Two. Work-Holding Devices—Work held on mandrel, Fig. 350. Tool-Holding Devices—Cutter held on arbor. Cutting Tools—Side-milling cutter, Fig. 351. Number of Cuts—One. Cut Data—Speed, 60 r.p.m.; $\frac{1}{4}$ -in. feed. Coolant—Compound, $\frac{1}{4}$ -in. stream. Average Life of Tool Between Grindings—1,000 pieces. Gages—Fig. 352; A, length from front end, and width of slot; B, depth of cut from left edge of bottom. Production—40 pieces per hr.

OPERATION 28. DRILLING FOR CUTOFF, REAMING AND COUNTERBORING SEAR-JOINT PIN HOLE

Transformation—Fig. 353. Machine Used—Dwight Slate Co. 16-in. three-spindle upright drilling machine. Number of Operators per Machine—One. Work-Holding Devices—Drill jig, Fig. 354; located by mandrel and right side, held by clamp A and thumb-screw B. Tool-Holding Devices—Drill chuck. Cutting Tools—One twist drill, one reamer and counterbore, Fig. 355. Number of Cuts—Three. Cut Data—Speed, 800 r.p.m.; hand feed. Coolant—Cutting oil, $\frac{1}{4}$ -in. stream. Average Life of Tool Between Grindings—140 pieces. Gages—Fig. 356. Production—20 pieces per hr. Note—Drill jig has two leaves with bushings, one for each size hole; one front and one back.

however, it is held in the same manner in the gaging fixture as it is held in the jig and with about the same amount of pressure on the holding screws, this trouble is largely avoided and rejections will not be as frequent, provided the jig itself is properly made.

Letters from Practical Men

Special Jig for Universal-Joint Manufacture

In the manufacture of universal joints we first drill, bore, ream and face the yoke hubs. These are machined to suit the specifications of the purchaser. They are made of drop forgings and consequently are subject to the varying dimensions common to all forgings.

The jig shown, Figs. 1 and 2, was designed to take care of all these varying dimensions and yet to center the work accurately, so that the hole through the hub will come central with the two projecting ears of the yoke designed to receive the working bearings of the joint. This is done by actuating the clamping levers through a system of wedges carried on sliding pieces running in planed ways, thus holding the travel of the wedge in a

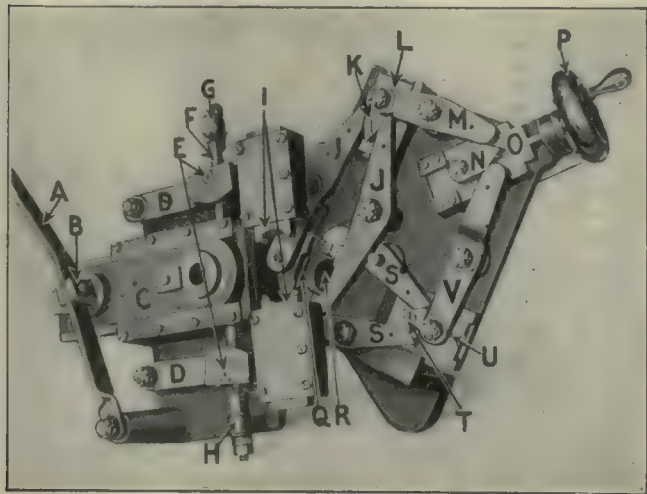


FIG. 1. JIG TURNED UP TO SHOW MECHANISM

straight line regardless of the inequality of the pressure of the two levers operating on each side of the wedge. The opposite ends of the levers are designed to grip the work, while the fulcrum upon which they are pivoted is placed nearly in the center. The yoke to be machined is placed in the jig in a vertical position with the hub end up.

The wedge-actuated levers are for gripping the fork end of the yoke only, while the hub, which is approximately round, is held between two jaws actuated by levers containing swivel nuts, one of which is tapped with a right-hand thread and the other with a left-hand thread.

By reference to Fig. 1 it will be seen that these nuts *E* are actuated by the screw *F*, which is adjustably held from end motion by the post *H*, with the locknuts on either side. The levers *D*, in which these nuts are mounted, are fulcrumed at one end, while the other end projects into a square notch cut in the edge of the sliding jaws *I*, thus causing these jaws to travel to or from each other according to the direction in which the ball crank *G* is turned.

The drill is guided by the bushing shown in one end of the sliding piece *C*, which is moved back and forth by

the lever *A* and is locked in position by the index pin *B*. By raising the lever *A* the index pin *B* is disengaged; and by a sidewise motion of *A* the sliding piece *C* is made to carry the drill bushing to a central position over

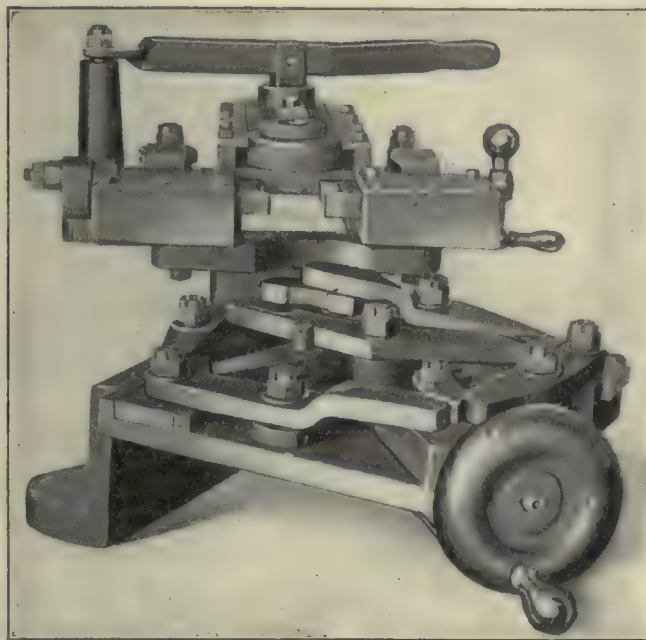


FIG. 2. JIG IN OPERATING POSITION

the work, when lever *A* is again depressed, forcing the index pin *B* into a hardened and ground bushing, locking *C* securely in place. After the hole is drilled, *C* is moved

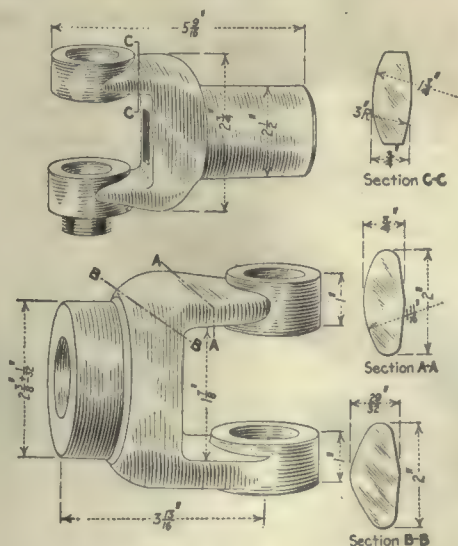


FIG. 3. THE WORK

back out of the way, so that the facing, boring and reaming operations may be performed.

This part of the jig just described is mounted on an angle plate that is bolted securely to the bottom part of the jig, so that it may be raised or lowered to suit different lengths of yoke hubs. The hole *R* contains a

master bushing in which may be placed bushings to guide the lower ends of the boring and reaming tools.

The levers *J* and *S* are for gripping the fork end of the yoke. One of the levers *J* contains a swivel jaw *Q*, which allows it to grip each projection of the fork with equal pressure, regardless of the variations in size of these projections. The levers *J* are closed by the wedge *K*, while the levers *S* are closed by the wedge *T*. The wedge *K* is actuated by the lever *M*, and the wedge *T* by the lever *V*. The levers *M* and *V* are actuated by the pivoted wedge *N*, which is mounted on the sliding piece *O*, having a threaded end engaging threads cut in the handwheel *P*, which acts as a nut sliding *O* back and forth according to the direction in which it is rotated. The action of this combination of levers is as follows: If the levers *S* come in contact with the work before the levers *J*, then the pivoted wedge *N* ceases to move the lever *V*, but is free to swing over and continue to move the lever *M* until the levers *J* have also gripped the work tightly. Thus it will be seen that the pivoted wedge *N* acts as an equalizer between the sets of levers *S* and *J*.

It was found desirable to have the levers *J* grip tighter than the levers *S*, so the angle of the wedge *K* was made about 30 deg., whereas the angle on the wedge *T* was made 45 deg.

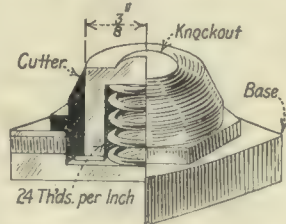
This jig has been in use in our factory for some time. It has been found easy to operate and does the work in a highly satisfactory manner. C. C. BLOOD.
Allegan, Mich.

Paper-Cutting Die

The die herein described is used in rather a unique way in that it operates in connection with a machine not commonly used as a punch press. This machine is an ordinary job printing press, and the die is used to cut the center out of a sheet of paper that has been printed and prepared for use in an electric recording instrument. The circular lines on the chart having been previously printed, this press graduates the scale, so to speak, and neatly removes the center of the disk so that it may be placed on the stud on the face of the instrument.

The die is of simple construction, consisting of a base, a cutter, a knockout plunger and a spring. The dimensions are so arranged that the total height exceeds the height of standard printers' type by just a sufficient amount to give a clean cut in the paper. As may be seen in the sketch, the cutting edge is made adjustable so that it may be advanced when shortened by grinding, being threaded into the base and held by a set-screw. The plunger used as a knockout requires only a very slight movement, and a light spring is sufficient to operate it satisfactorily.

It may be interesting to mention a circumstance that arose when these dies were made. The cutting portions were hardened. Through some peculiarity of the steel or the hardening process, they expanded to such a degree that the thread would not fit the block. The inner plunger was also a very loose fit, altogether a very unsatisfactory job. Not wishing to make them over (contract work),



A PAPER-CUTTING DIE

we took two plates $\frac{1}{4}$ in. thick, drilled one and tapped the other for a screw. The pieces were placed between these plates, heated and hardened over again. The diameter had been reduced the required amount in this way; that is, the contraction of the outside of the piece had been sufficient to close the hole, since the water was kept out of the hole by the plates.

These dies were cheap to make and resulted in a saving of one handling of the product, the charts having been formerly punched out on a foot press. They are used in the printing press in the same way that any type is used; the type is built up around it and all locked in the form in the usual way.

CHARLES EVERETT.

Hartford, Conn.

Melting Aluminum Chips

A bulletin recently published by the Bureau of Mines gives an account of experiments made to compare the recovery of metallic aluminum in melting down chips such as are obtained in the automobile factories in machining aluminum castings. As aluminum has sold at three times its normal price for the past year, and as a recovery of but 60 per cent. of the metal in the chips is common, and a 90 per cent. recovery is commercially possible, the preventable loss is of considerable magnitude.

The bulletin discusses the causes of the high loss in the usual method of melting chips and shows that the difficulty of getting the tiny globules of molten metal resulting from the fusion of the very fine chips to coalesce, when covered with a skin of oxide and dirt, is apparently the main cause for low recoveries.

Two methods of melting can be successfully used to promote coalescence. In one the chips are kept just above the fusion point and the globules made to coalesce by hand puddling, which breaks through the skin and makes the globules unite. In this method melting is best done in an iron pot heated by oil.

The other is by the use of a flux which melts off the skin of dirt and oxide, producing clean globules which can unite. The flux suggested is 85 per cent. common salt, 15 per cent. fluorspar, used in large amount (20 to 30 per cent. of the weight of the chips) and mixed with the chips before charging. Much higher temperatures are required by this method than by the puddling method, so the iron pot furnace is not practicable, and melting is best done in graphite crucibles or in a reverberatory furnace. The flux method does not require the constant hand puddling of the other method.

Since the presence of dirt and oxide causes low recoveries, the necessity for care and cleanliness in the collection and storage of chips is emphasized. Chips wet with cutting compound will oxidize superficially on storage, but by drying the chips by centrifuging this can be prevented.

Perfectly clean chips can be melted without much loss by either method, while very dirty chips cannot be handled at all so as to give the high recoveries of clean chips, although the two methods mentioned gave better results on dirty chips than any others tried.

Care and cleanliness in the collection of chips in the machine shop producing them will give chips from which a high percentage of metal can be recovered, with a corresponding increase in the value of chips sold.

Discussion of Previous Question

Improved Type of Sine Bar

Mr. Groocock, on page 77, criticizes an improved type of sine bar described by me on page 820, Vol. 44. He states that the sine bar has received too much attention in the *American Machinist* and intimates that I have revived something that is timeworn. In this connection it is worth while to note that the *American Machinist* has averaged but one sine-bar article per annum for several years and that the sum total of sine-bar articles in all the other technical magazines is insignificant.

Mr. Remacle, on page 342, refutes the contention that the sine bar is a familiar tool to most tool makers. It has been my experience that few tool makers know the

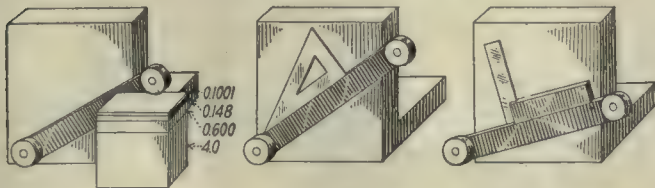


Fig. 1

Fig. 2

Fig. 3

THREE METHODS OF SETTING THE SINE BAR

power and accuracy of the sine bar. Happily, this condition is passing, and it is worth while to mention that in one of the New York City vocational schools the ability to establish an angle with the sine bar is a part of the machinist's course.

Another method of using the bar I described is with Johansson gages. This enables us to set the bar with an accuracy of four figures, one more than is possible with the vernier height gage. Gages, to the value of the sine of the angle multiplied by the center distance of the disks, are placed on the surface plate; the sine bar is placed with its back against an angle plate, and the correct angle is obtained when one of the disks rests on the surface plate and the other rests on top of the pile of gages that have been slid together. To illustrate: Required, an angle of 29 deg. $\text{Sine of } 29 \text{ deg.} = 0.48481$; center distance = 10 in.

Johansson gages equal in value to 4.8481 are required; $0.1001 + 0.148 + 0.6 + 4 = 4.8481$. In Fig. 1 is shown the set-up using this method, and this is to be followed when extreme accuracy is the essential thing.

Mr. Groocock also mentions in the description of his apparatus that under certain conditions his angle plate can be stood on end to take care of angles greater than 45 deg. The accuracy of the sine bar and hence its usefulness decrease rapidly as the angle becomes much larger than 45 deg. This is simply because the difference between the sines becomes smaller and smaller as we approach 90 deg. A good plan to follow when the angle is larger than 45 deg. is to subtract 45 deg. from the given angle, set the bar up for the remainder and then use a steel triangle such as is manufactured by several of the larger tool companies. This method is shown in

Fig. 2. If this method is not convenient, set up for the complement of the given angle and use a steel square, as shown in Fig. 3.

I feel that most tool makers would prefer to have their own sine bar, yet the possession of one such as described by Mr. Groocock would have drawbacks. There is a certain disadvantage connected with having several angle plates of varying sizes in one's tool kit.

New York City.

WESLEY McARDELL.

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Using the Sine Bar

On page 324, in discussing the sine bar and its uses Gustave A. Remacle raises several other very interesting points. Incidentally he discusses the sine-bar fixture described by me on page 77 and suggests that such a fixture would be limited in action. This fear of his is groundless, because the fixture has been a proved success for some years on a wide range of work. Mr. Remacle has shown us how he would do a certain job, but did not show us how he would secure either the work or the sine bar to the angle plate. He would of course use clamps, and the minimum number required would be three—two for the sine bar and one for the work. Generally four are used—two for each piece.

In my own practice with the sine bar, by means of the box angle fixture described the use of clamps was cut out, thus simplifying the setting, and making for accuracy of product. The box shape of the fixture allows it to be placed on either side or end.

Mr. Remacle fears that when fresh securing holes are drilled in the fixture it will lose its initial accuracy. Naturally, when fresh securing holes are needed, then the fixture should be again tested for squareness, etc. This is only commonsense, because when accuracy is demanded all the tools used must be frequently checked. The tool maker who relies on the continued accuracy of any tool is looking for a bag of trouble.

This is the point that I wish to discuss. Recently the writer received a consignment of Brown & Sharpe micrometers. These were, as usual, very carefully examined before they were accepted. Why? Brown & Sharpe have been making micrometers long enough to know how to turn them out accurate—and they do so. But these micrometers had been through many hands before we got hold of them; hence the necessity for a close examination, which is no reflection on the original accuracy of the tool. Further, so long as these micrometers are in service they will be checked for accuracy at least once a week. What is true of a micrometer is equally true of any other precision tool, such as a sine bar and its fixture.

For instance, in setting up his sine bar Mr. Remacle uses a parallel and a height gage. Suppose someone had taken 0.01 off the side of the parallel and suppose further that the vernier on the height gage had become misplaced a few thousandths. Then the work would be wrong. I know that both of these "accidents" are unlike-

ly to happen in a well-organized toolroom, but when accuracy is demanded we must make sure; that is, no tool can be regarded as a precision tool unless its accuracy is frequently tested. This applies of course to the whole rig used with a sine bar. Mr. Remacle says that he has never met a tool maker who possessed a sine bar. This really raises the interesting question, Who should find the tools—the employer or the employee? Over here the practice that is gradually becoming common is for the employer to provide all the precision tools required to produce his work. Many workmen still supply themselves with micrometers, but when a man is engaged it is not regarded as necessary that he shall bring a trunk full of mikes as a guarantee that he can do good work.

Employers never ask for such guarantees, but do ask for good work and are prepared to furnish the necessary tools to obtain it. This being so, a sine bar is not a necessary part of a tool maker's equipment. Mr. Remacle speaks of a sine bar 3-in. centers. This seems rather short, and the writer has a preference for a longer one—namely, 10-in. centers. For a given error in the setting instruments the longer bar gives the more accurate result. To emphasize this point, the writer recalls the use of a sine bar 60 in. long between centers. This special sine bar was made to test some master angles (used for testing gun sights) and was described by the present writer in the European edition of the *American Machinist* on Oct. 5 or 12, 1912.

The master angles to be tested were blocks about 7x2 in., made from cast iron properly seasoned. A set consisted of four blocks, each representing an angle (7 deg., 6 deg., 5 deg., 3 deg.), and by suitable combinations all degrees from 1 deg. to 16 deg. can be measured. For instance, two combinations are as follows: 7 deg. + 6 deg. = 13 deg., and 7 deg. — 6 deg. = 1 deg. The sine bar for making and checking these angles was, as stated, 60 in. between centers. Milled from the solid to a narrow H-section, with a boss at each end to take the pins, this bar was, comparatively speaking, quite light. For testing the various angles a disk was placed on one of the pins so that when laid on one of the angular blocks an Ames dial indicator would read zero both on the disk and the pin when the block was correct. Both the pins in the sine bar and the disks for each angle were hardened and accurately ground. The size of the disks was calculated from the well-known formula

$$D = 2L + A$$

where

D = Diameter of disk;

A = Diameter of pins in bar;

L = Length between center of pins.

Such a bar would of course be out of place in any private individual's tool kit. The need for such a length may be questioned, but undoubtedly more accurate work was obtained with the use of this long bar than would have been obtained from a 10-in. center bar. The master angles made from this bar are considered the last word in things accurate—that is, as far as our variable climate will permit. A set of these masters was returned to the gage room and found to be slightly incorrect when checked, although it was known that when made, some months previous, they were correct. Molecular disturbance other than temperature may have been the cause, but the change was probably due solely to temperature

variation. With the bar described, errors due to a rise in temperature of less than 10 deg. were distinctly shown by an Ames dial.

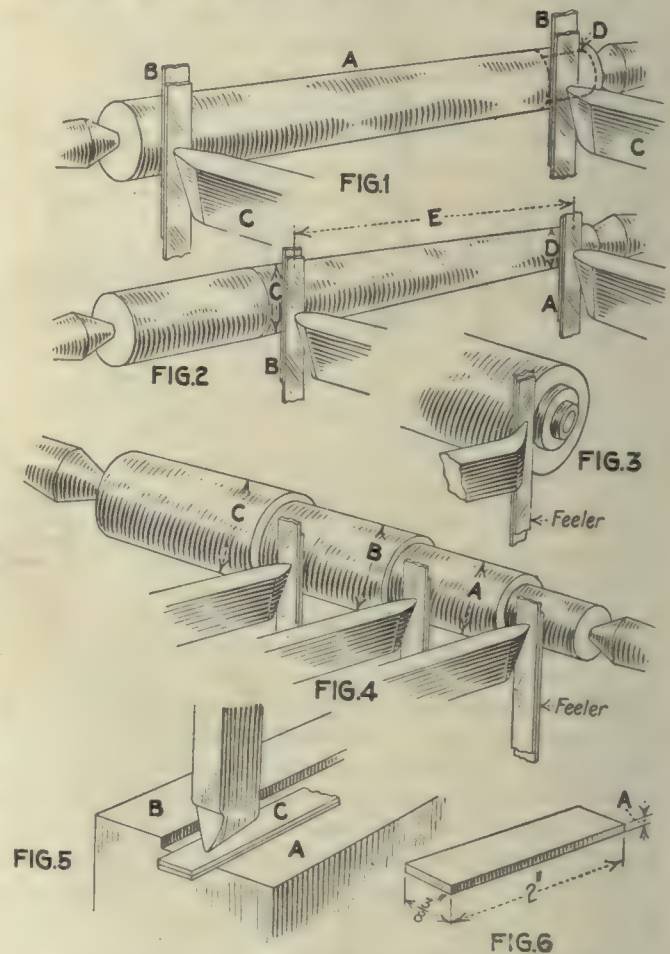
This brings us to the point that accuracy is comparative and that the higher the degree of accuracy we hope to obtain the more accurate must be all the equipment we use. Certainly, if you drill holes in a sine-bar fixture, you should test it afterward. **WALTER G. GROOCKOCK.**

Guildford, England.

The Feeler Gage and Its Use

Gustave A. Remacle's article on page 587, concerning the uses of the feeler gage, opens up a very interesting subject.

It is certainly strange that this gage is not used more extensively by toolmakers and machinists. Many mechan-



HANDY AIDS IN LATHE AND SHAPER WORK

ics who possess expensive tool kits cannot produce a feeler gage. In the following paragraphs is pointed out how a feeler gage can be employed advantageously.

In Fig. 1 is shown how lathe centers can be set parallel without the aid of an indicator; A is a turned plug, B the feeler blade and C a common lathe tool held in the tool post. If it is not advisable to test with a separate plug, on account of the length between centers, the job itself can be utilized for this purpose, by truing up a short portion of the outside diameter at one end, as indicated by the dotted lines at D . Then feel between the finished diameter and the tool C with the feeler B . reverse the job on the centers, and make the carriage to the other end, using the feeler B as before.

In Fig. 2 is shown a method of setting up a long taper job between centers in a lathe. By using feeler gages on a job of this nature, all guesswork is eliminated. After setting the taper attachment on the tailstock center to the approximate taper, and roughing out the taper, we proceed to measure the diameter at *D* and *C*. Having a taper of so many thousandths of an inch to the foot, it is easy to determine the most convenient length for *E*. Measurements, however, should be made as near the small and large ends of a taper as practicable. If, upon measuring, it appears that the diameter *C* is 0.050 in. too large on the length of *E*, it means that the taper is too acute by a matter of 0.025 in. a side, which is corrected by making the tailstock center or adjusting the taper attachment till a 0.002-in. feeler blade will slide at *B*, and an 0.027-in. blade at *A*; or any other combination can be used which gives the right relation.

In Fig. 3 is illustrated plainly how a piece of lathe work, with projecting collars to be faced accurately, can be handled quickly with the aid of a few feeler blades.

In Fig. 4 is shown a good example of how the feeler gage will hold its own on shaft turning. In roughing out work of this description, the feeler gage eliminates the calipering of diameters *A*, *B* and *C*. All that is necessary for setting the tool to a larger diameter is to have the right thickness of feeler gage handy and insert it between the turned portion and the lathe tool. I have finished turned jobs of this character by the feeler-gage method, and have found that if properly done, by taking light finishing cuts, the various diameters can be held to a very close limit.

In Fig. 5 is given an example of shaper work, where after finishing the surface *A*, the position of the shaper tool for the surface *B* is readily obtained by the feeler gage *C*.

In Fig. 6 is shown a form of thickness gage. Every mechanic should have a number of these gages in his tool kit to be used in conjunction with the feeler-gage blades. In having the thickness *A* run up $\frac{1}{16}$, $\frac{1}{8}$, $\frac{1}{4}$, $\frac{1}{2}$ in., etc., it is possible to enlarge the field of usefulness for the feeler gage almost indefinitely. These thickness gages should be made of tool steel, hardened, ground and lapped parallel, and the size stamped on before hardening.

Dayton, Ohio.

HUGO F. PUSEP.

✽

Blueprints Without Tracing

I have seen in one of your issues an appeal to your readers for articles on mechanical subjects. I am French; and while I read English and thoroughly understand what I read, I do not consider myself capable of writing a letter or article in that language. I therefore submit this in my own language, hoping that you will find it sufficiently acceptable.

On page 803, Vol. 44, Mr. Spalding told of his method of obtaining blueprints from a tracing made with a soft pencil on commercial rough tissue paper. A discussion of this article by W. E. Sharkey was printed on page 960 of the same volume and showed another process. I agree with Mr. Sharkey's criticism, but his method is also open to question. In order to draw with ink on tracing cloth it is necessary, first, to pencil in whatever guide lines are required or else one traces the whole drawing, in which case there is no saving of time over making an original drawing and tracing it.

Where one does not trace the whole drawing, it is next to impossible to execute it without erasure. When drawing any piece, except it be of the simplest character, one is compelled to erase, and these erasures are sure to appear on the blueprint.

In order to obviate these undesirable features one can draw direct on commercial glazed paper with carmine diluted with water—but do not use the common red ink of commerce. This method has the further advantage that the glazed vegetable paper does not take the dust. The original always remains clean; and even should it become dirty, it can always be cleaned with soft gum without risk of removing the drawing. The parts drawn in red ink are as permanent as those drawn in india ink.

One can draw directly in carmine without fear of errors, because this ink can be completely removed with chloride of lime solution without injury to the paper. There is the gain of time in not tracing the drawing in pencil, and the certainty of having an original tracing the exact lines only of which appear on the blueprint.

From the printing viewpoint the method gives prints that are better than an original pencil drawing and only slightly inferior to blueprints from an india-ink tracing.

Bordeaux, France.

H. GOURVENEC.

[Contributions in foreign languages are always welcome at the office of the *American Machinist*.—Editor.]

✽

The Apprentice and His Father

As a European apprentice, I would like to add my quota to the very necessary discussion on the training of apprentices. The first thought that comes to mind is the fallacy of blaming the condition on the young man alone. An old head cannot be placed on young shoulders; and it might well follow that if parents showed enough interest in the future welfare of the boy, he might be reasonably blamed in turn, if he failed to make good.

I am convinced, from observation, that a father's interest in his son practically ceases when the lad leaves high school, if it does exist that long. The natural result is that the boy drifts into the position offering the biggest money, without regard for the future, until it is too late. I have seen a timekeeper, earning 25c. per hr., drive to work in a \$5,000 machine owned by his father, and know of no other country where such a condition could exist. A father in a position to own and run such a machine would not tolerate around his house a son in such a position.

This is the idea paramount among the working classes of northern Europe: "Give the boy a better chance than his father, no matter at what sacrifice." The results speak for themselves. A boy in normal circumstances who is not training for some skilled trade is looked down on with contempt.

Some fail to make good—also a natural condition. But the system makes pretty good mechanics; and it is on record that on at least one occasion a good big transpacific passenger liner was built, launched and fitted, from truck to keel, by apprentices during a strike, without any botches either.

In Britain the technical side is up to the boy, but his school reports in many cases are sent to his employers, who base progress on both practical and technical ability. That is fair enough. They provide practical training and

advance the boys who make progress along technical lines. Therefore, every boy seeks technical training.

So far as unskilled labor or specialists breaking in is concerned, the same boys are on the job. The new man who cannot submit his apprentice papers to the apprentices in the shop where he starts to work is on the outside in short order, or the apprentices are.

During the past year or so I have taken eight boys into the drafting room and promised as a reward for making good that they should be transferred into the shop and then back into the office to complete their training. Only two showed any signs of being worth bothering with, and the other six most undoubtedly will graduate into mediocre drilling-machine hands, a condition befitting their ambition.

I repeat here the statement that if the father of any one of these boys had one iota of interest in his son, he would find out what progress the boy was making and at least coöperate to the extent of impressing him with the gravity of such behavior.

I do not write with the intention of breaking into print, but as I mentioned in the beginning, because I think such a discussion very necessary, in the light of present conditions.

M. G. DAVIS.

Flint, Mich.

✽

Questions of Lathe Design

J. H. Davis' pertinent questions on the subject of lathe design, which appeared on page 692, attracted my attention. I will endeavor to answer them from an American point of view. The handwheel for traversing the carriage on the bedplate is placed on the left-hand side of the apron as experience has taught us that this position is the most convenient for the operator. This is especially true when standing directly in front of the carriage while working on a comparatively short piece of material, either between centers or in the chuck. Thus it is readily seen that the operator can manipulate the carriage wheel with his left hand, leaving the right hand free for calipering work, etc.

As a machinist I appreciate the value of the above design perhaps more than the average mechanic, owing to the fact that I am left-handed. Thus I realize how awkward it is for me to hand-feed the carriage and attempt to caliper work at the same time. If the design were the reverse—that is, with the handwheel on the right-hand side—the majority of machinists who, of course, are right-handed would be confronted with the same predicament.

American-built lathes have left-hand lead screws for exactly the same reason that they have left-hand cross-feed screws—to make a right-hand movement of the screw, clockwise, give a right-hand movement to the actuated part.

I do not think American lathes differ from English lathes wholly because Americans have deliberately tried to proceed along original lines. To do this they might have to overlook many valuable features. We have adopted many ideas that had their origin in England, such as the automatic carriage feed. Mr. Davis concludes by stating that American lathes are on the whole more convenient to operate, and I heartily agree with him on this point. There is considerable competition in the machine-tool industry in this country, to say the least,

and this condition of affairs has led us to as near perfection in design as is possible.

F. B. JACOBS.

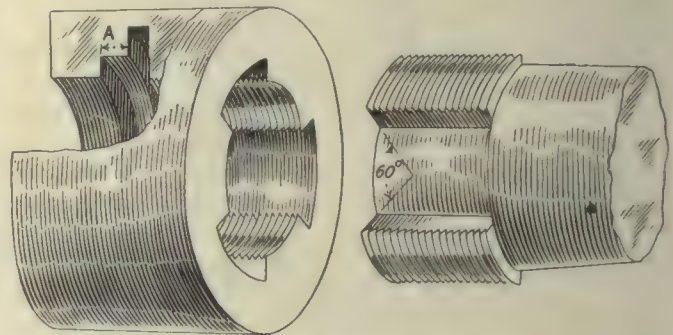
Indianapolis, Ind.

[We do not understand the reference to left-hand lead screws in American lathes. Practically all American lathes have right-hand lead screws—Editor.]

✽

Method of Chucking Work in the Dividing Head

The method of chucking work in the dividing head shown on page 339 is good. The chucking time, however, could be greatly reduced and production correspondingly increased by having the collet and nut with interrupted thread as shown herewith. To secure the work all that is necessary is to put it in the nut, place



INTERRUPTED SCREW AND NUT

on the collet and give one-sixth of a turn to the nut. In making the nut care should be taken to have the depth of the recess A slightly less than the thickness of the head of the work, in order to insure that it is held firmly.

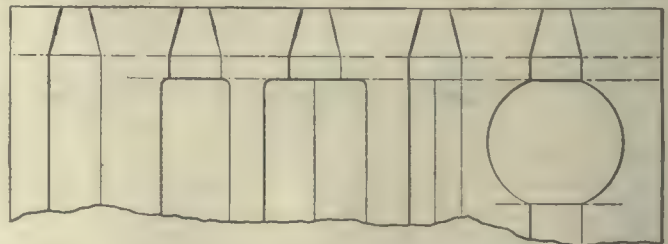
A. R. WHITTLE.

Quebec, Can.

✽

Core-Box Reamers--Correction

The author of the discussion on the subject of core-box reamers, which appeared on page 693, points out



CORRECTED DRAWING OF HYPOTHETICAL CORE BOXES

that an error was made in reproducing his drawing of the hypothetical core boxes.

Three lines were omitted: Two to indicate the bottom of the square "element" and one its termination.

To enable a clear understanding of the author's point the accompanying drawing is published in its corrected form.

Editorials

A British View of Machine-Tool Demand After the War

A recent editorial in *Engineering*, of London, discusses some of the problems that will face "the remobilization of the industrial army." A part of one paragraph is devoted to the prospects facing the machine-tool builders. It reads:

"The machine-tool makers ought to be able still further to increase the volume of their work, even upon the immense production achieved during the war, because many of the new factories erected will require other machinery in order to become effective for immediate peace production (as opposed to specialized war requirements), as they are now equipped in very many cases with appliances which can be used only for very definite war productions. The case of lathes for shells is one clearly illustrative of this point. There has been an enormous output of lathes, far beyond the peace needs of any community, and moreover, a lathe for turning a large shell body is of a design unsuited, in view of the relation of strength of headstock and bed to length, for efficient application to many forms of peace work. This, too, is apart altogether from the fact that the haste with which these lathes and other machine tools had to be got together necessitated less care in the materials used and in the design, so that they are practically obsolete, even from the point of view of strength as well as efficiency. A large number of new machine tools will be required to enable the new privately owned factories to be adapted for peace production, and the sooner machine-tool makers are released the better will it be for the future industry."

This comment, written undoubtedly from a close observation of the conditions in British munition factories and with a full realization of the demands that will face

manufacture is unsuited for the needs of peaceful industry. It points out that a large number of new machine tools will be needed to change over new privately owned factories to a basis for peace production.

If this is true for Great Britain, it must also be true for the other great belligerent nations. May it not be possible that the observers who have expressed a belief in a great period of industrial activity after the war, due to the needs of the work of rehabilitation, are not so far wrong as many have thought?

✱

Machinery Imports

A number of firms that have been busy for months on war material are now looking for some other machinery product to utilize the floor space, equipment and manufacturing organizations that have been developed since

TABLE 1. IMPORTS OF MACHINE-SHOP PRODUCTS

	Fiscal Years Ending June 30—		
	1908	1909	1910
Clocks, and parts of.....	\$471,133	\$468,597	\$701,852
Watches, and parts of.....	2,451,009	2,088,034	1,869,402
Dials, enameled, for watches, etc.....			26,263
Wire, and articles made from.....	1,332,973	979,998	1,382,811
Building forms, and all other structural shapes fitted for use.....	80,891	171,675	315,502
Cutlery.....	2,018,143	1,733,874	1,806,033
Firearms.....	287,679	234,648	243,367
Embroidery and lace-making machinery.....			1,300,968
All other machinery.....	3,646,480	4,258,743	8,888,411
Needles, hand-sewing and darning.....	414,998	431,147	476,810
Sheets, plates, wares, or articles of iron, steel or other metal, enameled or glazed with vitreous glasses.....	784,017	689,837	822,094
Shotgun barrels, in single tubes, forged, rough-bored.....	169,445	143,152	113,900
All other manufactures of iron and steel.....	3,367,939	3,289,730	5,732,941
Phonographs, etc., and parts of.....			27,197
Total.....	\$15,024,707	\$14,489,435	\$23,707,551

the opening of the war. In general, efforts are being made to discover some new machine product that gives promise of successful commercial exploitation. Thus the present should be a happy time for the inventor who has

TABLE 2. IMPORTS OF MACHINE-SHOP PRODUCTS

	1911	1912	1913	1914	1915
Agricultural implements.....	\$41,798	\$66,805	\$22,949	\$262,061	\$770,220
Philosophical and scientific apparatus.....	590,243	570,719	581,904	714,030	371,871+
Aeroplanes, and parts of.....		59,713	50,920	1,856	2,000
Automobiles, and parts of.....	2,250,759	2,438,325	2,023,207	1,432,576	1,372,412
Bicycles, motor and other cycles, and parts of.....		144,336	186,980	256,281	81,142+
Clocks and watches, and parts of.....	869,282	681,972	809,715	905,421	705,555
Watches, and parts of.....	2,293,679	2,313,677	2,615,744	3,386,738	3,039,651
Dials, enameled, for watches, etc.....	52,069	32,186	19,345	6,593	1,494
Antifriction balls and bearings.....	1,273,740	1,604,571	2,410,861	1,899,695	1,527,732+
Building forms, and all other structural shapes.....		123,642	277,374	378,420	224,904
Pen or pocket knives.....		814,283	752,705	1,288,037	1,025,470
Razors, and parts of.....		396,921	391,303	457,460	299,211
Scissors and shears.....		563,980	604,029	759,487	523,359
All other cutlery.....	1,992,644	259,879	278,527	355,535	229,250
Embroidery and lace-making machinery.....	1,778,335	125,016			
Machine tools.....					160,486
Sewing machines, and parts of.....					524,776
Textile machinery.....					305,892
All other machines.....	7,575,659	7,191,911	7,497,103	6,476,068	3,366,143
Needles, hand-sewing and darning.....	445,081	501,033	491,694	481,631	476,237
Shotgun barrels, in single tubes, forged, rough-bored.....	110,657	120,089	101,525	171,198	10,183
Table, kitchen, and other utensils or hollow ware, enameled or glazed with vitreous glasses.....	750,945	716,483	667,486	872,690	523,904
Wire, and articles made from.....	1,421,643	1,090,170	1,174,331	1,264,062	925,531
Phonographs, etc., and parts of.....	51,820	22,548	39,400	151,438	215,111
Total.....	\$21,498,354	\$19,838,259	\$20,997,102	\$21,521,277	\$16,682,534

British industry after the war, is deserving of careful consideration by American machine builders. It says that machine-tool building after the war ought to increase over the immense volume achieved during the war; states that much of the machinery built for munition

something just ready for the market, or for some product that has been laid on the shelf awaiting a convenient opportunity to manufacture.

In addition to looking over this field of possible new products, there is another one that might be profitably

considered—the machinery that has been imported into the United States. Our source of information is the Government statistics of imports.

A study of these figures shows that the average value of the imports of machines, machine parts and other articles that might properly enter into our consideration of foreign-made machine-shop products is a little greater than \$19,000,000 for each of the fiscal years 1908 to 1915. The records are in slightly different forms for the years 1908, 1909 and 1910 than are those for the following period. For that reason Table 1 gives the figures for the three fiscal years 1908 to 1910, and Table 2 similar statistics in more detail for the years 1911 to 1915. The highest total is for the year 1910, being \$23,707,551; the smallest is for the preceding year, 1909, \$14,489,435.

A study of individual items shows a few decided changes since the outbreak of the war. Some of the imports have greatly decreased, as scientific instruments, automobiles, bicycles and the general item "All Other Machines." For others there has been an increase, as agricultural implements, watches and phonographs, for example.

It would be difficult to trace all the causes for these changes. The tables are of principal value as showing what machines, machine parts and kindred articles have been imported during the last eight years, and in what amounts.

✱

Professor Sweet's Being Greater Than His Doing

Those who knew Professor Sweet well, felt that there was something greater and finer in the man than in any of his achievements. A unanimous tribute to his work is that no other man so profoundly influenced American machinery building. But his influence over men for right thinking and right doing means more than his own advancement of machinery construction.

Professor Sweet's being was greater than his doing.

So it is but natural that the strength and fineness of his character should be dwelt upon by one of his "boys" in the reminiscences that begin in this issue. Emerson said of character: "This is . . . a reserved force which acts directly by presence, and without means," and again, ". . . character is of a stellar and undiminished greatness."

Professor Sweet drew men to him, made them his friends, won their affection and influenced their lives because of the integrity and worth of his own character. This element in his greatness will continue undimmed whenever and wherever men sum up the lives of those who have contributed much to the benefits of mankind through machinery building. All of this is very properly emphasized by J. E. Johnson, Jr., in his two reminiscent articles.

Charm is added to the first article by the inclusion of a few personal reminiscences written only a few years ago by Professor Sweet himself. These betray the extreme modesty of "Professor" and, touching mainly upon relatively unimportant happenings, in no way hint the extent and greatness of his life's work and engineering achievements.

Indeed, he was greater than anything that he did.

Designing Charts

During the past five or six years many charts intended for the use of machine designers have appeared in the columns of the *American Machinist*. The predominating type has been the alignment, although a variety of others have been used.

During this period many of the most frequently needed designing formulas have been plotted in a form adapted for the use of those who have to calculate the proportions or strength of machine parts. Designing data are tools for the use of the man who is developing or improving old machinery. As tools, they should be in a condition for ready use. The chart is one of the best forms in which such information can be put.

But fundamental designing information accumulates but slowly. Thus the purpose of these comments is to ask readers to submit formulas, or observations from which formulas might be worked out, that would be of general service to machine designers. Not all designing data are adapted for presentation in chart form—but many of them are. Such of the information supplied by our readers as can be plotted to advantage will be handled in that way. With the formulas when presented should be a statement as to their origin and authority, and the ranges should be given for each one of the variables, and likewise their authority.

Desirable formulas are those which have the possibility of being widely used among machine designers and which concern information not available from any usually consulted source. The ranges of the variables should be those that will cover the requirements of ordinary practice.

✱

Instinct in Management

Instinct and intuition are not given as much credit as they deserve, in so far as they affect shop activities. We are all familiar with the intuition of the man in the engine room, whose subconscious self detects instantly the variations in the speed of his engines. We know from experience that a sag in the lineshaft speed is indicated at once intuitively, as it were, to the man at the lathe, who could scarcely detect the speed difference with an indicator.

There is another kind of intuition which enters into management and which is harder to define, but which nevertheless may be developed into a useful tool. Its findings are far superior in many cases to reports from the cost office or records shown by shop statistics. It is the ability to "feel" what is going on, and the man who has this ability has a strong shop asset that enables him to head off trouble before it assumes serious proportions.

Unfortunately, many shop managers are entirely lacking in this sense and rely on what they call their judgment, which might more properly be termed arbitrary opinion.

✱

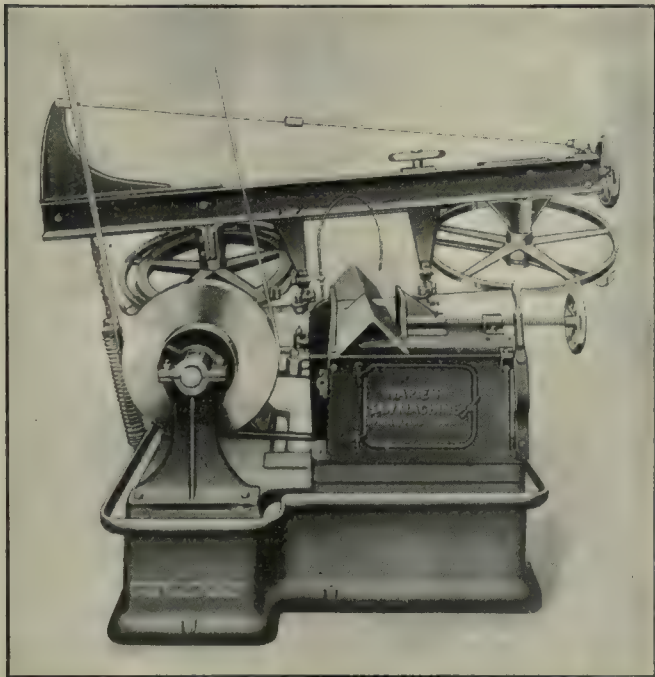
Professor Sweet had many friends both in this country and in England, where he lived for several years and which he afterward frequently visited. Believing that many of these will treasure a portrait of him, the reminiscent article in this issue has a reproduction of a pencil drawing signed with a fac simile signature. The original portrait was made by Arthur L. Ormay, chief illustrator of the Hill Engineering Weeklies.

Shop Equipment News

Bandsaw To Cut Off Metals

The illustration shows a new cutting-off machine built by the Quality Saw and Tool Works, Springfield, Mass. This is known as the Napier saw machine, and the illustration shows the B size. In addition to the size illustrated two others are under way, one smaller and one of greater capacity.

As can be seen, this machine substitutes a bandsaw for the usual short blade of the hacksaw, giving 12 ft. of continued cutting and averting the return stroke. The



BANDSAW FOR CUTTING OFF METALS

Capacity, 10 in. square; saw, 0.032 in. thick; pulleys, 24 in.; cutting speed, 275 ft. per min.; weight, 1,400 lb.

contact with the wheels keeps the saw cool, and lubricant can be supplied for washing away the chips when this seems desirable.

The arm carrying the two wheels is made up of two channel beams giving a light and at the same time rigid connection. The truss rod on top counteracts any tendency toward bending due to the tension on the saw. The saw is supported both sidewise and against the thrust of the cut by suitable guide rollers on the arms that project down from the beams. The outer of these arms is adjustable by the handwheel shown, so that this support can be brought as close to the other as the size of the work will permit. The outer bandsaw wheel is also adjustable to control the tension of the saw by means of the outer wheel, so that saws of length varying as much as 9 in. can be

readily used. This provides for using up saws that are accidentally broken before they are worn out.

Power is transmitted through a clutch in the belt pulley shown, the drive being by means of the beveled pinion on the shaft and a corresponding gear on the left-hand bandsaw wheel. This shaft is supported at the other end in a long and substantial babbitt bearing inside a sleeve formed by the support for the arm carrying the saw. This allows the arm to be easily tilted out of the way; and as can be seen, the weight is counterbalanced by a spring at the back. The saw feeds into the work by gravity due to the unbalanced weight of the arm, and this of course can be adjusted to any weight desired.

The machine is easily handled. It is supplied with a guard around the wheels and the outside of the saw, for protecting the operator and to prevent spattering of coolant over the floor.

It is claimed that the continuous cutting reduces the time per cut and that there is a minimum waste of material due to the thickness of the saw blades that can be used. The machine is also furnished with a 2-hp. motor instead of the belt drive.

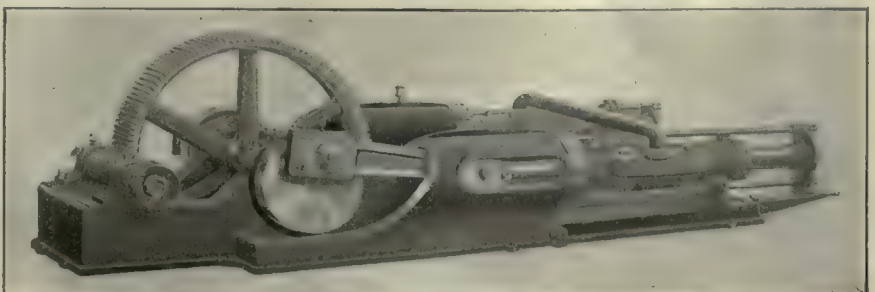


Horizontal Hydraulic Pump

The hydraulic pump illustrated is a recent addition to the line of high-pressure hydraulic pumps built by the Hydraulic Press Manufacturing Co., Mount Gilead, Ohio. It is of the horizontal, four-plunger type.

The pump is designed so that it may be equipped with 16 different sizes of plungers ranging from 1 3/8 to 5 in. in diameter, advancing by quarter-inches. The water cylinders are made of forged steel for the highest pressures. For the medium pressures, 1,500 to 2,900 lb. per sq.in. inclusive, cast steel is used, and for the lowest pressures the cylinders are of semisteel. The pressures range from 9,500 to 700 lb. per sq.in., and the water capacity from 24 to 326 gal. per min. All sizes have bronze valve seats and bronze or nickel steel valves.

The frame, or pump bed, consists of two heavy castings securely bolted together. The crosshead guides and main bearing containers are machined in this frame to insure permanent alignment and a rigid form of construction.



MOTOR-DRIVEN FOUR-PLUNGER HYDRAULIC PUMP

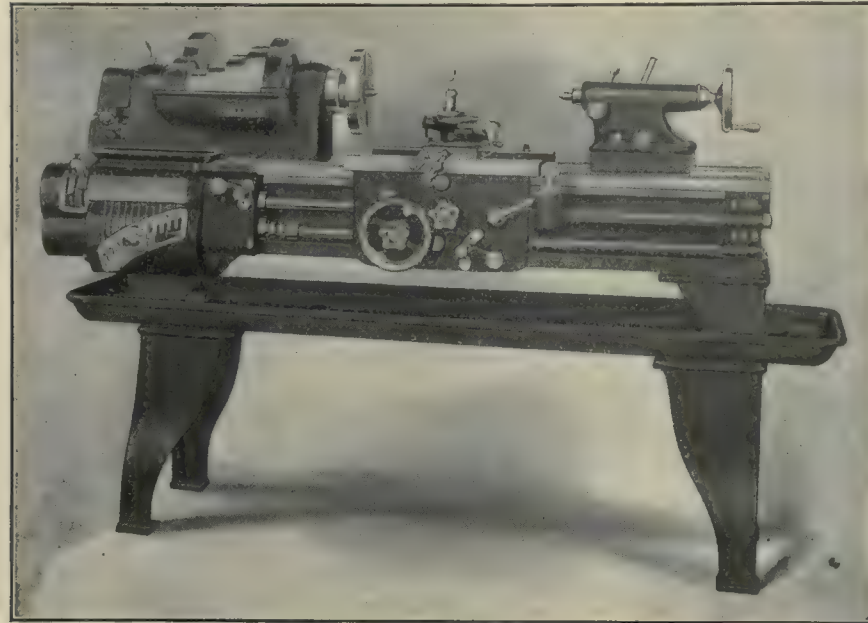
Stroke of plungers, 16 in.; motor required, 150 hp.; floor space, 18 ft. 8 in. by 6 ft. 10 in.

While the illustration shows the pump equipped with a spur gear and pinion, a herringbone gear and pinion may be fitted just as easily.

Quick-Change Lathe

The quick-change engine lathe described herewith is a recent product of the Mulliner Machine Tool Co., Syracuse, N. Y., and is made in both 12- and 14-in. sizes.

The general lines of design and construction will be gained from the illustration. The bed is ribbed trans-



QUICK-CHANGE ENGINE LATHE

Swing over bed, 12 $\frac{1}{4}$ in.; swing over carriage, 7 $\frac{1}{2}$ in.; proportion of gearing in the head, 10 to 1; cone diameters, 2 $\frac{1}{2}$, 4 $\frac{1}{2}$, 6 $\frac{1}{2}$, 7 $\frac{1}{2}$ in.; width of belt, 1 $\frac{3}{4}$ in.; hole through spindle, $\frac{1}{8}$ in.; length of carriage bearing on bed, 17 $\frac{1}{2}$ in.; 6-ft. lathe takes in between centers, 40 in.; weight, 5-ft. bed, 1,990 lb.

versely with heavy double-walled cross-girths. The headstock is of the pan type, with housings fitted with annular bearings of special form for spindle journals. The front and rear journals are self-adjusting and adjustable independently of each other. A ring self-oiling system is provided. The apron is made in a double-wall or box section.

The cone gears of the quick-change gear mechanism are cut with the improved B. & S. 20-deg. involute cutters, which form a pointed tooth slightly rounded at the top designed to be especially suited to a tumbler-gear mechanism, as it permits instantaneous engagement of the gears without clashing. The quick-change gear mechanism is mounted on the front of the machine, giving 37 different threads and feeds, as shown on an easily read index chart mounted on the quick-change gear box.

An auxiliary quadrant is provided for applying extra change gears.

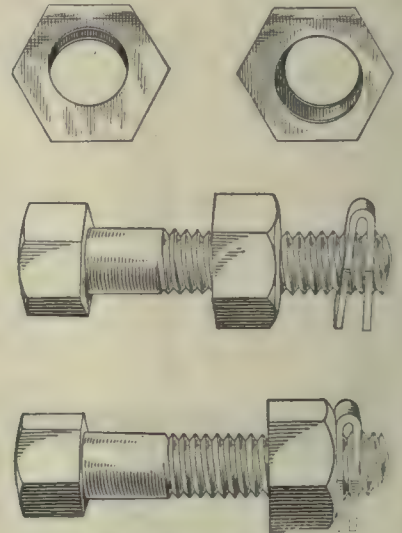
Spring Nut Lock

The form of nut lock shown is the latest arrival in a field to which the inventive genius has given so much attention. It has simplicity to commend it, and the claims of the manufacturer—the Industrial Development Co., Chicago, Ill.—based on extended tests, indicate a solution of the loose-nut problem. This form of nut lock will be made in all the standard sizes.

The spring nut lock shown consists of two hexagonal plates of thin steel stamped out of one piece, leaving a joint on one of its six sides. Circular holes to fit the required size of bolt are punched in each plate, and the plate is then bent over until the two holes are almost parallel, one hole overlapping the other by a small fraction of an inch.

The joining side acts as a hinge, and after being tempered it constitutes a powerful spring.

When the lock is slipped on the bolt and both legs engage the thread of the screw, the holes in each of the



SPRING NUT LOCK

legs are brought into perfect alignment. Because of this forced alignment of the holes the spring exerts a powerful pulling force on one of the legs and an equally powerful pushing force on the other leg. As a consequence the leg on which the pulling force is exerted engages the root of the threads only on the side of the bolt farthest from the spring, while the leg on which the pushing force is exerted engages the root of the threads only on the side of the bolt that is nearest to the spring. Tightened into place next to the nut, these opposing holds are claimed to secure a grip that will keep the nut in place under the most severe conditions.

Ball-Bearing High-Speed Bench Saw

The illustration shows a portable ball-bearing bench saw designed for sawing soft metals, fiber, wood, etc. The saw arbor runs at 3,500 r.p.m. on ball bearings mounted in dust-proof housings, with provision for ample lubrication. Speeds from 1,000 up to 6,000 r.p.m. can be supplied when desired.

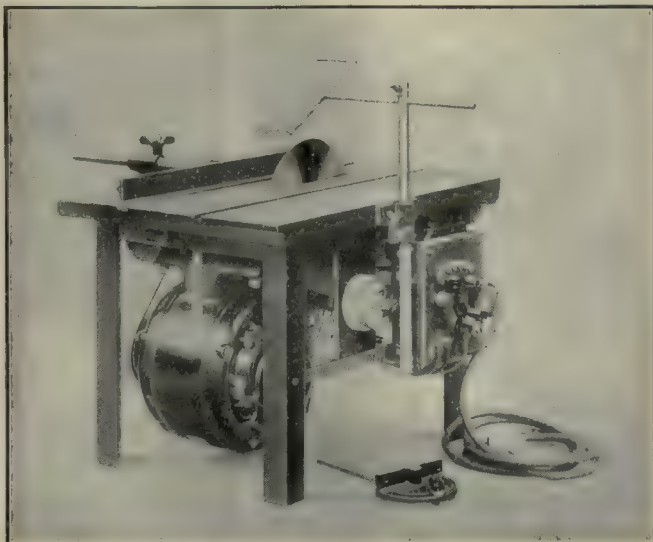
The machine is accurately and substantially constructed, the lower part or stand being made in one casting. The motor is hung in an inverted position on a specially designed dust chute, which is hinged at the upper end. The chute serves to protect the motor and also permits a convenient method of keeping the belt in proper tension. The turning of a handwheel raises or lowers the motor at will.

The illustration shows the saw table equipped with a $\frac{1}{2}$ -hp. direct-current motor, with starting box and switch. The table top is quickly raised or lowered to any position when it is desired to do grooving or slotting. The guides are easily and quickly adjusted in position and are interchangeable to either side of the saw. The plate

tirely offset the effects of disalignment. This extension arm can be easily and quickly installed in place of the smaller high-speed internal attachment regularly supplied by the same firm.

Bench Drilling Machine

The illustration shows a bench drilling machine built by the De Mooy Machine Co., 1833 East 55th St., Cleveland, Ohio. The column and base are in a single piece. The table is mounted in a bracket that swings on the



BALL-BEARING HIGH-SPEED BENCH SAW

Size of top, 16x22 in.; height of machine, 18 in.; weight with $\frac{1}{2}$ -hp. motor, 150 lb.; size of saws, 8 in.; capacity for sawing $2\frac{1}{2}$ -in. stock

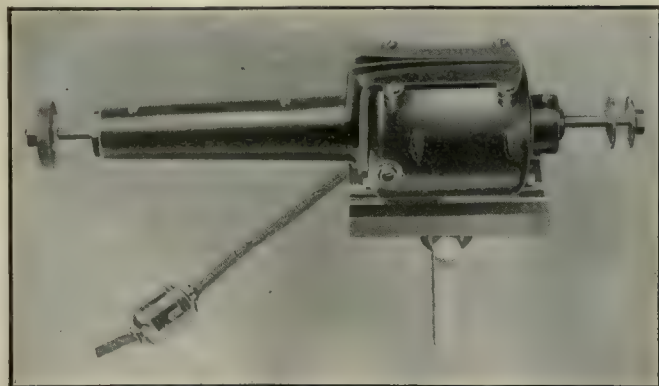
glass shield, supplied as an extra, can be attached or detached without the use of tools. Motors for 110 or 220 volts, alternating or direct current and of $\frac{1}{4}$, $\frac{1}{3}$ and $\frac{1}{2}$ hp., can be supplied to answer various requirements.

The bench saw is a recent product of H. G. Crane, Brookline, Mass.

Portable Tool-Post Grinder With Extension Arm

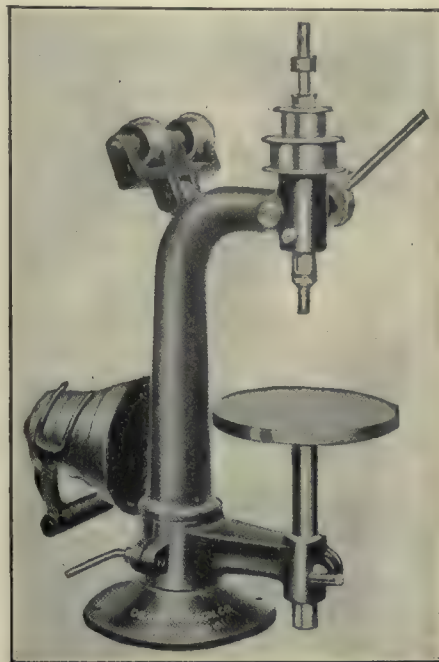
The illustration shows a portable tool-post grinder manufactured by the Wisconsin Electric Co., Racine, Wis.

To provide for deep internal grinding of cylinders the extension arm, at the left, is provided. This extension



PORTABLE TOOL-POST GRINDER WITH EXTENSION ARM FOR INTERNAL GRINDING

arm is a separate unit mounted on ball bearings. The power is transmitted to it from the motor through a flexible coupling designed to eliminate vibration and en-



BENCH DRILLING MACHINE

Capacity, $\frac{3}{8}$ -in. diameter; diameter of table, $8\frac{1}{4}$ in.; maximum distance from spindle to table, $7\frac{1}{2}$ in.; maximum vertical movement of spindle, $2\frac{1}{4}$ in.; maximum vertical movement of table, 6 in.; height, 24 in.; floor space, 21x9 in.; weight, 60 lb.

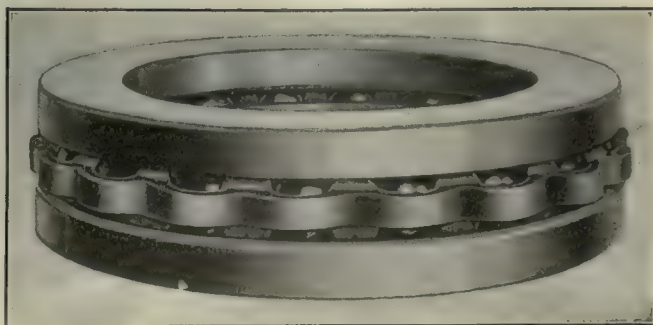
column. The long central stem of the table provides vertical adjustment that, in conjunction with the quill traverse, is sufficient to cover the range of work for which this drilling machine is adapted.

The machine is built in two sizes, for the smaller of which the dimensions are given.

Ball Thrust Bearing

The feature of the ball thrust bearing shown, the latest addition to the line made by the Rochester Ball Bearing Co., Rochester, N. Y., is the solid brass retainer.

The brass retainer is claimed to be an improvement over the more commonly used sheet-metal form in that



BALL THRUST BEARING

wear resulting in particles of the steel falling into the races is avoided. The injurious effects of any foreign particles in the races need no explanation.

The form of bearing illustrated is usually made with round grooves, although V-groove bearings are regularly made for high-speed light-duty conditions. Thrust bearings for heavy duty are made with self-aligning spherical-seat washers.

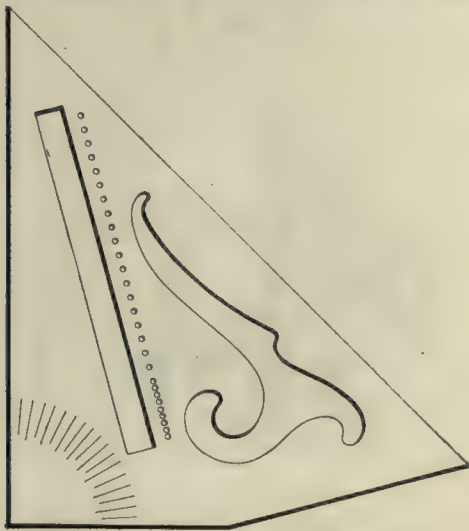
The illustration shows a medium-weight bearing of large size. The retainers of smaller bearings are not scalloped.

✱

Combination Drawing Triangle

The combination form of drawing instrument shown requires little explanation.

This instrument was designed to serve as a triangle, protractor, irregular curve, scale, section-liner, lettering



COMBINATION DRAWING INSTRUMENT

angle and for other drafting necessities. It is made of celluloid in a number of sizes, by the Earl J. Early Co., 307 Arch St., Philadelphia, Penn., and is marketed un-

der the name of "Lin-o-graph." The celluloid of which the triangles are made is of course transparent and is available in a variety of colors.

✱

Heavy Turret Boring Lathe for Shells

The heavy boring lathe shown was designed especially for the inside boring operations on high-explosive shells.

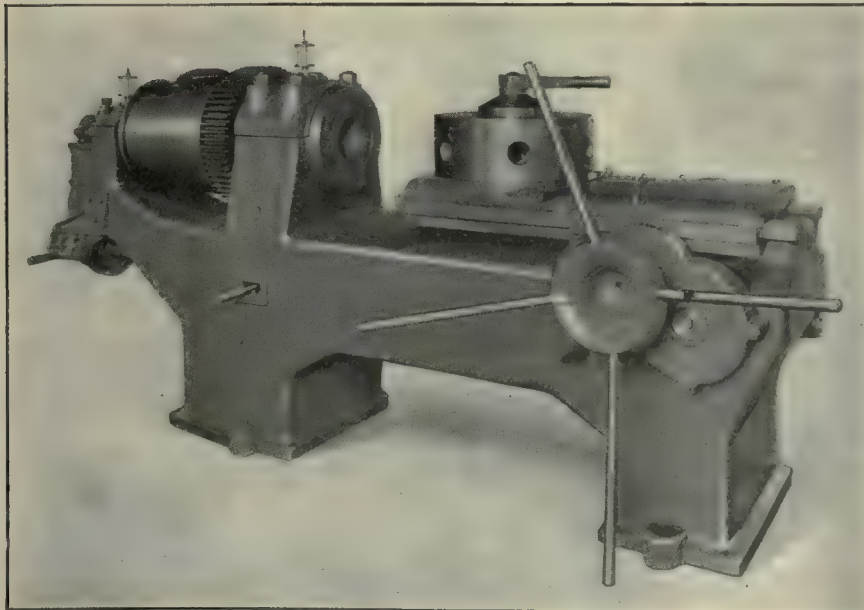
The bed is cast in one piece, the legs and headstock bearings being integral. The front headstock bearing, which with the rear spindle bearing is fitted with self-oiling rings, is 8½ in. in diameter by 12 in. long. The spindle is made large enough for the bearing to take the shell completely inside and is made in one piece with the 15-in. heavy flange to which the chuck is bolted. The chuck (not shown) is of the collet sleeve type, which grips and drives the shell through three self-centering hardened-steel jaws.

The main gear, which is 4½-in. face and 3 diametral pitch, is fitted to the spindle on a diameter of 8½ in., which is calculated to provide ample driving power. The back gearing has a ratio of 9:1.

The back gear has a 3½-in. face, 4 diametral pitch, and is driven from the cone pinion, which is made of cast steel. The thrust of the tool is absorbed by a special self-adjusting thrust bearing fitted with a dustproof self-oiling case of cast iron and capable of a continuous working load of 8,400 lb.

The turret is of heavy construction. While a heavy central stem has been provided on the carriage, the turret is spigoted at its outer edge, thus affording a wide base to resist the tool pressure. A hole through the center stem permits driving out the boring bars. The turret is fitted with a hardened-steel ring tempered and ground, into which a hardened-steel key is fitted, thus holding the turret firmly in any position that may be selected to machine the work in hand.

The carriage runs on flat shears, each 3 in. wide. The power is applied by a steel rack 3 in. wide, 4 diametral pitch, placed in the center of the carriage. The usual tripping device for disengaging the power feed at any point on the travel is provided. The center of the boring bar is only 6 in. above the shears. Four feeds of 1/64, 2/64, 4/64 and 8/64 in. are designed to take care of all rough and finish cuts. No gears have a narrower face than 17/8 in. and 1 3/16 in., while the smallest pitch selected is 6 diametral pitch. The worm gear on the power feed is 4 diametral pitch, geared 50 to 1 with a steel worm. Ball bearings take up all the thrust of the worm. The capstan bars are 24 in. long, and the gearing provides a thrust of 79 lb. on the tool for .1 lb. on the capstan. This provides a 2,000-lb. tool thrust by 25-lb. pressure on the capstan. The machine is a recent product of the Reliance Machine Co., Toronto, Canada.



HEAVY-DUTY BORING TURRET LATHE

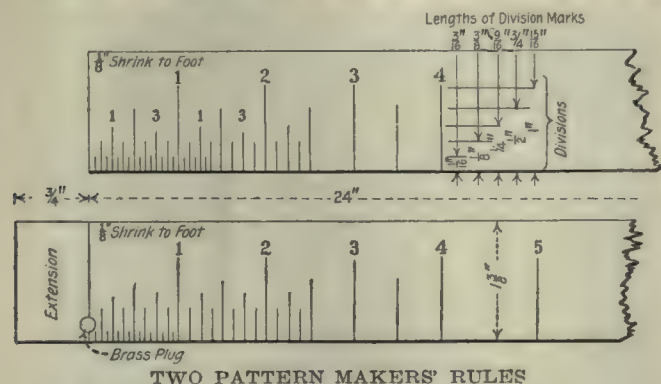
Capacities, 4-, 5-, 6- and 8-in. high-explosive shells; length of bed, 9 ft.; distance of center from floor, 40 in.; diameter of turret, 20 in.; turret holes, 3 1/4 in. diameter; length of carriage, 42 in.; pulleys, 15 and 18 in. in diameter; width of belt, 8 in.; weight of machine for 4-, 5- or 6-in. shells, 8,000 lb.

Pattern Makers' Rules

By M. E. DUGGAN

Many of the dimension mistakes made by pattern makers—especially by the younger ones—in the construction of a pattern can be attributed to the rule used. A rule marked on both edges and on both sides with eighths, tenths, etc., is a sure invitation for mistakes. No apprentice should be allowed to work with a rule so marked. It keeps the young journeyman guessing and once in a while finds the old experienced man napping.

Working with a borrowed rule is another cause for mistakes. Mental habit is one of the hardest things in



the world to alter. We allow the mind to work automatically, and a change requires concentration and effort, which are not only a burden, but are liable to cause error.

The shrink rules used by pattern makers in general are as follows: $\frac{1}{8}$ -in., $\frac{3}{16}$ -in., $\frac{1}{4}$ -in., $\frac{5}{8}$ -in. and $\frac{3}{8}$ -in. shrinkage allowance to the foot. Some shops adopt a shrinkage-allowance standard of their own—tenth- or twelfth-inch rule. In one shop where I was employed, $\frac{1}{2}$ in. to the foot allowance was made on all patterns for steel castings.

During the many years that I have worked at pattern making I have used every one of the rules above noted. I have made as many mistakes as the average pattern maker, if not more. The rule that I used was in many instances the cause of these mistakes. I have settled this to my own satisfaction.

You will notice that I place the blame for my many mistakes upon some other person or thing and doing so in a scientific, business-like and diplomatic manner and getting away with it form one of the highest attainments in the pattern-making trade. As a past master in this art, I have qualified for a diploma.

In the illustrations are shown two shrink rules that I made of select white maple, $\frac{3}{2}$ in. thick and $1\frac{3}{8}$ in. wide. The division lines are on *one side* and at *one edge only*. The length of each division line is clearly shown. The inch divisions are stamped in the wood with large figures. The quarter-inch divisions are stamped in the wood also and are indicated by figures one-half the size of the ones indicating the inch divisions. The shrink figure—large, clear and plain—is stamped in at the zero end of the rule.

The lower rule is a duplicate of the one at the top, with the exception that it has an extension at the zero end, also a brass-plug insert at the zero line. A small hole is made in the brass plug exactly on the zero line. This rule I use for setting dividers, compass, trammel

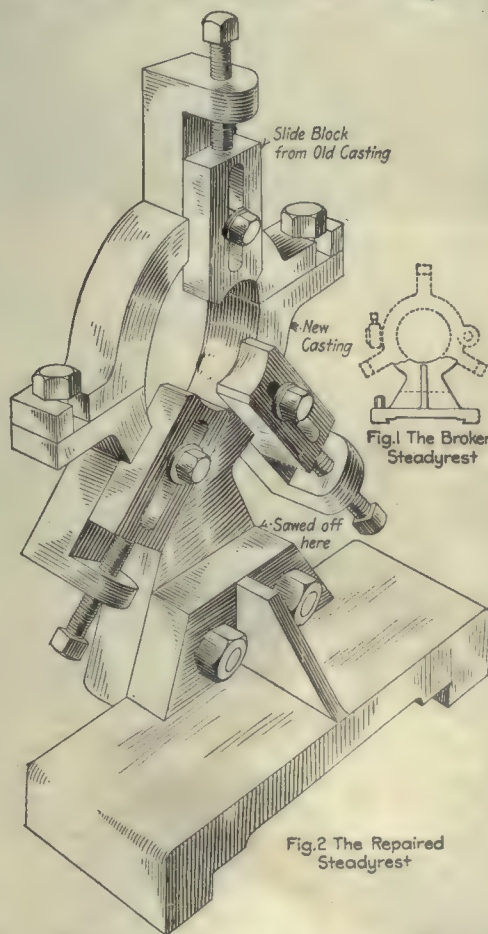
points, etc. The fixed leg of the instrument is placed in the punch mark at zero; the other leg is opened out to the exact division on the rule. It is foolproof. The common method is to place the fixed leg at the first, second or third division or inch and guess at where you are going to put the other leg.

Repair Job on Lathe Steadyrest

By H. H. PARKER

A steadyrest had been broken off as shown in Fig. 1, leaving only the dovetailed base and clamp. As the lathe was an old one, it was impossible to obtain a new part; and as one was needed at once, the base portion was utilized as follows, at a considerable saving in pattern work and machine work over that required in making a complete new rest.

The broken portion was sawed off, and then a casting was made of a top and lower portion of a new rest, very similar to the old one except that the lower portion was made without a dovetailed base. Also, to simplify



REPAIRED LATHE STEADYREST

pattern work and machining, a hinged cap was not used; two slots in the cap permitted its removal when the screws were loosened. This arrangement made the pattern work very simple. Both were one-piece patterns with one side flat and no loose pieces. Shallow slots were cast in for the slides and dressed up with a file. The old sliding blocks and adjusting screws were retained.

The new part was bolted to the old base by two $\frac{1}{2}$ -in. bolts, the new casting being drilled and tapped for them, with the solid portion of the bolts extending in a little distance, as shown.

Accurate Way of Spacing Cams

BY FRED H. COLVIN

The accurate spacing of shoulders in the engine lathe is not an easy task, as any errors are apt to be cumulative. The device shown herewith was devised in the Fay & Bowen shop, Geneva, N. Y., and has been found to work out nicely in spacing the cams for the Curtiss aeroplane

The pin *B* in the arm *D* serves to locate the carriage in the proper position, the indicating arm pivoting at *C* and the readings being taken at the front of the lathe carriage at *D*.

The bar *A* can be lifted so as to allow the carriage to move freely, by means of the lever *E*. The block and pins *F* both support and guide the spacing bar, but do not restrain it in any way.

When moving from one space to the next, the bar *A* is raised by means of the lever *E*, so as to clear the pin *B*. The carriage is then moved along one notch and the bar again lowered into position with the pin in the next space.

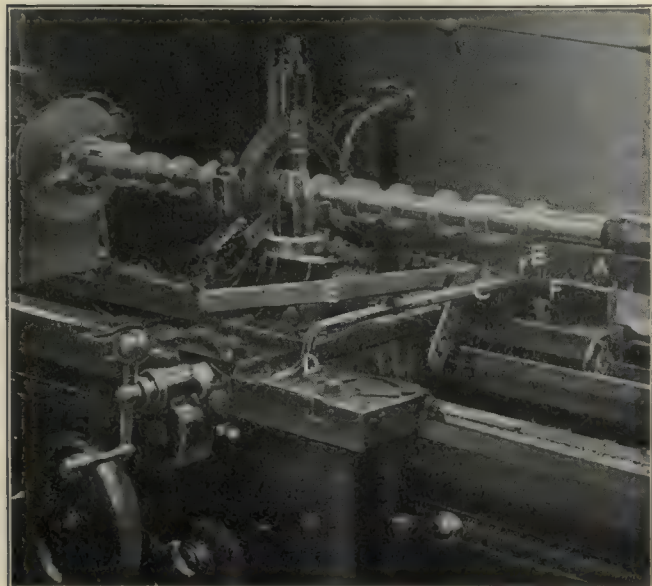


FIG. 1. FRONT VIEW OF SHOULDER-SPACING LATHE

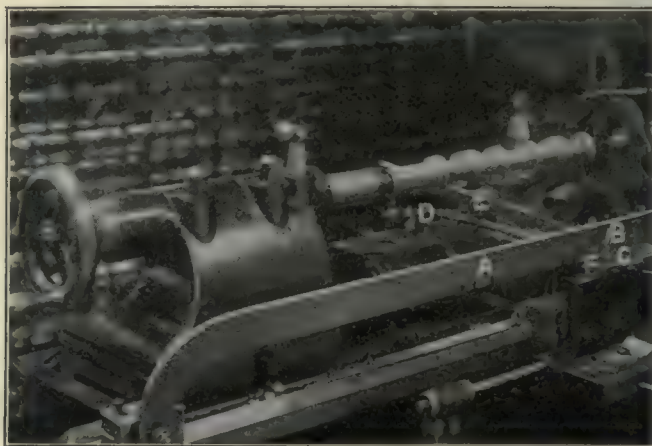


FIG. 2. REAR VIEW OF LATHE, SHOWING SPACING BAR

motor shown in the lathe in Figs. 1 and 2. This camshaft carries eight cams and four bearings, as can be seen, and the tolerance is only 0.004 in.

The spacing is done by the combination of an accurately spaced bar and an indicating arm with a 20 to 1 leverage. The bar *A* is of tool steel and hardened on the edge. Then the notches are ground and lapped to Johansson gages.

Then the carriage is adjusted so that the pin *B* contracts with the groove in the bar, and in so doing swings the arm *D* at the pivot *C*. When the line on the end of *D* coincides with the graduations on the plate fastened to the carriage wing, the carriage has been moved the correct amount. Then the cam, or bearing, is faced to the correct distance from its neighbor and the process is repeated.

Personals

W. J. McKechnie has been appointed general manager of the American Forging and Socket Co.

A. W. Foote, president of the Foote-Burt Co., Cleveland, Ohio, has accepted the presidency of the H. A. Lozier Co.

W. P. Anderson has resigned as general superintendent of the Dayton Engineering Laboratories in order to become president of the newly organized Dayton Screw Co.

George S. De Laney, formerly general manager of the Rivett Lathe and Grinder Co., Boston, Mass., has become associated with the Taylor & Fenn Co., Hartford, Conn.

C. H. Saunders, formerly Boston sales manager of the Pratt & Whitney Co., has accepted a position as sales manager of the cutter and fixture department of the Becker Milling Machine Co., Hyde Park, Mass.

A. W. Petersohn, who for the past two years has had charge of toolroom of the Aurora Automatic Machinery Co., Aurora, Ill., has been promoted to the position of supervisor of piece-rate and layout departments.

R. G. Clyne, for the past seven years with the Western Cartridge Co., East Alton, Ill., as mechanical engineer, has resigned to establish his own business in St. Louis, Mo., in the design and construction of special machinery.

Business Items

The Perkins Appliance Co., Springfield, Mass., has moved into a new plant at 4 Birnie Ave., that city, where it will have double its former facilities to meet its rapidly increasing business.

The Leland-Gifford Co., Worcester, Mass., has opened an office at Room 418, Singer Building, 149 Broadway, New York City, in charge of Walter F. Henly, formerly with the Fairbanks Co.

Trade Catalogs

Trucks and Turntables. Whiting Foundry Equipment Co., Harvey, Ill. Catalog No. 124; pp. 16; 6x9 in.; illustrated.

Tapping Chuck. Braden Manufacturing Co., 135 W. Third St., New York. Catalog D; pp. 8; 3½x6 in.; illustrated.

21-in. Heavy-Duty Manufacturing Lathe. Hilmoff Machine Co., 50 Church St., New York. Circular; pp. 4; 9x11 in.; illustrated.

Auto Sand-Cutting Machine. The Sand Mixing Machine Co., 52 Vanderbilt Ave., New York. Catalog; pp. 24; 7x9 in.; illustrated.

Bolt Heading and Rod Heating Furnaces—Oil or Gas Fuel. Tate, Jones & Co., Inc., Pittsburgh, Penn. Circular No. 151; pp. 4; 8x11 in.; illustrated.

Tool Dressing Furnaces and Blacksmith Forges—Oil or Gas Fuel. Tate, Jones & Co., Inc., Pittsburgh, Penn. Circular No. 152; pp. 4; 8x11 in.; illustrated.

Grinding Wheels. Star Corundum Wheel Co., Detroit, Mich. Catalog No. 9; pp. 100; 6x9 in.; illustrated. With this there is also a supplement on "Safety Code for the Use and Care of Abrasive Wheels."

Rotary Oil Pumps. The Goulds Manufacturing Co., Seneca Falls, N. Y. Bulletin No. 113; pp. 16; 8x10 in. This contains illustrations showing pumps feeding compounds and oils to metal working machines.

Catalogs Wanted

John Alderdice & Co., Ltd., Warrnambool, Victoria, Australia, would like to receive from manufacturers latest catalogs, accompanied whenever possible by full price lists f.o.b. New York. Their main departments include valve and cock department, pump department, general engineering, brass foundry, iron foundry.

Forthcoming Meetings

American Society of Mechanical Engineers. Annual meeting, Dec. 5-8, Engineering Building, New York City. Calvin W. Rice, secretary, 29 West 39th St., New York City.

American Society of Mechanical Engineers. Monthly meeting, first Tuesday. Calvin W. Rice, secretary, 29 West 39th St., New York City.

Boston Branch National Metal Trades Association. Monthly meeting on first Wednesday of each month, Young's Hotel. W. W. Poole, secretary, 40 Central St., Boston, Mass.

Providence Association of Mechanical Engineers. Monthly meeting, fourth Wednesday of each month. J. A. Brooks, secretary, Brown University, Providence, R. I.

New England Foundrymen's Association. Regular meeting, second Wednesday of each month, Exchange Club, Boston, Mass. Fred F. Stockwell, 205 Broadway, Cambridgeport, Mass.

Engineers' Society of Western Pennsylvania. Monthly meeting, third Tuesday; section meeting, first Tuesday. Elmer K. Hiles, secretary, Oliver Building, Pittsburgh, Penn.

Rochester Society of Technical Draftsmen. Monthly meeting, last Thursday. O. L. Angervine, Jr., secretary, 857 Genesee St., Rochester, N. Y.

Superintendents' and Foremen's Club of Cleveland. Monthly meeting, third Saturday. Philip Frankel, secretary, 310 New England Building, Cleveland, Ohio.

Western Society of Engineers, Chicago, Ill. Regular meeting, first Wednesday evening of each month, excepting July and August. J. H. Warder, secretary, 1785 Monadnock Block, Chicago, Ill.

Philadelphia Foundrymen's Association. Meetings first Wednesday of each month, Manufacturers' Club, Philadelphia, Penn. Howard Evans, secretary, Pier 45 North, Philadelphia, Penn.

Technical League of America. Regular meeting, second Friday of each month.

Plants of Remington Arms Co.--I

BY HUGH M. WHARTON

SYNOPSIS—The largest concern for rifle manufacture in the United States is the Remington Arms Co., operating two plants having a combined capacity of 8,000 guns per day. To meet the war orders now being filled, factory buildings containing more than 2,000,000 sq.ft. of floor area have been completed within a year. This article takes up the general construction features of both plants and is devoted to a discussion of the type of building adopted, the walls, floors, supports for overhead fixtures, provisions for fire protection, etc.

The first "Remington" gun was made in 1816 in a little country blacksmith shop about two miles from the village of Ilion in the central part of New York State. The Remington Arms Co. of today has two large plants,

supervision these plants were developed by the writer and his associates, but after they were completed it was decided to postpone building the new plant until later. The plans were accordingly laid away until the autumn of 1914, when European orders for military rifles began to arrive in such volume that they could no longer be handled by the old Ilion works.

Under these new conditions, with such large orders on hand, the work at Ilion could not be interrupted, and the idea of moving to Bridgeport had to be abandoned. The only thing that could be done was to enlarge the Ilion works by adding new buildings and by replacing some of those that had become obsolete by larger ones better adapted to the work. The old Bridgeport plans of 1909 were resurrected, modified to suit the conditions at Ilion and to meet the requirements of the New York State labor laws, and the reconstruction of the Ilion works

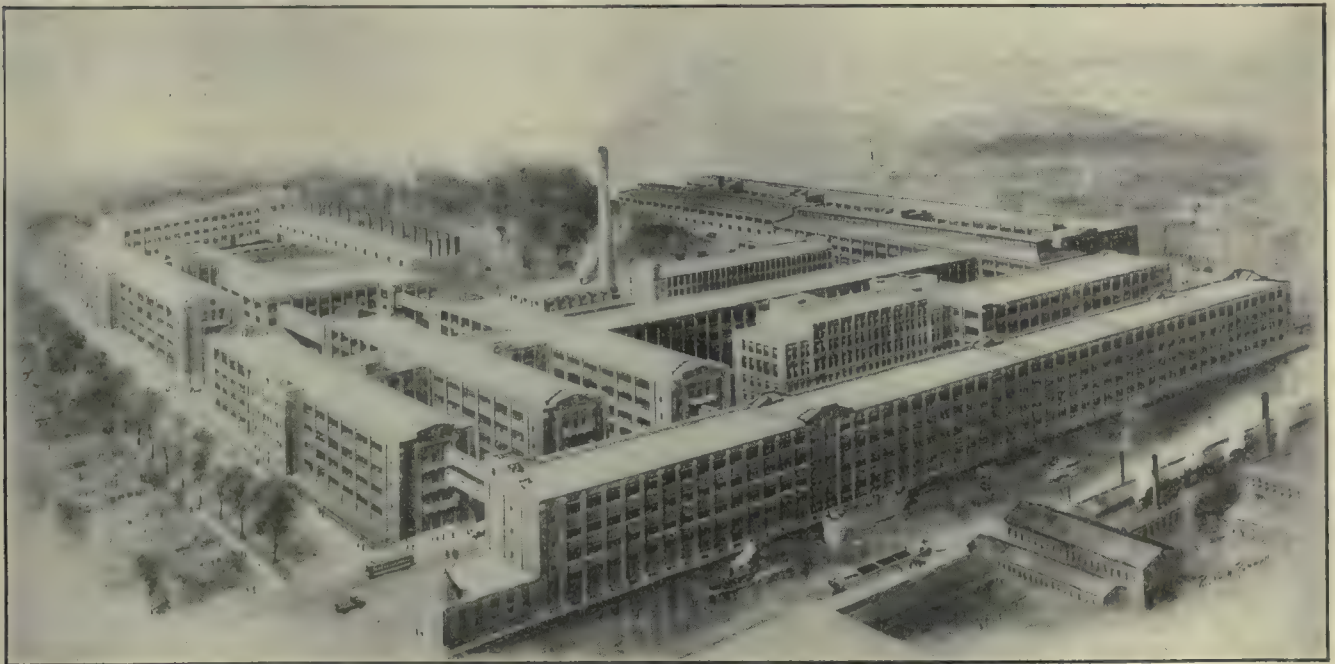


FIG. 1. ILION WORKS OF THE REMINGTON ARMS U. M. C. CO. AS THEY WILL BE WHEN ENTIRELY RECONSTRUCTED

one at Ilion and one at Bridgeport, Conn., equipped to manufacture 8,000 guns every day.

Although the development of this industry through a whole century would be an interesting story in itself, it is enough for the purpose of this article to say that by 1900 the works at Ilion had grown into a collection of buildings of different types and varying floor levels, erected from time to time to meet the immediate needs of the hour, and no longer well adapted as a whole to the requirements of modern manufacturing.

In 1909 it was thought worth while to consider replacing this old plant by a new one to be built at Bridgeport, adjacent to the works of the Union Metallic Cartridge Co., an allied company under the same ownership, and Charles C. Tyler, then works manager of the Remington Arms Co., and now vice-president of the Remington Arms Union Metallic Cartridge Co., undertook to have the necessary plans prepared. Under Mr. Tyler's

was begun without further delay. Soon after this work was fairly under way, the building of an entirely new works at Bridgeport was started, using the same original plans with some further minor alterations.

The purpose of this article is to give a general idea of the character of both these new works.

A study of the operations in the manufacture of fire-arms shows that, insofar as they affect the character of the buildings and the general design of the whole plant, they may be divided roughly into two general groups.

The first includes such operations as drop-forging, barrel rolling and heat treating. On account of the relatively high temperature due to the presence of a large number of heating furnaces, these operations should preferably be housed in one-story, noncombustible buildings, with all the natural ventilation that it is possible to get. Drop hammers, of course, must be placed on solid ground.

The second group includes machining small steel parts, woodworking operations on stocks, assembling and inspection. As there are no bulky pieces of material and no great weights requiring special handling equipment, the multiple-story loft building is the type most suitable

main building units placed side by side in a row, with equal spacing between them and joined together in the middle by connecting wings in which are placed the stairways, elevators, lavatories and other service equipment. This is probably the most flexible plan that can

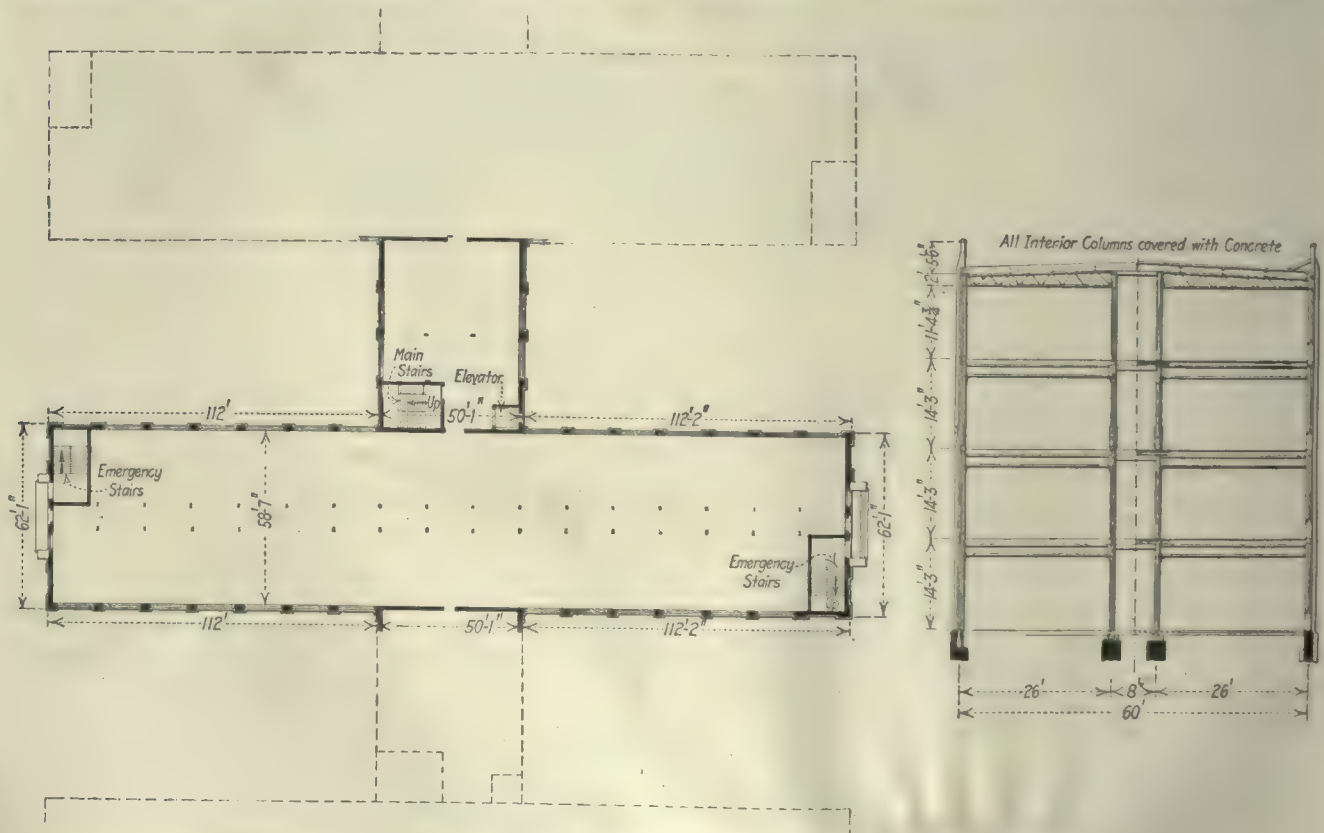


FIG. 2. BRIDGEPORT WORKS OF THE REMINGTON ARMS UNION METALLIC CARTRIDGE CO.—SPRING OF 1916

for these operations except, perhaps, in the case of a very small plant, for which a single-story building with saw-tooth roof would be quite satisfactory. As the greater proportion, by far, of the total floor space is required for this second group of operations, this group determines largely the general design of the plant.

The general plan adopted for the Remington works is a sectional one built up of a number of multiple-story

be devised for a manufacturing plant. Any desired number of units can be built at the start, and future growth is provided for by the addition of more units without disturbing the general plan or without interrupting manufacturing operations. It is also more compact than any other arrangement of separate buildings, the distance between any two remote points being a minimum for the transportation of material. At the same time it pro-



FIGS. 4 AND 5. PLAN AND CROSS-SECTION OF A TYPICAL UNIT BUILDING

vides a relatively large proportion of wall surface to floor surface, which means that no point on any floor need be remote from a window.

Fig. 1 shows the Ilion plant as it is today, and Fig. 2 a general view of the Bridgeport works. The photograph

reduce this dimension to 64 ft. The plan of a Bridgeport unit is exactly like the one shown, except that the 80-ft. spacing was maintained.

As the floors of the new building are intended only for manufacturing operations they are kept entirely clear



FIG. 3. CLEAR FLOOR SPACE IS MADE POSSIBLE BY DOUBLE ROW OF COLUMNS

for Fig. 1 was taken from a wash drawing and is open to the usual objections to such a view. The floor area of the Ilion plant in new construction is 660,000 sq.ft., in old construction temporarily left standing 150,000 sq.

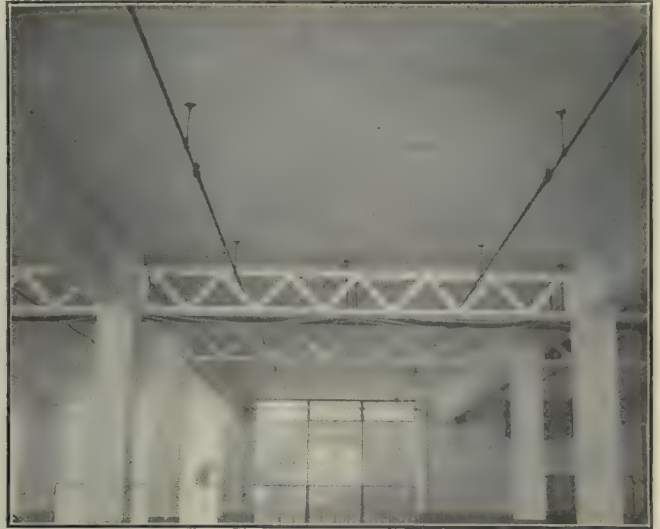


FIG. 6. VIEW ALONG CEILING PANEL OF A MAIN BUILDING

of everything except the necessary building columns and an emergency stairway, or fire escape at each end. The connecting building, or wing, is used for all service equipment such as main stairs, elevators, coatrooms, restrooms for women, washrooms and toilets, and in some cases these wings are used for the inspection and temporary storage of parts. Each unit, therefore, is practically a complete factory in itself. The width of the main building was fixed at 60 ft. because this seems to be about the maximum at which satisfactory daylight can be obtained without excessive story height. With this width of building interior columns are needed to support the floors and, as it was considered highly desirable to keep the manufacturing floors free from obstructions of any kind that would interfere with the orderly arrangement of machines, a departure was made from the usual practice of spacing interior columns equally across the floor. By placing them in two rows near the middle a clear and unobstructed manufacturing floor was obtained along each side of the building, about 26 ft. wide and the full length of the building, leaving a central passage with a clear width of 7 ft.

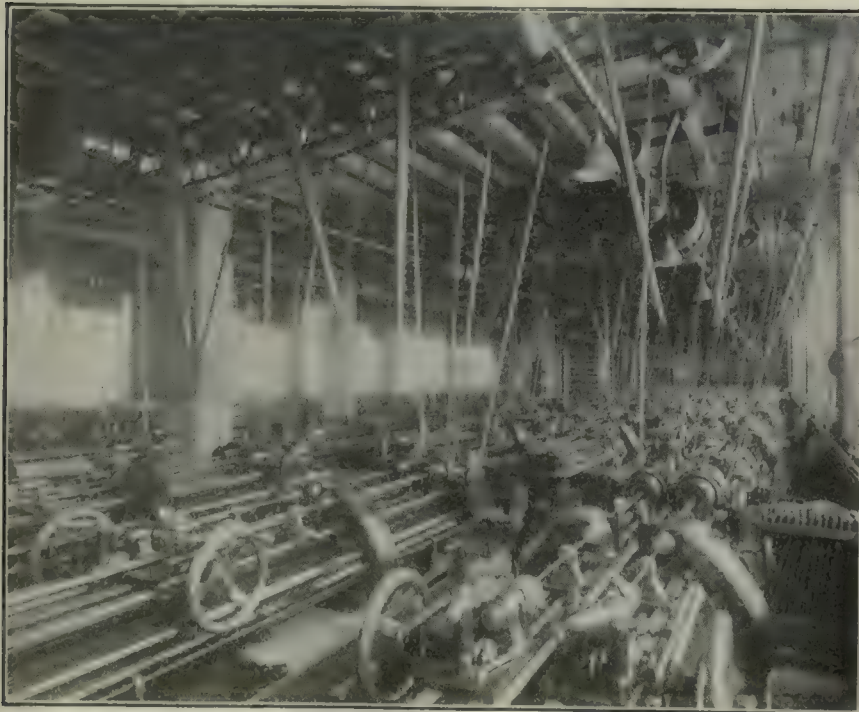


FIG. 7. VIEW IN BARREL-DRILLING DEPARTMENT

ft., while that of the Bridgeport works is 1,500,000 sq.ft.

The plan of one unit adopted for Ilion is shown in Fig. 4. Each main building is 60 ft. wide and 272 ft. long, and each connecting building 48 ft. wide and 64 ft. long. In the original plans the spacing between main buildings was made 80 ft. in order to allow as much light as possible to reach the windows of the first story, but the ground available at Ilion made it necessary to

between the columns for the movement of employees and for the transportation of materials.

Anyone who has attempted to arrange a large number of machines to the best advantage in a shop of this kind will appreciate the value of the clear floor space shown in Fig. 3. The double row of columns defines physically the main passage and helps to prevent the encroachment of machinery and piles of material that seem to be natural results in manufacturing.

In the main buildings the columns are spaced 16 ft. apart in the direction of the long axis of the building. This spacing is maintained throughout all the buildings very strictly in order to obtain interchangeability of the loose beams that support the shafting and which are illustrated further on. In the connecting wings columns are not the serious obstruction they would be on the manufacturing floors; therefore, in these wings the spacing is 16 ft. in both directions. In developing the details from the general plan the problem was not treated as one of building construction alone, the buildings being looked upon as an important part of the manufacturing equipment which should be properly designed for the manufacturing operations and machinery to be housed in them. Wooden floors were preferred because no other floor affords the same facility for fastening down machine tools. The live loading assumed is probably higher than usual, but it allows for the possibility of occasional concentrated loads due to piling up material and parts. Floors were to be as stiff as possible, to insure freedom from vibration due to machinery, and yet, at the same time, in order to provide for the arrangement used for supporting shafting, no intermediate beams between the main floor girders nor any longitudinal beams or girders could be permitted. A laminated wooden floor probably fulfills these conditions better than any other type. All machine-shop floors are designed to support a live load of 175 lb. per sq.ft. Steel frames support the side walls as well as the roof and floors. With the assumed floor loads and the given length of span (26 ft.) steel floor girders would have been necessary anyway, but, aside from this, the use of wall columns allows the window areas to be made much larger than if the floors were supported by the walls. In this case it was important to get as much daylight as possible. The actual glass area of the windows is nearly 60 per cent. of the wall area. All windows have steel sash, and the walls are built of brick, but, as they have wooden floors, the buildings are not fireproof. Wall columns are fireproofed by being inclosed in the brickwork, and interior columns are fireproofed with concrete. The steel floor girders, however, are exposed as any covering would have prevented the use of the arrangement for supporting the overhead shafting which is illustrated further on. Other conditions being equal, a manufacturing building that is wholly fireproof is to be preferred to one that is not, but, in the case of a machine shop in which the processes involve no fire risk and the materials handled are not combustible, an absolutely fireproof building is not so important as one so designed that machinery and shafting can be set up anywhere on the floor or moved from place to place quickly, easily and at a minimum expense. In this respect the construction adopted appears to be superior to any type of fireproof construction that has yet been developed. In order to provide sufficiently high windows to light the floors properly the story height in all buildings throughout both works is 14 ft. 3 in.

Floor levels are also the same for all buildings of each plant. At Ilion the contour of the ground was such that this provision involved an increase in the cost of construction in some cases, but as several of the buildings are connected by bridges at more than one floor and as electric trucks are used for transportation throughout the



FIG. 8. VIEW IN MILLING DEPARTMENT

plant, it was felt that variations in floor levels should be avoided.

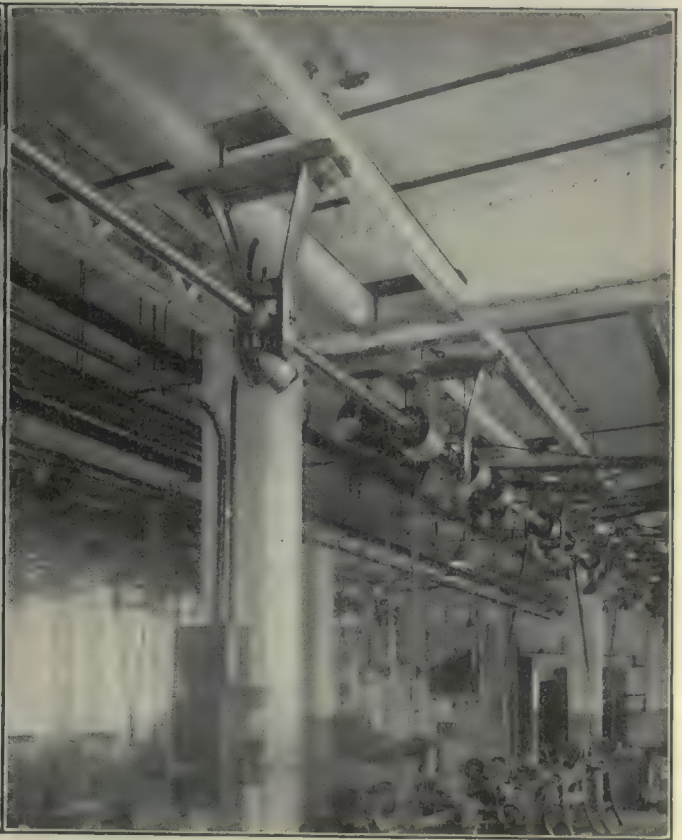
The cross-section of one of the main units at Ilion is shown in Fig. 5. At Bridgeport they are one story higher. The original design was for five-story buildings, but as they have wooden floors, the design for Ilion had to be altered to meet the requirements of the State of New York, which does not allow the erection of factory buildings more than four stories high unless they are fireproof. The original design also showed a tunnel, or subway, for pipes and cables, under the first floor between the two rows of interior columns, high enough to walk through and extending the whole length of the building. With no pipes of any kind buried under the floors, the expense and inconvenience of taking up floors in order to get at pipes are eliminated. The slope of the ground at the site originally chosen was such that this tunnel involved very little additional cost, as it was necessary to provide a basement under one end of most of the buildings anyway. A cross basement under the service wings gave easy access to all these pipe subways.

In the modified design for Ilion these subways were omitted on account of their cost. In the Bridgeport design they are placed under the connecting wings but not under the main buildings.

As already stated all floors are of wood. Ground floors are of 3-in. yellow pine or hemlock laid on tar concrete having a top surface of tar and sand. The wearing surface is 1 $\frac{1}{8}$ -in. maple. Upper floors are built up of 2x8-in. long-leaf yellow-pine joists on edge nailed solidly together. Two layers of tarred felt are laid over these and protected by an intermediate floor of $\frac{7}{8}$ -in. pine over which is laid the wearing surface of 1 $\frac{1}{8}$ -in. maple.

Main floor girders occur only at the columns and are 16 ft. apart. There are no intermediate nor longitudinal beams. Latticed struts tie the interior columns together in the direction of the long axis of the building, but, as the top flanges of these are kept at least 6 in. below the under side of the floor above, the ceiling panels included

All main pipes and conduits are carried overhead through the central passageways, the branches being taken off between girders and carried across the under side of the floor either over or through the latticed struts. In order to avoid any possibility of interference with overhead shafting all transverse pipes are kept at least 9 in.



FIGS. 9 AND 10. CEILING CONSTRUCTION FOR LINESHAFT AND COUNTERSHAFT SUPPORTS



FIG. 11. CONCRETE BALCONY FOR FIRE ESCAPE

between the main floor girders are flat and unbroken from side wall to side wall of the building. These large ceiling areas, unbroken by beams, allow an economical and most effective spacing of sprinkler heads and insure an unobstructed flow of water from them in case of fire. They also afford the greatest facility for extending electric conduits and other small pipes across the under side of the floor.

above the bottom flanges of the floor girders. The photograph, Fig. 6, was taken looking directly across the building along the ceiling and through one of the longitudinal struts.

Floor girders are built up of a plate and four angles. Aside from any question of economy of material a fabricated girder was preferred to a plain rolled section because of the greater facility afforded by its flat flanges for supporting and attaching the I-beams from which the shafting is hung. All lineshafts and countershafts and all overhead electric motors are hung from the under side of 6-in. I-beams the ends of which rest upon the bottom flanges of these girders. A plain rolled section, with its sloping flanges, would not provide the flat seat that is necessary. In the interior views of two departments, Figs. 7 and 8, these beams can be seen in position. The other views, Figs. 9 and 10, were taken especially to illustrate these construction details.

The I-beams are usually set in pairs, held together and properly spaced by cast-iron top and bottom plates that are clamped to the beams by long machine bolts extending through both plates. These clamp plates are about 4 in. wide and long enough to give the desired spacing to a pair of beams and, as there are no holes to be drilled, they may be clamped on the beams whenever necessary. The ends of the beams are similarly clamped to the flanges of the floor girders by means of bolts and special cast-iron clamps. Shaft hangers are

fastened by bolts through the bottom plates. Motors are inverted and their bases are bolted up in the same way as the shaft hangers. When motors or starting switches are attached to the building columns no holes are drilled in the columns, but the apparatus is held by bands clamped around the columns.

The main idea in this whole scheme is to avoid drilling holes in the steel framework of the building and to be able to set up shafting with the least amount of labor, or to change the location of machinery quickly and cheaply. The arrangement used is probably as flexible as any that could be devised. Practically all spacing between floor girders is uniform throughout (16 ft.) so that the I-beams can all be cut to one length and can be used anywhere in any building. All clamps are interchangeable and are simply loose cast-iron pieces bolted up with ordinary machine bolts. Story heights are exactly the same in all buildings, as is also the distance from each floor to the lower flange of the floor girders, so that when machines are moved from one department to another the length of the belt from machine to counter-shaft remains unchanged.

The photograph, Fig. 11, shows the detail of the end of one of the Iliion units with the balconies and doors leading to the fire escape. These inclosed stairway wells, or fire escapes, at the end of each unit provide a means of exit in an emergency in case the main service stair cannot be reached or cannot be used. This well is inclosed by a brick fire wall through which there are no openings inside the building, the only access to the stairway being by means of the door at each end of the central passage on each of the upper floors. This door opens onto a concrete balcony, and from the balcony another door opens into the stairway well.

At Bridgeport no doors were provided for the opening leading from the balcony into the stairway. As these stairs are not intended for regular use the door latches are arranged to open only from one side, to allow anyone to pass freely out of the building, but not to pass in.

Operations on Sugar Machines in Honolulu

BY FRANK A. STANLEY

The special tools used and some operations performed with them on medium- and small-sized work in the shops of the Honolulu Iron Works Co. are shown by the accompanying illustrations. These parts are all members of cane-crushing mills or of other equipment required by sugar plantations.

Figs. 1 and 2 represent two views of a special double-ended facing machine constructed by this company for operations on a number of castings of circular outline and of such proportions that they cannot be readily handled on the faceplate of a lathe or on the platen of a planer. This machine consists primarily of a big lathe head and spindle, on the nose of which is mounted a faceplate with a swinging capacity of about 6 ft. in diameter, while an auxiliary plate is attached to the tail end of the spindle. The headstock is mounted on a big floor plate provided at each end with large T-slots and carrying at each end a heavy angle plate for holding the work. These angle irons have a height of four or five feet and are adjustable along the slotted base plate by a handwheel and screw, as clearly represented in the illustrations. The angle irons, or work-holding fixtures, are provided with numerous slots in their bases to receive the holding straps and clamps for the various jobs that they are required to handle. The parts that are customarily machined here are readily secured in upright position to the vertical face of the fixture.

The cutting tools for facing the work are carried in holders in slots in the faceplates. These tool holders serve as slides, which are fed regularly in or out by radially located screws automatically operated by a star feed at the end of each screw, the star wheel striking a contact stud screwed in a bracket projecting from the front end of the headstock quite near to the base plate.

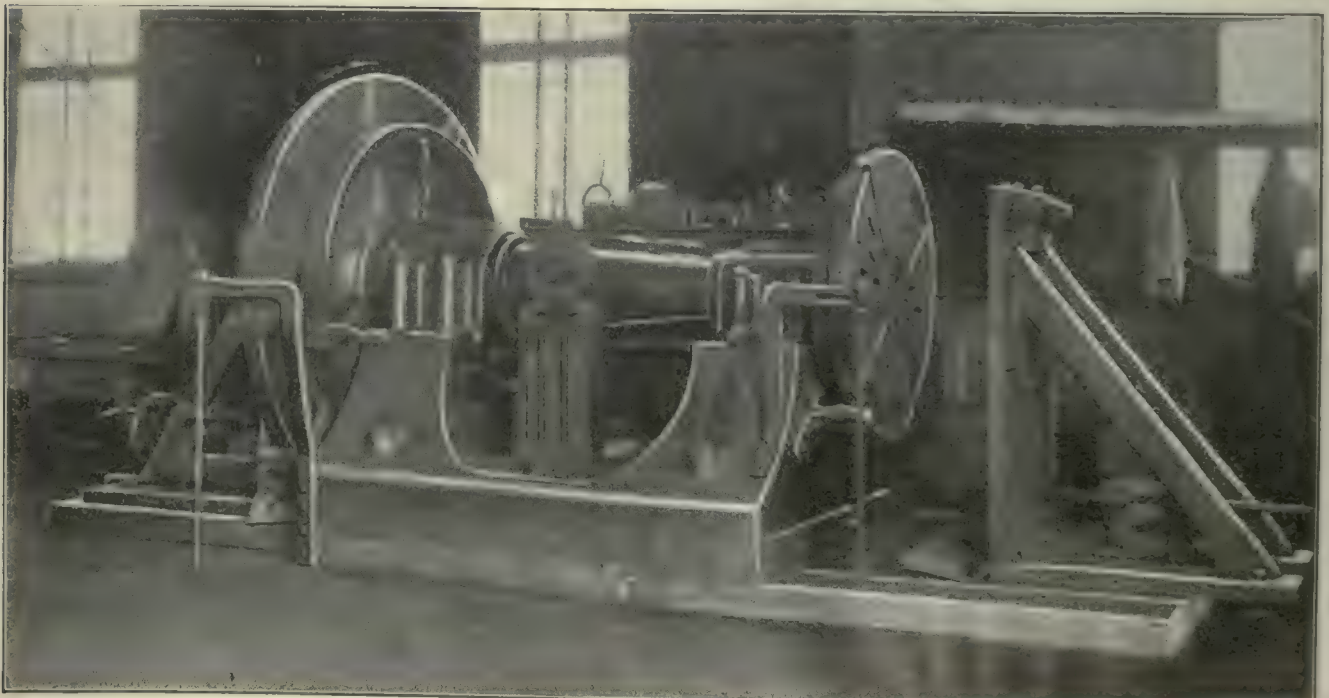


FIG. 1. A SPECIAL FACING MACHINE

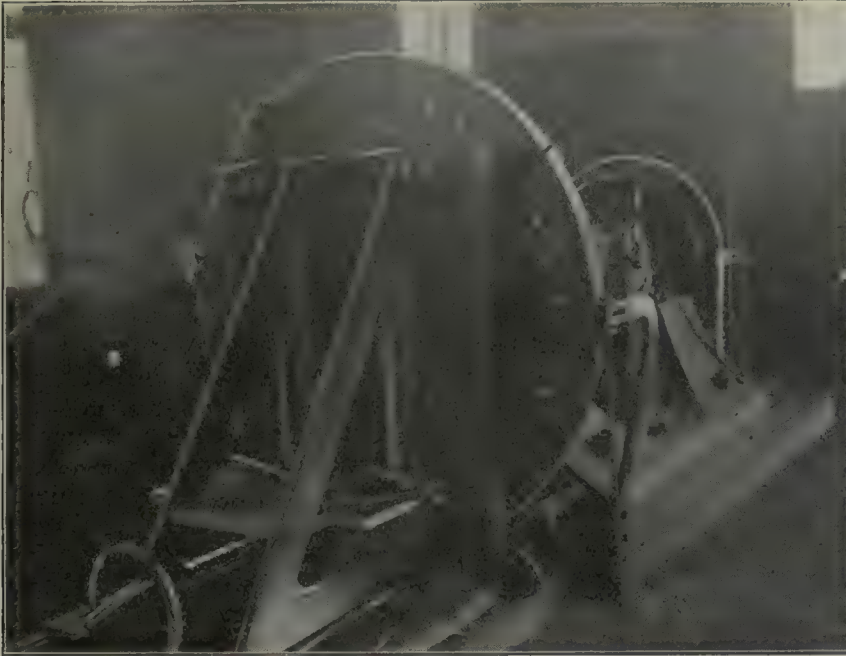


FIG. 2. FACING HEAD AND TOOLS

A series of these cutter heads may be seen on the faceplate, Fig. 2. This view also shows the star feeding arrangement. There are eight slots in the faceplate and, therefore, eight tool slides. Each tool holder carries several cutting tools. The tool slides may be so adjusted as to give any desired rate of advance one ahead of the other in feeding across the work, so that a very coarse rate of feed may be adopted and yet each tool have only a normal feeding advance for each movement of the star feeding attachment.

The construction of the vertical fixture, or work table, enables the casting to be held without liability of springing, and the work is readily fed forward toward the spindle to bring it to the desired thickness by the handwheel and screw at the rear of the angle iron.

When the castings have a number of bosses or other irregularly disposed surfaces to be faced, the different tool slides may be set so that a number of these surfaces are operated upon simultaneously, thus reducing correspondingly the amount of time required to pass over the work.

The machine is driven electrically, and the controlling apparatus is clearly shown at the front of the spindle of the head.

SPECIAL PLATES FOR BORING MILL

For certain boring-mill jobs, to facilitate holding the work properly some of the boring-mill equipment is provided with special plates for the regular table. One of these is shown on a machine in Fig. 3. This plate is provided with radial slots to receive chuck jaws and is used for a variety of castings that would not conveniently rest on the smaller regular table. These plates are easily placed and removed.

This view illustrates a cylindrical head secured in chuck jaws, while the inner face is surfaced by the right-hand tool of the machine. It will be noticed that directly over the center of the table a jib-crane arm may be swung with its trolley and hoist for handling work on the table. Similar crane facilities are provided for the other boring machines in this department.

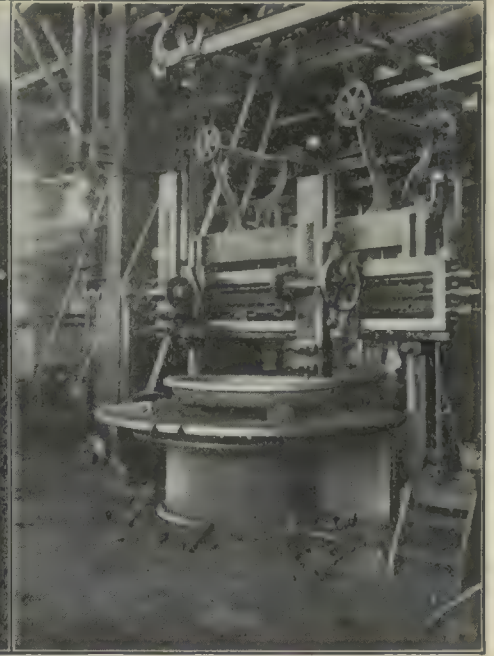
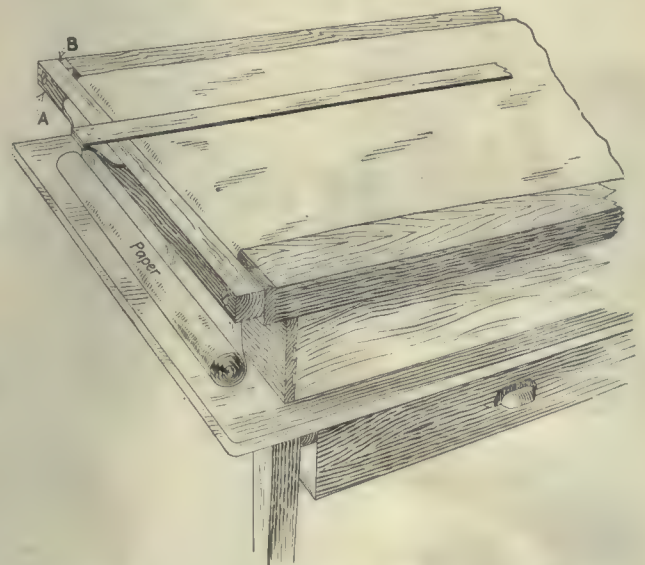


FIG. 3. SUGAR-MILL JOB ON BORING MILL

Arrangement of Drawing Board for Handling Large Drawings

BY M. FAVOR

In the making of layouts an occasion often arises where it is desirable to use a sheet of paper which is longer than the board. This would prove rather an awkward task were the board handled in the usual manner, but by ar-



ARRANGEMENT OF DEVICE ON DRAWING BOARD

ranging the board as shown in the illustration a sheet of flat paper of any length may be used.

The arrangement consists of a strip of wood, or steel, A screwed in the edge of the board. The blocks B are placed between the strip and the edge so as to leave a space through which the paper may be passed.

This scheme permits the paper to be run through the slot and over the board, and allows the roll to rest on the table. As the T-square slides against the strip there is no tendency to crease the paper, which can be large enough to permit making a drawing of any length.

Methods Followed in a Trade-Education Shop

BY ROBERT MAWSON

SYNOPSIS—On this and the accompanying data page are shown special small tools, jigs and fixtures used in a state trade-education shop. The tools are somewhat simple in nature, as the production required is not large. The intention seems to have been to instruct the students in making tools to produce parts interchangeably. The jig and fixture data pages appearing in the "American Machinist" for the past two years were used by the students as the basis of selection for design and construction.

In a previous article were shown some of the jigs designed and built by students in a state trade-education shop, Bridgeport, Conn. In this jig and fixture data page are shown other similar tools made by the students. Such tools make clear to the boys the advantages of jigs and fixtures in obtaining interchangeable results. A careful reading of the jig and fixture pages shown in the *American Machinist* will help any shop, either large or small, in designing similar small tools.

The jig used in boring the cover plate for a grinder is one of the simpler plate tools. The casting is dropped onto the jig and held in position with two straps. The tool, though simple in construction, is proving efficient in

service. A milling fixture is shown, which is an aid in machining the base of the lower half of the steady-rest. The casting, which is of a peculiar shape, is held rigidly, and the operation is successfully performed. The jig used in drilling the saddle is also of simple design.

A method of locating the apron, Fig. 7, for both drilling and reaming, is worthy of note. Setscrews on the side of the jig are used to force the rough casting against pads. To hold the work securely during the drilling and reaming operations three straps are used. The jig cover is located on the jig base by two dowels and is then placed over the casting. To hold the cover in position two swinging bolts are used.

For the purpose of insuring interchangeability by simple means the tools shown appear to have been well selected.

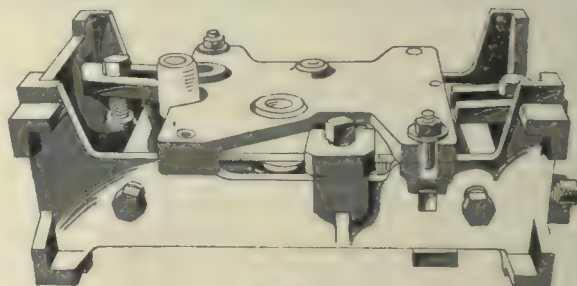


FIG. 8

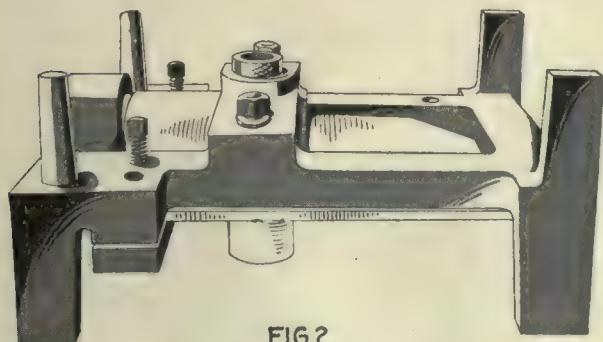


FIG. 2

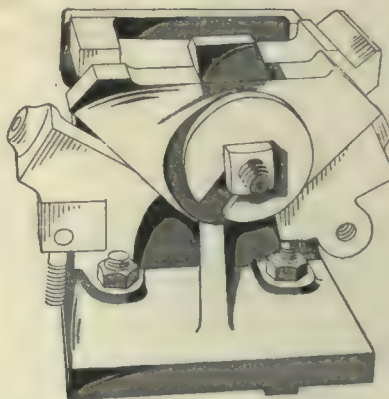


FIG. 4

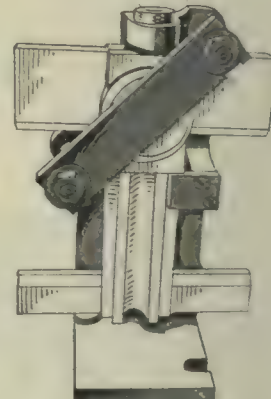


FIG. 6

JIGS AND FIXTURES DESIGNED AND BUILT BY STUDENTS IN A TRADE-SCHOOL SHOP, WITH WORK SHOWN IN POSITION

FIGS. 2 AND 2-A

Operation—Boring cover plate for grinder. The rough casting is dropped onto the jig, being located by its contour. Two straps are then tightened on the piece to hold it securely.

Holes Machined—One 1¼-in. bored 5¼ in. long, and one 1-in. bored 3½ in. long.

FIGS. 4 AND 4-A

Operation—Milling lower half of steadyrest, Fig. 3. The casting is located on two adjustable screws and held against the vertical wall of the fixture with an open washer and nut.

Surface Machined—Base of casting, using a 2.135-in. diameter cutter and a 1.810-in. diameter 90-deg. angular cutter operating at 103 r.p.m. with a feed of 0.032 in. per revolution.

FIGS. 6 AND 6-A

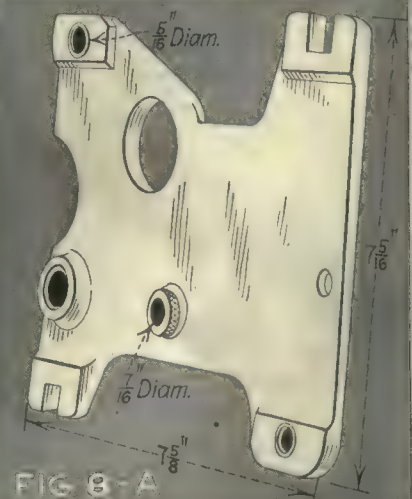
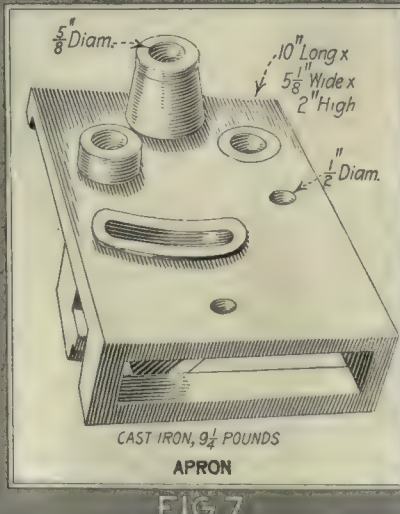
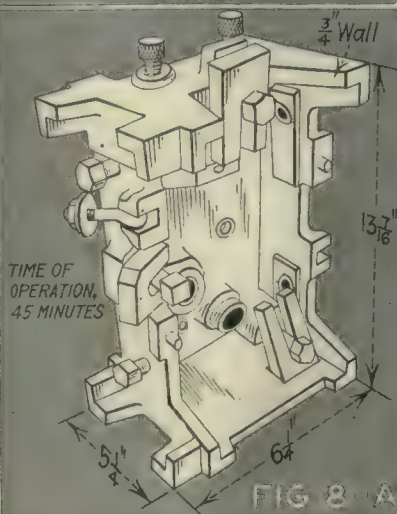
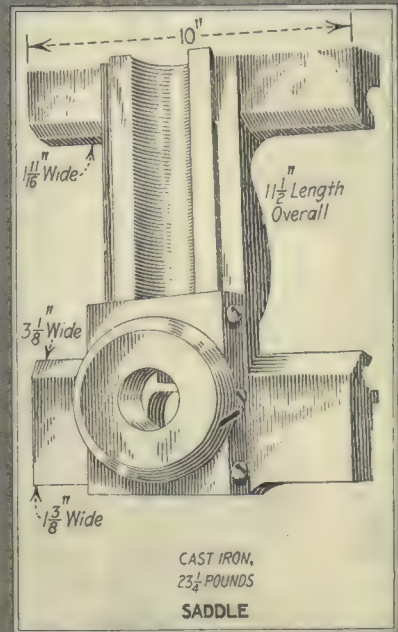
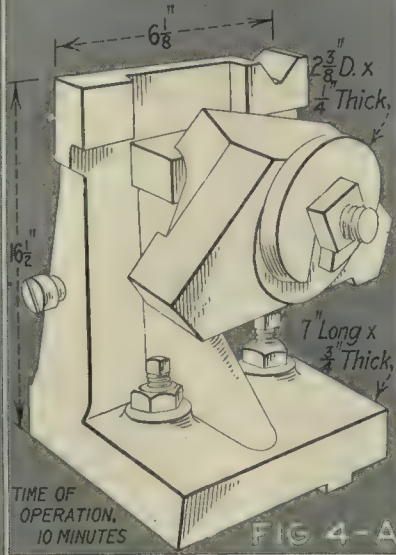
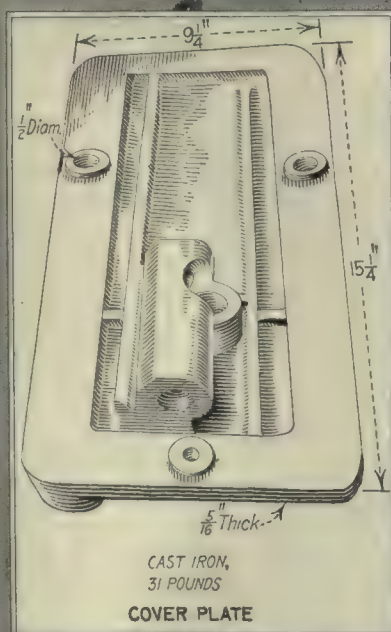
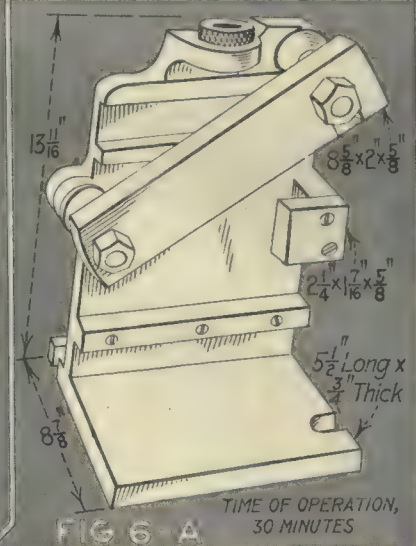
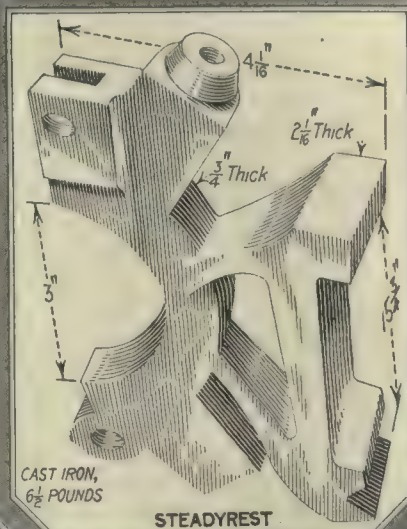
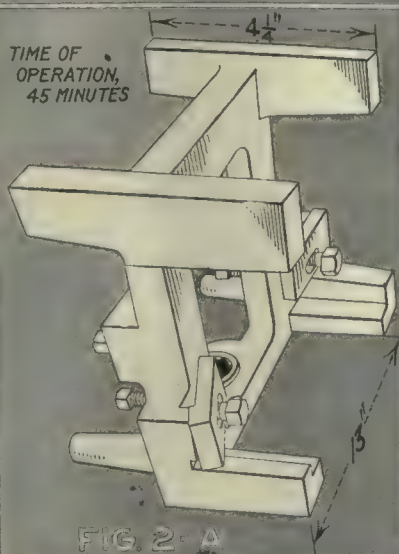
Operation—Drilling saddle and lower slide, Fig. 5. The castings are located against a hardened-steel stop plate, and a long strap holds them in position.

Holes Machined—One 1½-in. drilled 1½ in. long. The hole is then tapped with ¾-in. 16 threads for a distance of 1½ in. The slip bushing is placed in the fixed bushing of the jig, and the feed screw in the lower slide is drilled to suit a ½-in. 10 per inch-square thread. The nut is then tapped as a separate operation.

FIGS. 8 AND 8-A

Operation—Drilling and reaming apron, Fig. 7. The rough casting is located against pads, being forced against them by setscrews on the side of the jig. Three straps tightened on the casting hold it securely. The jig cover is placed over the casting, being located on the jig base by two dowels. Two swinging bolts hold the cover in position and permit rapid fastening and unfastening. The cover plate for the jig is shown separately in Fig. 8-A.

Holes Machined—Two ¾-in. and one 1½-in. spot drilled and reamed; two ¾-in., two 1½-in. and three 1½-in. drilled.



ALL BUSHINGS USED FOR GUIDING TOOLS ARE BLACKENED. ALL JIG AND FIXTURE BODIES ARE CAST IRON. STRAPS AND FASTENINGS, MACHINERY STEEL; GUIDE BUSHINGS ARE TOOL STEEL, HARDENED AND GROUND

Standardizing Inserted-Blade Milling Cutters

By C. F. SCRIBNER

In taking up efficiency work of a practical nature in a plant engaged in the production of a line of medium and heavy machinery I was forcibly struck with the expensive types of milling cutters used for many of the operations. It was no uncommon occurrence to observe cutters of 5, 6 and even 8 in. in diameter which had

and covering both face- and end-milling cutters was laid out as shown in the line drawings accompanying Tables 1 to 4. It will be noticed that all cutters 7 in. in diameter and over were made with cast-iron bodies, while those smaller than 7 in. were provided with machine-steel bodies into which the blades were inserted.

The bodies were bored, reamed and turned, then taken to a universal miller, where the slots were cut for the blades and the holes for the taper pins were drilled and reamed. The blades were made of high-speed steel, machined all over with an allowance for grinding the blade

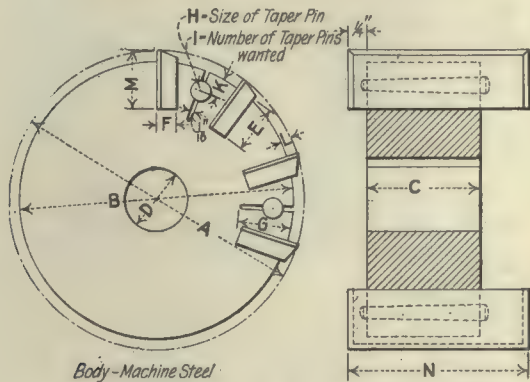


TABLE 1. STANDARD INSERTED-BLADE MILLING CUTTERS FOR END MILLING, 3 TO 6 1/4 IN. IN DIAMETER

A	B	C	D	E	F	G	H	I	K	L	M	N	No. of Blades
3	2 1/2	1 1/2	3/4	5/8	1/2	3/8	No. 4	4	1/4	3/8	3/8	2 1/2	8
3 1/2	3	1 3/4	7/8	3/4	1/2	3/8	No. 4	4	1/4	3/8	3/8	2 1/2	10
4	3 1/2	2	1	3/4	1/2	3/8	No. 4	5	1/2	3/8	3/8	2 1/2	10
4 1/2	4	2 1/4	1 1/4	1	1/2	3/8	No. 4	5	3/4	3/8	3/8	2 1/2	10
5	4 1/2	2 1/2	1 1/2	1	1/2	3/8	No. 4	6	3/4	3/8	3/8	2 1/2	12
5 1/2	5	3	1 3/4	1 1/4	1	3/8	No. 4	6	3/4	3/8	3/8	2 1/2	12
6	5 1/2	3 1/2	2	1 1/2	1 1/4	3/8	No. 4	7	3/4	3/8	3/8	2 1/2	14
6 1/4	6	4	2 1/4	1 3/4	1 1/2	3/8	No. 4	7	3/4	3/8	3/8	2 1/2	14

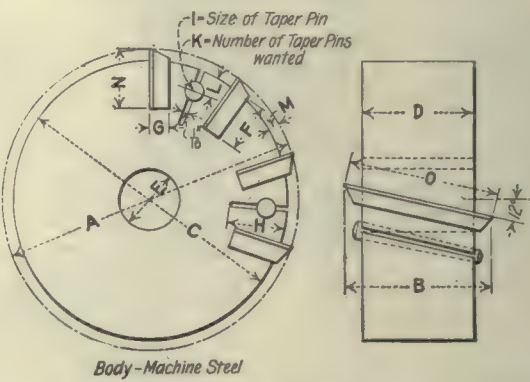


TABLE 3. STANDARD INSERTED-BLADE MILLING CUTTERS FOR FACE MILLING, 3 TO 6 1/4 IN. IN DIAMETER

A	B	C	D	E	F	G	H	I	K	L	M	N	O	No. of Blades
3	1 1/2	2 1/2	1 1/2	3/4	5/8	1/2	No. 4	4	1/4	3/8	3/8	2 1/2	1.789	8
3 1/2	1 3/4	3	1 3/4	7/8	3/4	3/8	No. 4	4	1/4	3/8	3/8	2 1/2	1.789	8
4	2	3 1/2	2	1	3/4	3/8	No. 4	5	1/2	3/8	3/8	2 1/2	2.045	10
4 1/2	2 1/4	4	2 1/4	1 1/4	1	3/8	No. 4	5	3/4	3/8	3/8	2 1/2	2.045	10
5	2 1/2	4 1/2	2 1/2	1 1/2	1 1/4	3/8	No. 4	6	3/4	3/8	3/8	2 1/2	2.045	10
5 1/2	3	5	3	1 3/4	1 1/2	3/8	No. 4	6	3/4	3/8	3/8	2 1/2	2.045	12
6	3 1/2	5 1/2	3 1/2	2	1 3/4	3/8	No. 4	7	3/4	3/8	3/8	2 1/2	2.556	12
6 1/4	4	6	4	2 1/4	2	3/8	No. 4	7	3/4	3/8	3/8	2 1/2	2.556	14

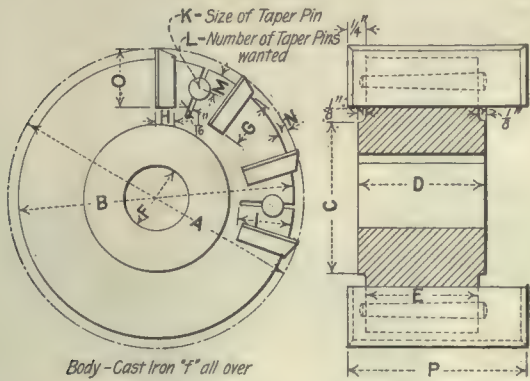


TABLE 2. STANDARD INSERTED-BLADE MILLING CUTTERS FOR END MILLING, 7 TO 12 IN. IN DIAMETER

A	B	C	D	E	F	G	H	I	K	L	M	N	O	P	No. of Blades
7	6 1/2	3 1/2	2 1/2	2	1 1/2	1	3/8	No. 5	7	3/4	3/8	3/8	1 1/2	3	14
7 1/2	7	4	2 3/4	2 1/2	1 3/4	1 1/4	3/8	No. 5	7	3/4	3/8	3/8	1 1/2	3	14
8	7 1/2	4 1/2	3	2 3/4	1 3/4	1 1/4	3/8	No. 5	8	3/4	3/8	3/8	1 1/2	3	16
8 1/2	8	4 1/2	3 1/2	2 3/4	1 3/4	1 1/4	3/8	No. 6	8	3/4	3/8	3/8	1 1/2	3	16
9	8 1/2	4 3/4	3 3/4	2 3/4	1 3/4	1 1/4	3/8	No. 6	8	3/4	3/8	3/8	1 1/2	3	16
9 1/2	9	4 3/4	3 3/4	2 3/4	1 3/4	1 1/4	3/8	No. 6	9	3/4	3/8	3/8	1 1/2	3	18
10	9 1/2	4 3/4	3 3/4	2 3/4	1 3/4	1 1/4	3/8	No. 6	9	3/4	3/8	3/8	1 1/2	3	18
10 1/2	10	5	4	2 3/4	1 3/4	1 1/4	3/8	No. 6	9	3/4	3/8	3/8	1 1/2	3	18
11	10 1/2	5	4 1/2	2 3/4	1 3/4	1 1/4	3/8	No. 6	10	3/4	3/8	3/8	1 1/2	3	20
11 1/2	11	5 1/2	4 1/2	2 3/4	1 3/4	1 1/4	3/8	No. 6	10	3/4	3/8	3/8	1 1/2	3	20
12	11 1/2	5 1/2	4 1/2	2 3/4	1 3/4	1 1/4	3/8	No. 6	10	3/4	3/8	3/8	1 1/2	3	20

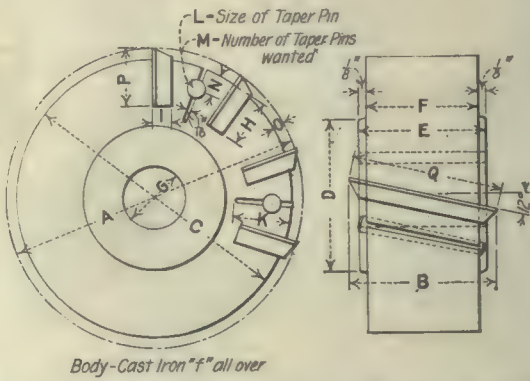


TABLE 4. STANDARD INSERTED-BLADE MILLING CUTTERS FOR FACE MILLING, 7 TO 12 IN. IN DIAMETER

A	B	C	D	E	F	G	H	I	K	L	M	N	O	P	Q	No. of Blades
7	2 1/2	6 1/2	3 1/2	2 1/2	2	1 1/2	1	No. 5	7	3/4	3/8	3/8	1 1/2	1 1/2	2.556	14
7 1/2	2 3/4	7 1/4	4	2 3/4	2	1 1/2	1 1/4	No. 5	7	3/4	3/8	3/8	1 1/2	1 1/2	2.556	14
8	2 3/4	7 1/4	4 1/2	2 3/4	2	1 1/2	1 1/4	No. 5	8	3/4	3/8	3/8	1 1/2	1 1/2	2.556	16
8 1/2	2 3/4	8 1/4	4 1/2	2 3/4	2	1 1/2	1 1/4	No. 5	8	3/4	3/8	3/8	1 1/2	1 1/2	2.556	16
9	2 3/4	8 1/4	4 3/4	2 3/4	2	1 1/2	1 1/4	No. 6	8	3/4	3/8	3/8	1 1/2	1 1/2	2.556	16
9 1/2	2 3/4	9 1/4	4 3/4	2 3/4	2	1 1/2	1 1/4	No. 6	8	3/4	3/8	3/8	1 1/2	1 1/2	2.556	18
10	2 3/4	9 1/4	4 3/4	2 3/4	2	1 1/2	1 1/4	No. 6	9	3/4	3/8	3/8	1 1/2	1 1/2	2.556	18
10 1/2	2 3/4	10 1/4	5	2 3/4	2	1 1/2	1 1/4	No. 6	9	3/4	3/8	3/8	1 1/2	1 1/2	2.556	18
11	2 3/4	10 1/4	5 1/2	2 3/4	2	1 1/2	1 1/4	No. 6	10	3/4	3/8	3/8	1 1/2	1 1/2	2.556	20
11 1/2	2 3/4	11 1/4	5 1/2	2 3/4	2	1 1/2	1 1/4	No. 6	10	3/4	3/8	3/8	1 1/2	1 1/2	2.556	20
12	2 3/4	11 1/4	5 1/2	2 3/4	2	1 1/2	1 1/4	No. 6	10	3/4	3/8	3/8	1 1/2	1 1/2	2.556	20

been made of solid high-speed steel. The nonuniformity of results obtained in hardening cutters of this type in the ordinary shop may be imagined. Added to this was the cost of material for such cutters, and the whole matter looked as if standardization was the remedy for the whole problem.

This standardization of all large milling cutters was decided upon, and it was determined to make use of inserted-blade cutters to the greatest extent possible. With this in mind a series of sizes from 3 to 12 in. inclusive

to thickness to insure a good fit in the slots. After hardening, the blades were ground, the taper pins inserted and driven to a seat, and the cutters were ground for diameter and the clearance on the cutting edges of the teeth.

The results have been greater uniformity in hardening, cost of cutter maintenance has been reduced, and the productive capacity of the machines has been materially increased—all due to this phase of standardization of operating conditions.

John E. Sweet--Reminiscences and Characteristics--II

By J. E. JOHNSON, JR.*

SYNOPSIS—The author tells of the getting together of "Professor Sweet's boys" and of the pleasure the Professor found in the yearly gatherings of men whose lives he had influenced. Some of the Professor's engineering achievements are touched upon, with appreciation of the artistic qualities of all his work. But greater than all these was his tireless helpfulness of those around him, of chance acquaintances and of a much larger number whom he reached through his writings.

As to the portion of Professor's life during and subsequent to the Cornell days we have the recollections of "Professor Sweet's boys." Perhaps it will be as well to give here a brief description of the loose organization to whose members this term was applied.

It was perhaps the most significant phase of Professor Sweet's character that men once thrown in contact with him, even if not very intimately, retained a vivid recollection of him and a desire for more of his companionship. This was partly because of his personal charm and partly because of the generosity with which he gave himself, to whoever might ask of him, without any question of the right of the person asking the favor, but simply on the ground that that person asked his assistance. The repetition of a story previously published well illustrates this trait.

On the last day of Professor Sweet's life a man from Texas—a total stranger—came to ask advice about a new type of engine governor. Professor spent the whole forenoon with his visitor, but was seized at three o'clock with the attack that ended his life. He went home, but before his death at eight he found time to telephone the office concerning further information that must be given to the stranger when he returned. This act was characteristic of Professor, and it was therefore not surprising that he bound to himself, with ties dissolved only by death, a considerable number of the men with whom he had contact in the course of his long life. Many of these had been his students at Cornell, and upon them, whose contact with him came at the most impressionable portion of their lives, he made an indelible impress. In them he excited a feeling of profound affection and also perhaps of exclusive ownership in himself; but as time went on, after he had founded the Straight-Line Works, other men went to work for him in any capacity from that of apprentice to that of superintendent. To all those who sought what he had to give, he gave freely, and in later life, I think, he made in his own mind very little distinction between the "Straight-Line boys" and the "Cornell boys." Others of the "boys" never even worked for him; they came somehow to know him and to love him and so were taken into the fold.

During the period of my employment I often heard him speak of this, that and the other one, always of the

good things that they had done or the new things they were trying to do. I heard him speak more than once of the great pleasure he experienced from the accidental foregathering of four or five of these at the shop one Saturday afternoon. In the early autumn of 1901 I received a letter from E. J. Armstrong, superintendent of the Ball Engine Co., who had at one time been superintendent of the Straight-Line. He asked me what I thought of the project of getting together as many as we could of the old boys for a dinner in Professor's honor and of making some sort of presentation to him to show our affection for him. I responded enthusiastically and so, I think, did all the others to whom Mr. Armstrong wrote. No organization was formed, except a dinner committee, and Mr. Armstrong did practically all the work as secretary of that. Mrs. Sweet was taken into our confidence, but the matter was kept entirely from Professor's knowledge. Fortunately for our plans, he and Mrs. Sweet took a long trip to Mexico during that fall and returned only a short time before the date set for the dinner.

In casting around for something to present, one or two suggested a watch. Mr. Armstrong wrote that as the one Professor already had, which had a rubber case, "fell apart whenever he opened it, and his eyes were getting too poor for rapid reassembling," it was decided that a watch would be most suitable. The trouble was that a watch is jewelry, and Professor with his extreme simplicity of taste would not like and probably would not use a watch of the ordinary character. At the same time he had often expressed his admiration for the wonderful works made by Jurgensen. He also admired very greatly the black finish on iron made by the Bauer Barff process. Accordingly, a set of Jurgensen works was procured and a special case made of Bauer Barffed iron, bearing on the cover a bas relief in gold of the first Straight-Line engine. The project was financed by voluntary subscriptions from the "boys."

THE FIRST SWEET DINNER

The date chosen for the dinner was one of the evenings during the latter part of the week of the New York meeting of the American Society of Mechanical Engineers in December, 1901. The dinner was held at the old "Arena." Professor had planned to go back to Syracuse the afternoon of the day for which the dinner was set, but Mrs. Sweet discouraged the idea and Mr. Armstrong persuaded him to stay over to help "talk to some men to whom he (Armstrong) wanted to sell an engine." We all gathered in a reception room, adjacent to the dining room, at an early hour, and Armstrong then brought in Professor to meet the men who were "to buy the engine." His surprise and delight in meeting again these men, many of whom he had not seen for twenty years or more, was something that will always be one of the pleasant recollections of my life. He went around the room greeting each one in turn with equal delight, but with varying degrees of surprise in the different cases. One man, not

*Consulting Engineer, Metallurgist.

interested in engineering and whom Professor had not seen for nearly twenty-five years, came all the way from Cleveland to attend the dinner. After the greetings were over, we adjourned to the dining room, where the dinner was served. In deference to Professor's strong temperance convictions no wines or liquors of any kind were served, and I think that no one even smoked, but at the later meetings Professor insisted upon providing the cigars himself.

Albert W. Smith, then Dean of Leland Stanford University and now of Sibley College, presided. No outside talent in the way of speakers was called in; a half-dozen or so of the "boys" had been given subjects and were called upon. Engineers are not always good speakers, but perhaps because in this case what they had to say came straight from their hearts, I think I have never heard speeches of such a high order of real excellence and suitability for the occasion as those were. The lamented John A. Hill was there, on account of Professor's long association with the *American Machinist*, and made a rattling speech, one or two sentences of which have always remained in my memory. One of them was that he believed "in holding the wake while the corpse was still alive and could have part of the fun," a fact we too often forget.

None of the speakers made the slightest allusion to any feature of the dinner except the reunion, until the last one, F. A. Halsey, now editor emeritus of this journal. At the conclusion of a few well-chosen sentences Mr. Halsey drew from his pocket the case containing the watch and presented it to Professor "as a token of our affection and esteem." The old gentleman had been having as much fun as anybody out of the proceedings, but that was too much for him. He arose to his feet with the tears streaming down his cheeks and said, "Gentlemen, I had expected to make a few remarks, but I cannot," and sat down. We sat around and talked to a late hour, and it was unanimously voted that the meeting was such a great success that we should hold one every year, and this was accordingly done.

OTHER DINNERS OF "PROFESSOR SWEET'S BOYS"

Every year, with the exception of 1911, when Professor was on a trip around the world, a fair-sized company of "the boys" met at dinner to do him honor. Once we had only eight or ten, but at most of the gatherings there were from fifteen to twenty-five or thirty. Considering that there were only about fifty on the whole list and that some of these were so far away or so circumstanced that they could never come, it will be seen that the percentage of the attendance compared with any other similar annual dinner was very high. In a good many instances men came a thousand miles or more simply for this dinner, and in one case a man came from Denver and in another from San Francisco. Considering that these gatherings were only informal affairs and that the sole attraction was meeting and honoring Professor once more, this fact constitutes as remarkable a commentary as anything could on the hold which he maintained on his friends.

These dinners were repeated every year at the same time and place until 1910. In 1911 Professor was on a tour around the world, and no dinner was held. In 1912 Professor's eightieth birthday occurred, on Oct. 21, and in that year the American Society of Mechanical Engi-

neers gave him the large dinner mentioned in his "Reminiscences," already quoted, in the United Engineering Building in New York.

Thereafter the dinners were held at the Onondaga Hotel in Syracuse on Professor's birthday, as his increasing age made it more difficult for him to stand the strain of coming to New York. Up to the very last dinner the list increased of those who, by close association and affection for Professor, felt entitled to be enrolled, and in one case at least the second generation made its appearance at the dinners.

SOME OF PROFESSOR SWEET'S ACHIEVEMENTS

As to Professor's great works, little can be said that the engineering profession does not generally know. At Cornell he had charge of the mechanical end of the first "dynamo" built in America, of which Professor Anthony designed the electric end, and he started there the manufacture of micrometer calipers, which he called "measuring machines," because he preferred the simple English name for everything. He also began there the making of limit gages and standard gages of hardened and ground steel, such as are now common, but which at that day were scarcely known. He not only had these gages made by the students, but he literally fathered their general introduction into shop practice, as well as that of many other mechanical refinements now in common use, but too numerous to mention here. A notable feature of his designing was that he achieved results by leaving things off rather than by putting them on. If somebody had accomplished a given result through the use of a lot of moving parts, he would scheme some simple way whereby the same result could be obtained with the aid of one or two parts.

THE ARTISTIC QUALITY OF HIS DESIGNS

Another feature of Professor's designing, which in a sense was connected with that last described, was his tremendous artistic sense. He had entered engineering through architecture and had realized fifty years ahead of the rest of the American world that true art in architecture consists of a harmonious adaptation of the means employed to the end desired, not in the addition of superfluous parts for purposes of ornament only. He believed, and rightly, as we now know, that art in machine designing consists in the most direct and harmonious adaptation of the means at hand to the object desired. The fluting of columns, the ornamental paneling of flat surfaces and the like, the use of curves where a straight line would serve and, above all, where a stress was to be transmitted were customary in machine designs only twenty or thirty years ago, but they were all abominations in Professor's truly artistic sight. In matters of appearance, as well as in the mechanism used, he believed in the harmonious assembling of the essential and the absolute elimination of the unnecessary.

This is so much a feature of the best present-day designing that those familiar only with the present do not realize how different were the conditions previous to Professor's precepts and example concerning the beauties of simplicity. He had a saying, "Whatever is right, looks right"; and if something looked wrong, he would analyze it until he found what the wrong was. It is probable that he came nearer to criticizing the work of others in this direction than in any other except in matters in-

volving moral turpitude, such as theft of another man's design or ideas, copying without acknowledgment and the like. In those matters, though he commonly did not say very much, the little he did say was greatly to the point and left the hearer in no doubt at all as to his meaning and his sentiments.

He was quick to acknowledge the merits of the work of others in truly artistic design, as in all other directions. I have heard him speak in terms of the greatest admiration of the splendid simplicity of the lines of the Centennial Corliss engine and of the work of some European designers in which art was served by suppressing ornamentation.

THE STRAIGHT-LINE ENGINE

In the brief autobiography previously quoted Professor mentions some of the details of the Straight-Line engine, but does not tell how remarkable was the workmanship or how radical was the design as compared with previous practice. At the time I was there, now nearly twenty-five years ago, he was using hardened and ground bushings for the valve gear, so that if a pin became worn, its bush was knocked off and a new one put on, while if the bore became worn, its bushing was knocked out and a new one inserted. In this way the life of these parts was indefinite. The main-bearing shells were solid, but had eccentric cheek pieces of hard babbitt fitted inside them so that rotating up these cheek pieces by liners behind the thick edge took up the wear, but left the center of the bearing surface unchanged. The valve stem was a bush of hard babbitt about two feet long, hand reamed to an exact fit on the ground valve stem. The babbitt bush was held in a gland, so that it could accommodate itself to the line of the valve stem; the piston-rod packing was the same, except much shorter. This construction made an absolutely tight joint, which was good for years without any adjustment whatever and with an irreducible minimum of friction. Special trams were invented, which centered themselves to the actual bore of the cylinder and permitted the main-bearing shell seats in the frame to be bored absolutely at right angles to the center line of the cylinder.

Professor made a study of the action of oil in moving machinery; and when the Straight-Line engine was built, it was an engine with the lubricating system built into it instead of being an engine with some oil cups stuck on it. It is probable that the system of lubrication, which was an inherent part of that engine twenty-five years ago, has not been bettered since. He not only schemed simple ways to make the oil go where he wanted it to go, but equally simple ones that prevented it from traveling where he did not want it to go—for instance, the knife-edge rings mounted on the shaft close to the ends of the main-bearing shells and inside of hoods cast in the frame, which caught the oil thrown off by the knife-edges and returned it to the oil cellar in the base of the main bearing. These things are simple and obvious enough when they are once done, but those whose memory goes back so far will remember what a huge step in advance they constituted over anything that had been done up to that time.

The question of the relationship between mathematics and engineers is one that has often been fought over. In the reminiscences already quoted Professor gives the disastrous results of the first attempt to teach him algebra.

I doubt whether any subsequent one was more successful, for he knew nothing of that science or of any higher mathematics. Yet by intuitive reasoning power, sometimes assisted by simple but marvelously ingenious applications of graphics, he achieved results that were positively startling. The best illustration of this is the story of him told by Mr. Armstrong.

On one occasion during a call from some professor the latter spoke of the very difficult problem in geometry which the mathematicians had just succeeded in solving—namely, that if three circles of different diameters are drawn in any position in a plane and a pair of tangents are drawn to each side of each pair of circles and prolonged to their intersection, the intersecting points of all three pairs of tangents will lie in a straight line. Professor thought this over for a few minutes and said: "Yes, certainly, I can see that that is true."

The other professor said: "I guess you don't understand, Professor. This is a very difficult problem, and we have just finally accomplished its solution. I don't think it is as obvious as you think it is."

"Why, yes," said Professor, "of course it is obvious. Instead of three circles in a plane, take three balls lying on a surface plate. Instead of drawing tangents, imagine a cone wrapped around each pair of balls. On top of the three balls lay another surface plate. It will rest on the three balls and will necessarily be tangent to each of the three cones. The apexes of all the cones must lie in the intersection of the two surface plates, and as the intersection of two planes is always a straight line, the apexes of the cones will lie in a straight line. It seems to me that this is perfectly obvious." So it was to a man who could think in those terms, but to how many of us, no matter what our mathematical training, would it be "obvious"?

This was characteristic of his method of attack on all new problems. He did not have to, and would not, play the game according to the accepted rules in such cases. He would strike out a method suited to the conditions, choosing a simple method of attack from a totally unexpected direction, and yet so logical that it could not for a moment be denied. Of course, problems did arise not capable of solution even in these ingenious ways, and these he would mull over in his mind. If he finally became convinced that he could not solve them, he had no more false shame about asking for assistance than would a boy in asking help of his father for his arithmetic lesson.

HIS EXTREME MODESTY

It is probable that no man ever achieved the standing in a profession that Professor had and yet was so unwilling to admit that he had it, or if he were forced to admit this, that he deserved it. His modesty was literally incurable. He came of plain people. He was neither proud nor ashamed of this origin; he simply recognized it as a fact. But that his achievements entitled him, not only to professional distinction, but that his ability and above all the charm of his personality qualified him to ornament a position in any society was something he could never be made to believe. With this same habit of mind went other characteristics. He had come up through the ranks as a mechanic, and he never felt that he was entitled to very much greater pay than a mechanic. He never permitted the Straight-Line Engine

Co. to pay him a salary bigger than would be expected by the foreman of a good-sized shop. He lived in the same simple way, which was very comfortable, without the slightest sign of meanness or niggardliness of any kind and yet without a penny being wasted or spent for ostentation.

As a sort of corollary to his own beliefs and conduct in this respect he felt very strongly that other people perhaps lived better than they should, spent more on their living than they were justified in doing. The point of view that, for most men to command a position or standing of a given kind they had to live, in a broad way, up to certain standards, never appealed to him in the least. The fact even that a man by living too simply might shut himself off from the possibility of increasing his income out of all proportion to the increase in expenditure that it required never entered his head. He had an instinctive belief that it was wrong, and nothing could alter that. He never made himself a bore by preaching his own beliefs, but once in a while he would let drop a sentence that meant volumes.

HIS KEEN SENSE OF HUMOR

Very often a man with high ideals of conduct is spoilt for human companionship by a sense of dignity that replaces or stifles his sense of humor. It was far otherwise with Professor. He had a keen sense of humor and could illustrate his point with a short story or a witty saying in a manner characteristically American, and a good story well told was sure of at least one appreciative hearer when he was present. I have seen him almost convulsed in a quiet, chuckling laugh over something that hit his fancy especially. At the dinner in October, 1915, one man told a number of stories, mostly Southern stories about negroes. These amused Professor so much that he wrote afterward to the story-teller and asked to have some of them written out for his further enjoyment.

Here again, perhaps, his modesty played a big part. He was never in his own mind a king amid inferiors, but one of a group from each of whom he could learn as eagerly as they could learn from him. This trait kept up his spirit of fellowship and made companionship agreeable, and leadership natural, to him.

HIS TIRELESS HELPFULNESS

I have already spoken of Professor's helpfulness, but I cannot refrain from reverting to this subject again, because it was so borne in upon me during my service with him. Nearly everybody in central New York who was doing anything mechanical, and a very large percentage of those in a vastly greater region, knew or knew about Professor. They would come in, exchange greetings, introduce themselves, if necessary, and proceed at once to outline the peculiar problem or difficulty that they had in hand at the time. This all went as a matter of course. The famous sign, "Visitors Always Welcome," engraved in the stone over the doorway, had its inception in Professor's temperament, and these people were as absolutely welcome as though they had been paid clients, though in over twenty years I never knew one of them so far to forget his dignity as to offer to pay for the help that he got. The idea that he should be paid never entered Professor's head, except when it was put there by someone else, and never stayed then. He got his pay in the interest that he took in the things brought to his atten-

tion. Sometimes a little fun of a quiet kind was mixed with the interest.

Two cases I remember that happened while I was there; they are only typical of thousands of others. A man came in greatly obsessed with the idea that the steam engine incurred a serious loss by the necessity of starting and stopping its reciprocating parts twice during every revolution. After he had explained his cure for the trouble, Professor said: "Now, you know it does not cost anything to push on a thing, no matter how hard you push, as long as the thing does not go anywhere. Take the case of the steam in a steam boiler. It is pushing on every square inch of the boiler's surface with a hundred pounds' pressure; but as long as the boiler does not give way, it does not cost anything." This was the simple but unshakable foundation upon which he proceeded to build up an explanation that removed the man's obsession without expense or even pain to himself.

A TYPICAL INCIDENT OF HIS HELPFULNESS

On another occasion a man came in, considerably excited over the amount of heat that the steam engine discharged as latent heat in the exhaust steam. On this occasion, as I guess happened pretty frequently, I broke into the conversation, because this touched on the subject of thermodynamics, with which at that time I was quite fully loaded. This unfortunate individual had found that a pound of exhaust steam contained nearly one thousand thermal units. He had then gone to a professor in one of the universities and asked him how hot a thousand thermal units would heat four pounds of air, and the professor had calculated for him that it would heat the air to over a thousand degrees. We will hope that the questioner had not mentioned to the professor that the thousand degrees was to come from exhaust steam. With this information the man proceeded to line out a system whereby he could heat this quantity of air to that temperature and thereby increase its pressure and make it do a lot of useful work. I explained that a stern and natural law, known as the "second law of thermodynamics," stood in the way of all such feats and that the loss which he lamented was a part of the inevitable, natural losses incident to converting heat into work; moreover, that neither his scheme nor any other could prevent this loss unless the whole fabric of our scientific knowledge collapsed into a ruin. After he had gone, I said to Professor: "Did you want me to take so much of a hand in that discussion?" He said: "Yes, that was right. Get that idea out of that poor man's head and prevent his wasting his own, or somebody else's money."

HIS INSPIRATION IN THE SHOP

It is perhaps as remarkable a commentary as any upon Professor's character that in spite of this remarkable temperament, which generally implies an easy-going disposition and, therefore, poor ability in handling labor, he had a good idea of what a day's labor was and surrounded himself with subordinates who were able and willing to get it for him, always, of course, without any bulldozing, rough language or any of the other methods of the "hell-driver." To a great extent he got it because he had inspired the men in the shop with some of his own spirit and they were willing, without much driving, to give a fair day's labor for the fair day's pay

that they always got. On one occasion, however, his foundrymen struck. Not being imbued with the modern doctrines of political economy, Professor fought this strike by simply paying off his men and refusing to talk to any of their representatives, organizers or others until they were ready to go back to work again, which they eventually did on his terms.

This illustrates what I might better have said earlier, that his marvelous disposition did not obscure his judgment as to what was right for himself and his stockholders and that, if he were forced to fight, he would fight—not with violence, but with great determination—for what he believed to be right. I suppose that he would turn in his grave at my saying this, because the mention of war or personal conflict was utterly abhorrent to him. The point of view that our sons might come to a worse end than to lay down their lives in defense of the rights of their country or humanity—that, in short, there could be an ethical and moral side to war—was a point of view that could not be made to enter his head.

When all is said and done, while I do not believe that the world knows now or will long remember half that

Professor did for the furtherance of mechanical engineering in its broader sense, nevertheless it seems to me that in him, as in those whom Emerson mentions, his character exceeded his achievements. As a moral force in the world he was greater, because rarer, than his achievements.

I can never forget his unfailing modesty, his absolute unselfishness, his helpfulness without thought of the cost to himself and the way he never preached, but un-faillingly lived, the golden rule. To these things must be added his *human* personality and his magnetic power of attracting to himself a large percentage of the men he met, of holding their interest and affection for long years, generally for life, and of inspiring them with high ideals of conduct without ever mentioning the subject. Remember, too, his marvelous ability to instruct men technically and to broaden and simplify their methods of thought.

These seem to me to be the outstanding characteristics which, possessed by a man whose achievements equal those of the greatest engineers of our time, put him upon a pedestal so that he overtops them all in those things that truly make for greatness.

The Manufacture of Punchings

By C. W. STARKER*

SYNOPSIS—On page 529, Vol. 44, of the "American Machinist," the author described features of the design and manufacture of punchings for electric motors and generators. In the following article the scrap problem, manufacturing allowances, construction and life of dies are discussed.

The accumulation of odd pieces of sheet steel is one of the serious problems in the manufacture of rotor and stator laminations and similar punchings for electrical apparatus. These odds and ends are as a rule known as "scrap," although some 75 to 80 per cent. of them are generally utilized. Expressed in per cent., it may be stated that between 40 and 45 per cent. of the material entering the punch shop leaves again as actual scrap. Even this scrap is not thrown away. When put into proper shape for shipment so as to avoid excessive freight charges, it can usually be sold to steel mills or foundries at \$18 to \$20 per ton. To get these odd pieces into compact form hydraulic baling machines are used, as shown in Fig. 1. The loose punchings are put into a compartment below the floor level; two of the walls of this compartment are formed by rams or hydraulic pistons that compress the material into bundles, as shown in the illustration. Each bundle weighs between 250 and 300 lb. For a large punch shop, this scrap material may amount to one or two million pounds every month, representing an annual value of \$50,000 to \$100,000.

DIFFICULTIES IN COST ACCOUNTING

The real value of that part of the so-called scrap used for making various small punchings is rather difficult to determine, in fact it is one of the most vexing problems in punch-shop accounting. Circles or centers

coming out of large stators, for instance, are generally used for making smaller circular punchings. The loss in this case is only a rim, according to the difference in diameters. The width of this rim is usually $\frac{1}{2}$ in. on a side as a minimum. However, there are not always orders on hand in the punch shop that allow of such favorable use, and punchings leaving a larger rim must be made from the centers. The maximum rim permitted is about 2 in. on a side. Then again, there may be cases where it is necessary to use a large circle for making various small circular punchings, or pole punchings, such as shown in Fig. 2. If an operator has to use up such odds and ends, he cannot of course make as good time as if he used a straight strip of a proper width, usually known as "long iron." It is therefore necessary to pay a higher labor rate for using up scrap, and it is this feature that complicates the cost calculation. A deduction on the value of centers should obviously be made to allow for the additional labor in using them up. On the other hand there are cases where it might be argued that a center should be valued at more than long-iron value—for example, where a circular punching is made from a slightly larger center—as in this case there is no loss from corners such as would occur if a square sheet of long iron was used, as indicated by A (Fig. 2). By actual observation extending over a sufficiently long period, the losses due to inability to use up accumulated odds and ends can be determined from the manufacturing conditions prevailing in a given shop. The percentage of cases where additional labor is to be paid, or where pieces are used to particularly good advantage, can also be determined, and in this manner a figure is obtained that, while more or less arbitrary, represents a fair average and is based on actual working conditions. To show how many factors enter into the question of valuation of scrap, it may be

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added that even the seasons of the year have an influence. For example, during the fan-motor season early in winter, there is a large demand for small pieces of sheet steel to be used for fan-motor punchings, while at other times this demand does not exist, and the material accumulated cannot be used up.

ECONOMICAL DESIGN

In designing electrical apparatus, designs are encouraged that tend to reduce scrap of punchings. Laminations for alternating-current rotors or direct-current

include the labor for the building up of the laminated core. The curve is drawn for sheet steel 0.0172 in. thick. For other thicknesses of material, a multiplying factor must be used; for example, for material 0.0281 in. thick, the curve values should be reduced in the ratio of the cost per pound of the two materials, which is approximately 0.0185 in. and 0.0286 in.

Ordinary Bessemer sheet steel cannot be used for rotor and stator laminations of electrical motors and generators, principally on account of its lack of uniformity. It may however be used for direct-current motor-pole

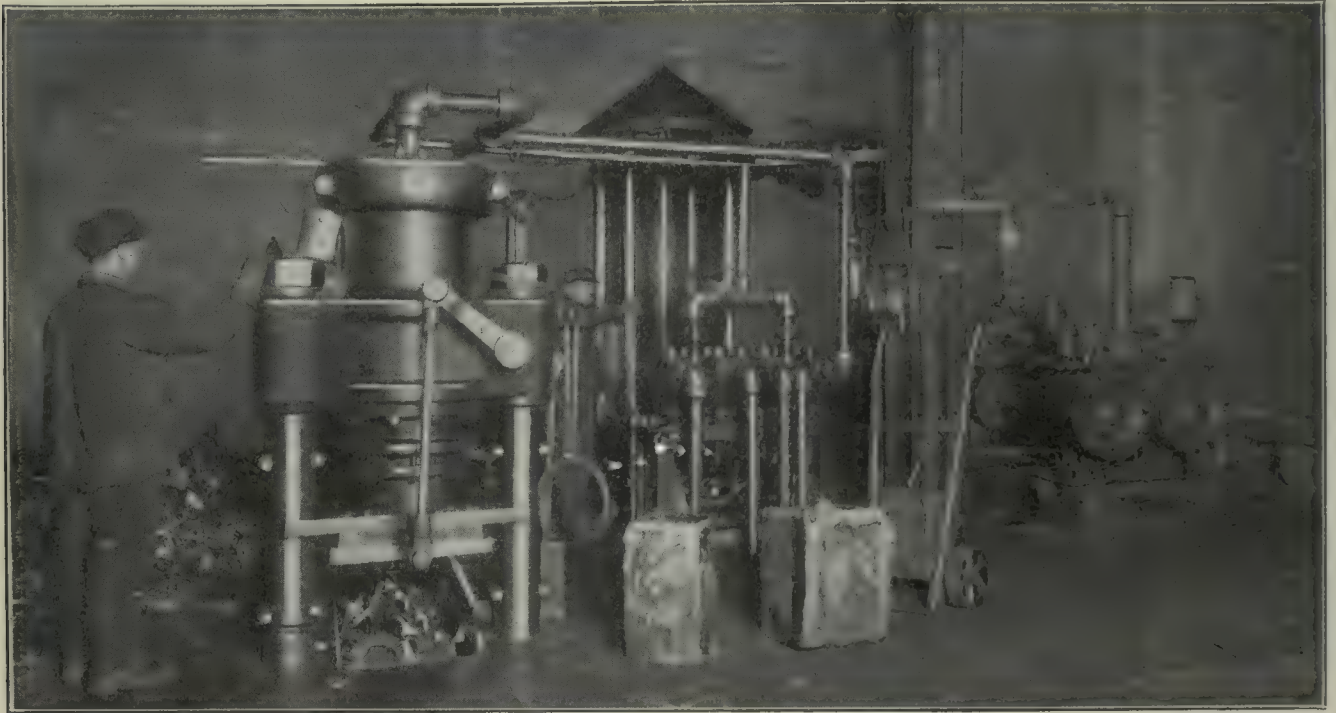


FIG. 1. HYDRAULIC SCRAP-BALING MACHINES

armatures may be built up directly on the shaft, or built up on an arbor, pressed and riveted together so as to form a solid unit. The punchings in either case extend clear to the shaft, the only scrap being the center hole for the shaft and perhaps vent holes if such are used. This construction is preferred to building the punchings on a cast-iron spider, as it not only reduces scrap of punchings but effects other economies by the absence of a spider. On larger sizes of machines it becomes economical to use a spider, as the center cut out of the punching on these larger sizes can be used for making smaller ones. The dividing line between these two constructions is a question of cost; that is, a question of whether the value of the punching centers equals or exceeds the cost of the spider. In Fig. 3 is shown a curve that is used as a guide by the designers. The curve shows the value of centers per bundle 1 in. thick, based on a material value of the centers equivalent to 80 per cent. of the long-iron value for diameters above 6 in., for various inside diameters of rotor punchings. From this table the value of the centers for a given width of the rotor core can be determined, and if this amount is less than the cost of a spider, it is more economical to omit the spider and to use the built-up or riveted construction. For closer cost calculation, it would, of course, be necessary to figure in detail the cost of the end plates used on either side of the core and also to

punchings. For rotor and stator punchings the material physically must be ductile and soft, but not to such an extent as to drag in the die. It must be uniform and strong enough to stand punching of narrow teeth with the usual amount of rough handling, filing of the completed core, etc. Further it should be hard enough to prevent the breaking of the teeth. These conditions are fulfilled by a soft openhearth steel, known as grade M. A., which is now generally used. As an exception, a silicon steel of particularly high magnetic qualities is sometimes used on motors or induction regulators although this material is intended principally for transformer work—that is, punchings not requiring slots or teeth. This material is somewhat hard to punch, it is brittle and the scale usually occurring on the material introduces difficulties in manufacture. A particularly tough material and of heavier gage, 0.0375 in., is used for stiffening laminae at the ends of the cores. This material is too thick to be punched with compound dies as it would require very heavy presses and too frequent renewal of dies.

Purchasing department specifications are issued for these various grades of material and they specify the principal requirements. Among these there is a maximum permissible variation in thickness, measured either by micrometer, and in this case generally specified as plus or minus 10 per cent. of the nominal thickness, or

by weight, in which case it is usually specified as plus or minus $2\frac{1}{2}$ per cent. All electrical sheet steel is tested for watt loss, permeability and aging, according to the rules adopted by the American Society for Testing Materials. These rules specify in detail definite methods for cutting test specimens from the sheet and for building up test bundles of certain dimensions. These bundles are surrounded by test coils to which an alternating-current voltage is applied, and the losses found by watt-

ence in iron losses is insignificant. All punchings for primaries of alternating-current motors and for direct-current armatures must be annealed.

In former years it was customary to cover the punchings of one side with a layer of paper. Today this process is superseded by a method in which a thin film of varnish is baked on at a high temperature. This process is less expensive than the former method and makes a very effective insulator. Low-priced asphalt varnish may

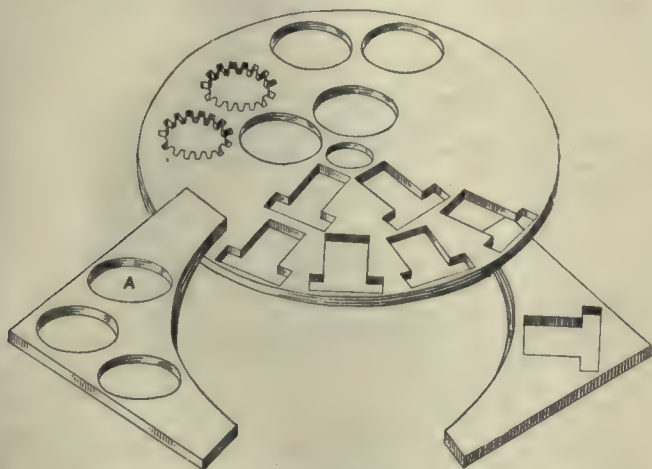


FIG. 2. SMALL PUNCHINGS MADE FROM SCRAP

meter readings. Details of these rules and methods may be found in the Year Book of the society.

The standard sizes of sheets obtainable at the mill vary somewhat with the grade and thickness. Their width generally varies in 2-in. steps and a corresponding length depending on the size of slab or billet used, as follows: 21x84, 23x92, 25x100, 27x108, 29x87, 31x93, 33x99, 35x105, 37x74 and 39x78 in. In designing machines it is essential to keep these sizes in mind and to select punching dimensions so as to use the material most economically. A margin allowance of $\frac{1}{4}$ in. on one side is usually made.

ANNEALING AND ENAMELING

All electrical sheet steel used on generators and motors is annealed at the mill. Generally speaking, the annealing has the object of producing a finer grain by heating. Roughly it may be said that compared with the original material, the annealing reduces the electrical losses in the iron in the ratio of about 3 to 1. Some manufacturers anneal the material a second time after punching, which results in a slight further gain, perhaps of from 3 to 5 per cent. in permeability, but has the disadvantage of causing warping of the punchings, which results in poor alignment of the assembled laminations and necessitates filing, which in turn tends to increase the iron losses. For this reason it is preferable to use mill-annealed sheet steel, without a second annealing after punching.

In this connection a few words should also be said about the process used for insulating the laminations in a core from one another. The object of such a film of insulation is to carry still further the original object of laminating; namely, that of preventing the flow of eddy currents. Sometimes the oxidized surface of the iron is sufficient protection. Particularly in the squirrel-cage rotors of alternating-current motors, which have partially closed slots, the annealing may be omitted as the differ-

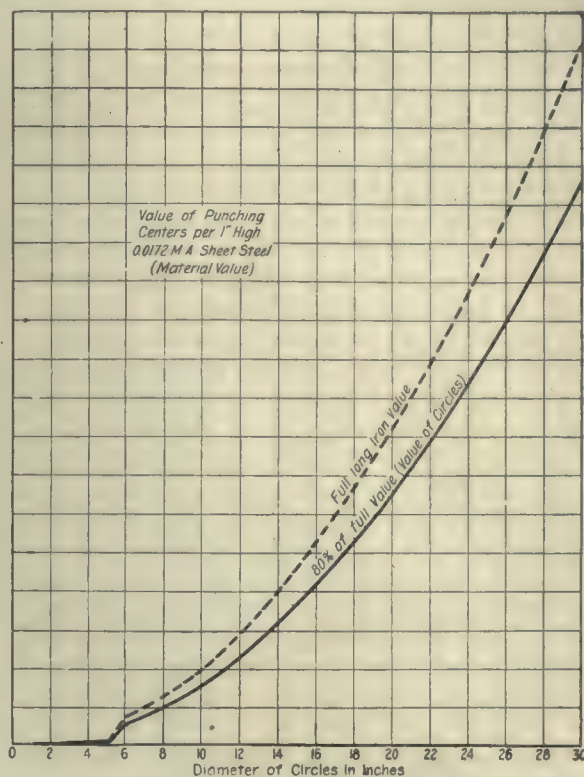


FIG. 3. VALUE OF PUNCHING CENTERS PER 1 IN. HIGH 0.0172 M. A. SHEET STEEL (MATERIAL VALUE)

be used, and as it is applied hot, excellent heat-resisting qualities are obtained. The thickness of the film is small, usually between 0.001 and 0.002 in. This method has therefore the additional advantage of a better space factor; that is, there is more actual iron in a built-up laminated core of a given width. This enameling is done after the punchings are completed so that the edge of the teeth and the burs are equally covered, and any bad effect the oil may have on the varnish is avoided. A specially designed machine is used for this enameling process. The punchings pass through rolls that apply the varnish, then they proceed on an endless chain over gas flames and finally through an oven that dries the enamel.

MANUFACTURING ALLOWANCES

Expense for upkeep of dies is another of the serious problems, and a large factor in the usually high overhead expense of the punch shop. The upkeep of dies depends, first on the construction of the die, whether hard or soft, then on the grades of material in the punching, as well as the material of which the die is made, and finally on the degree of accuracy demanded in the finished punching. When the limit for variations or burs on the punching is reached, it becomes necessary to re-grind the die or to replace it. The cost, particularly of compound dies, is high, and it will readily be seen

that too frequent renewal, on account of too rigid demands of accuracy, will unduly increase the indirect expense of the punch shop and in turn will increase the cost of the product over which this expense must be distributed. The shop management carefully watches this expense and stimulates efforts to reduce it by keeping a monthly sheet in the punch shop, such as shown in Fig. 4, which gives the expense for die repair in relation to the output in punchings for each subdivision of the punch shop.

The usually high overhead prevailing in punch shops is largely accounted for by the expense for repairs to dies, including die grinding, expense for new small tools, handling of tools, setting of dies and inspection. All these items, to which might be added part of the expense for defective work, have a direct connection with the accuracy demanded and the manufacturing variations permitted. With an annual output of several million dollars' worth of punchings, it will readily be seen to what this seemingly small detail may amount. To determine the amount of bur occurring in commercial manufacture, a large number of punchings were measured by micrometer and the burs were found to average between 0.002 and 0.008 in. Individual cases occurred where 0.018 and 0.029 in. were observed. It is desired to limit the maximum bur to 0.004 in. This limit can be maintained only by grinding or rolling of the punchings. The accuracy with which the dies are originally made and with which they are set up also has a good deal to do with the amount of bur, so that regrinding of the dies does not always bring the desired result and too frequent regrinding is therefore undesirable. The better plan is to improve punchings that show burs by rolling them, which can be done at small expense, approximately $\frac{1}{2}c.$ for labor per pound of punchings. Points such as these should not be considered as minor details, for they represent a large item of expense; they influence the design, performance and cost of apparatus, and designers who are familiar enough with these details take them into account and thereby are enabled to produce better and more competitive apparatus than others.

Definite standards for the variation of punchings should therefore be mutually agreed upon between the engineers and the shop, allowing as much variation as is consistent with good workmanship and good design. For certain classes of work where it is necessary and economical to draw the limits closer, the permissible variations may be fixed accordingly. For rotor and stator punchings of electrical machines, the following rules are considered good practice: Small round-hole dies are to be kept within plus and minus 0.002 in.; larger round-hole dies within plus and minus 0.003 in. Allowance on the outside diameter of ordinary punchings, made with round-hole dies, from 6 to 12 in. in diameter, is -0.004 in. to $+0.006$ in.; for 12 in. in diameter and up -0.005 in. to $+0.006$ in. For rotor and stator punchings made with compound dies, the following limits are allowed: From 1 to 15 in. in diameter $+0.002$ in. to -0.004 in.; from 15 to 20 in. in diameter $+0.002$ in. to -0.005 in.; from 20 to 25 in. in diameter $+0.003$ in. to -0.005 in.; from 25 to 35 in. in diameter $+0.004$ in. to -0.006 in.

The allowance on the bore for rotor punchings, shaft fits, is being made particularly small to secure the greatest possible security against loose punchings, due to the variation both of shaft and punchings, the limits being $+0.001$ in. and -0.003 in. for all diameters of bore.

For pole punchings on direct-current machines the variation in height—that is, the difference between inside and outside radius on the individual punching—is allowed to be $+0.003$ in. to -0.002 in. for 1 to 4 in. height and $+0.005$ to -0.002 in. for 4 in. and above.

The life of dies varies greatly with the grade of steel used in the part having the cutting edges. A series of tests has been carried on to determine the relative life of a single slot die made from 13 different grades of steel, using the same thickness and grade of punching mate-

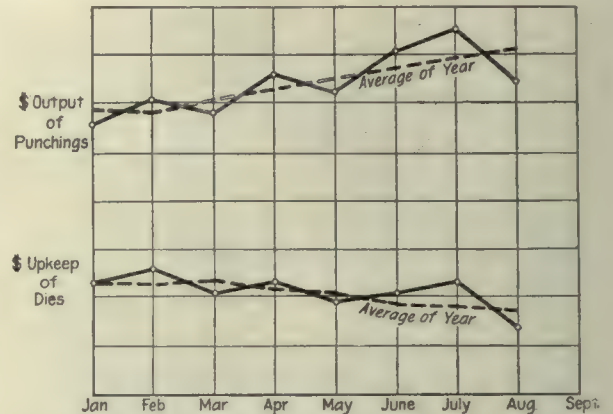


FIG. 4. EXPENSE SHEET SHOWING RELATION OF DIE REPAIRS TO OUTPUT

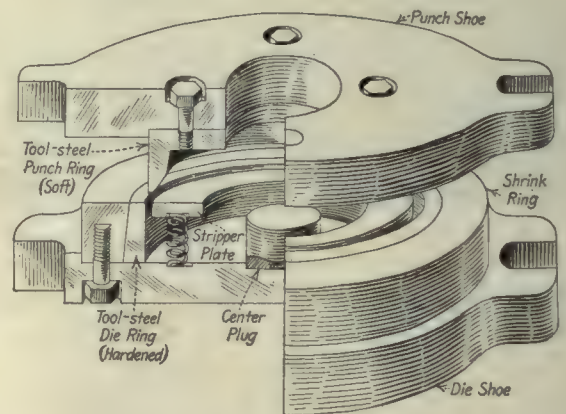


FIG. 5. ROUND-HOLE DIE

rial. These steels are usually known by various trade names. The best of those tested punched close to 125,000 slots for one grinding, the poorest only about 12,000 slots per grinding. The amounts ground off in one grinding vary between 0.015 and 0.020 in. From these wide variations, it will be seen that it is rather difficult to say anything definite about the life of a die. However, to give a general idea, such as may be required to judge the cost of development for a certain order, the following figures may be taken. They are based on actual observation in commercial production. A round-hole die up to about 8 in. in diameter punches approximately 25,000 pieces for one grinding. This amount decreases for the larger diameters to about 15,000 pieces for 8 to 15 in. in diameter and 8,000 pieces for 15 to 20 in. in diameter. A compound die for these same steps in diameter punches about 20,000, 10,000 and 5,000 pieces between grindings. In each grinding an average of 0.015 to 0.018 in. is taken off. A standard length that may be ground off on the punch is usually adhered to in making the die, so that the number of regrindings

possible can be calculated; for example, for 1 1/4-in. length, the die could be ground about 75 times before renewal becomes necessary. This then gives for a compound die an average life of something like 750,000 punchings. Taking an average size of induction motor (about 15 hp.), a compound die would be good for producing about 3,000 motors. In many cases the annual sales greatly exceed this figure, and the same punching ordinarily is used on several different ratings, so that the life of a compound die may in some cases be only a few months of

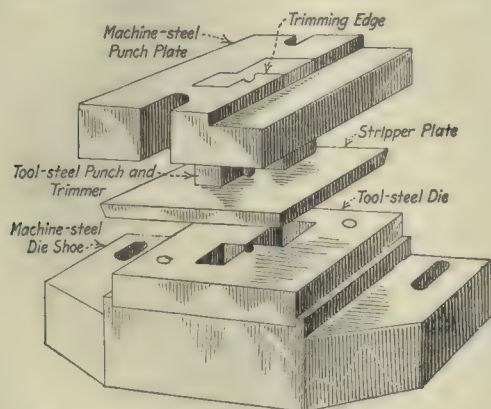


FIG. 6. SLOT DIE FOR AUTOMATIC MACHINE WITH TRIMMER

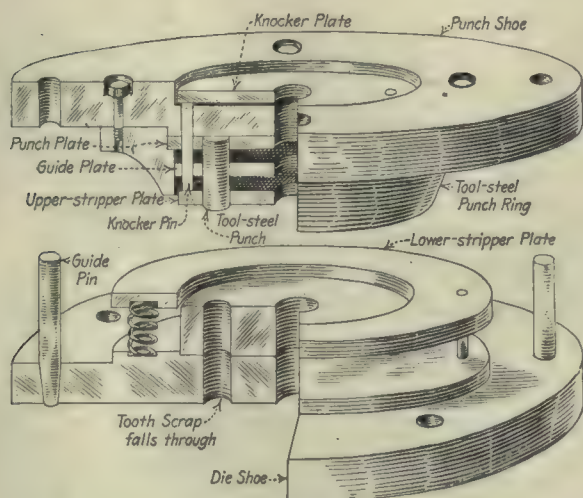


FIG. 7. COMPOUND DIE FOR STATOR PUNCHING

the injured part was removed. This is expensive, consumes time, delays production and results in more frequent renewal of the die. From the tool department standpoint, it is argued that the shrinking or warping in the hardening process introduces difficulties in obtaining the proper small clearances between the male and female part. It is customary, therefore, to harden the die—that is, the female part—in all cases, but to leave the punch soft on compound dies or combination dies for rotor and stator punchings. In the case of the female part it is permissible to do the hardening for the reason that the grinding and repairing are more easily done than in the male part or punch. In the case of a round-hole die the punch is usually left soft also. In slot dies both parts are usually hardened, as repairing in this case is not a serious problem. Dies for pole punchings and other punchings using 1 1/8-in. or heavier material are always hardened, both punch and die.

PUNCH AND DIE

The terms "punch" and "die" used in the foregoing are sometimes misapplied. The punch-shop operator usually calls the upper half in the press the punch, the lower half the die. This is not necessarily so. The punch may be defined as that part which goes inside the other part. In designing a punching tool, the choice of which part should be the upper and which the lower one in the press, depends entirely on which arrangement allows the easiest and most time-saving removal of the finished punching and of the scrap. Sometimes there are even cases where the die part contains punches. These punches are set into the female part to avoid a second operation and for the reason that there is not sufficient room in the other part for supporting these punches.

DIE CONSTRUCTION

While it is not contemplated in this article to qualify the reader to become an expert tool designer, the main principles of die construction and the most commonly used terms should be understood. In Fig. 5 is shown a general sketch of a round-hole die, such as is used for punching round holes above 6 in. in diameter. The upper part in this case is the punch; it consists of the punch shoe, made from machinery steel, and the punch ring, which is bolted to it, made from tool steel and left soft. Note the cutting edge on the punch. The die or female part, in this case the bottom die, has a machine-steel die shoe, and bolted to it is a machine-steel ring. This ring is drawn over the die ring proper by bolts, a tapered fit being provided as shown in the illustration. The ring has the cutting edge and it is made of tool steel and hardened. Inside of this die ring is the stripper plate, which rests on springs and has the function of pushing the center of the punching out of the die for easy removal. Sometimes the die has a cast-iron center plug that may be of variable diameter and that serves the purpose of locating the punchings centrally. In Fig. 6 is shown the construction of a slot die, such as is used on automatic machines for indexing slots in segmental punchings. The die in this case has an extension for trimming the radius. The various parts are marked in the sketch and from the foregoing will be readily understood.

In Fig. 7 is shown a typical example of the construction of a compound die for stator punchings. There are

regular production. In estimating tool development it may be necessary therefore to figure on more than one compound die to start with. On the other hand, there are cases, particularly on larger machines, where a die would outlast by far the probable life of the design. This fact should be kept in mind, as the expense for the die must be absorbed in the number of punchings made or likely to be made.

HARDENED OR SOFT DIES

The reasons for and against the hardening of dies for such punchings as those under discussion should also be understood. Engineers sometimes advocate hardened dies, as these are said to give better punchings. It may also be true that hardened dies have a longer life. However, in manufacture, if anything happens to the die, it is easier to repair a soft die by calking, filing, etc., than a hardened die, which would have to be ground off until

again the upper and lower die shoes, and there are guide pins and holes provided to assure proper alignment. The tool-steel punch is bolted to the upper half and punches the outside of the punching. The lower half has the stripper plate resting on springs, which removes the material outside of the outer diameter of the punching—that is, corners and margin. The lower half, it will be noted, is in this case acting as a punch for the outside diameter. The punches for the slots, however, are set into the punch plate that is part of the upper die. There is also a guide plate that serves to hold the punches in position instead of supporting them at the ends only, in the punch plate. In back of the punch shoe there is a knocker plate set into a recess with sufficient clearance to slide along the vertical axis. This plate is connected with the upper stripper plate by screws and by the knocker pins. The action of this stripper plate is as follows: In operation, after the punching is punched out and the upper and lower halves separate again, the outer scrap is pushed up by the lower stripper plate. The material coming out of the slots, "tooth scrap," falls through the lower half of the die, the punching itself is carried up with the upper half until it is almost at the top of the stroke, when a stationary knocker pin hits the knocker plate and releases the punching. In the meantime the operator has pulled his sheet back so that the punching will not fall on the place where it was punched out. Then he advances the sheet so that the next cut may be taken. In this way the punching is easily pushed off with the sheet itself without requiring the operator's hands. This is a good example of how to arrange punches in the upper and the lower half of the die to facilitate removal and to save time. There are many interesting and ingenious designs of dies for the manufacture of punchings for electrical apparatus, and there is little written about them or put in the form of drawings, most of it being handed down by word of mouth as the accumulated experience of the tool department; but in this article it is not intended to go into this further.

Chuck for Air-Pump Packing Rings

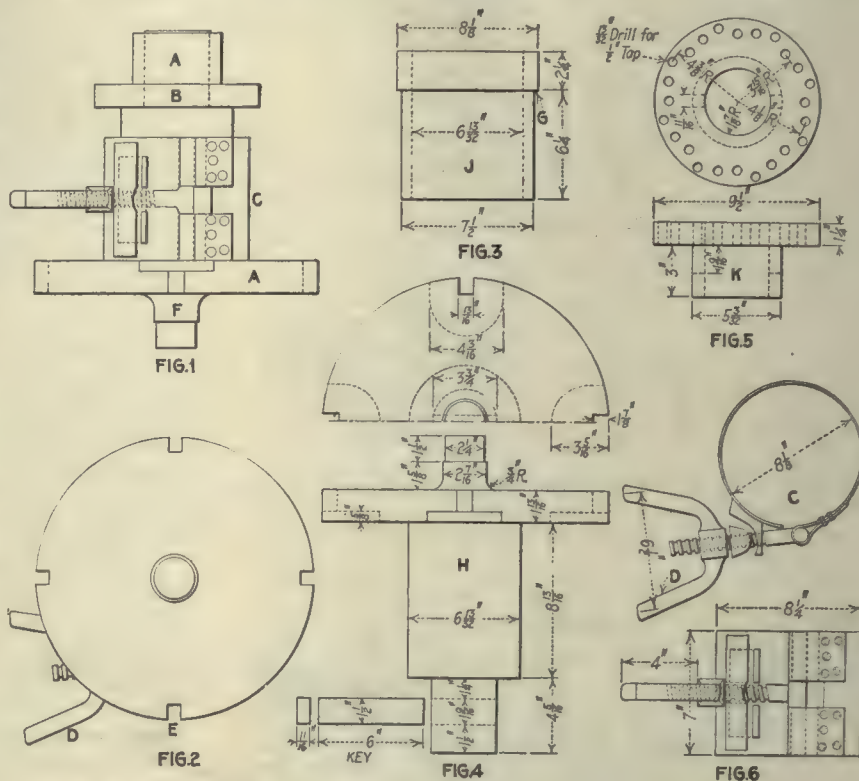
By F. R. STEWART

It has been the practice to return air-pump packing rings after they have been slit at the proper angle. Many of the methods used are slow and inaccurate, especially so if the piece cut out is $\frac{3}{8}$ in. or more for rings 8 to 9 in. in diameter. Re-turned rings mean longer life for cylinders and greater efficiency for pumps.

It is the practice of one large railroad system to rebore cylinders that are found $\frac{3}{32}$ in. out of round, and to bush the cylinders when worn $\frac{3}{16}$ in. larger than nominal diameter. Rings are manufactured in its shops to fit these rebored sizes, so it is necessary to have a chuck that is

easily convertible to re-turn these rings to the numerous outside diameters increasing by $\frac{1}{32}$ in. This is accomplished by means of the chuck shown, fitted to a Bullard vertical turret lathe.

An outside view of the chuck with the packing-ring clamp *C* in place is shown in Figs. 1 and 2. Details of the clamp *C* are shown in Fig. 6. The part *A* is clamped to the face of the boring-mill table by means of four bolts



CHUCK AND CLAMP FOR PACKING RINGS

through the slots *E*. The pilot *F* is a correct fit in the central hole in the table.

A set of bushings similar to the one shown in Fig. 3 are turned so that the inside fits the part *H*, Fig. 4, and the outside fits inside the finished bore of the packing rings. Where the packing-ring diameters are between wide limits it is necessary to build out to the larger diameters with a series of bushings.

The bushing shown in Fig. 3 is slipped over the pedestal *A*, Fig. 1, the packing rings are then applied with joints quartered until the last one projects $\frac{1}{16}$ in. to $\frac{1}{8}$ in. above the top edge of the bushing. The steel clamp *C*, Fig. 6, draws the rings tight against the bushing *J* by turning the handle *D* on the square threaded screw. When the setscrews in the cap *K*, Fig. 5, are drawn down against the rings sufficiently tight, the clamp *C* can be removed, thus exposing the outside of the rings for turning. The shoulder *G*, Fig. 3, is $\frac{1}{32}$ in. less than the thickness of the ring.

An Improvised Ruling Pen

By B. A. DONLEY

A mechanic designing a piece of machinery had to have a ruling pen. None being available, he took a piece of $\frac{1}{8}$ -in. steel wire 6 in. long, sawed it about 1 in. deep through the center, and after grinding it to his satisfaction he sharpened it and finished the job satisfactorily.

United States Munitions*

The Springfield Model 1903 Service Rifle

Operations on the Receiver--III

SYNOPSIS—The description of machine and bench operations on the Springfield model 1903 service rifle is continued in this article. Work and tool-holding devices, cutting tools, jigs and fixtures are illustrated and production time is given for all operations.

Devices—Work held in vise jaws, Fig. 370-A. Tool-Holding Devices—Cutter held in bar; see A, Fig. 370-B. Cutting Tools—Cutter; special radius cutter; see Figs. 370-B and 371. Number of Cuts—One. Cut Data—Strokes of machine, 30 per min.; feed, about 0.003 in. per stroke; hand feed. Coolant—Cutting oil, $\frac{1}{4}$ -in. stream. Average Life of Tool Between Grindings—250 pieces. Gages—Fig. 372; A, width of slots; B, height from bottom; C, use of gage. Production—20 per hr., two machines.

OPERATION 34. MILLING RECEIVER CLIP SLOT, ROUGHING

Transformation—Fig. 373. Machine Used—Pratt & Whitney No. 2 Lincoln type, belt drive. Number of Machines per Operator—One. Work-Holding Devices—Work held in vise

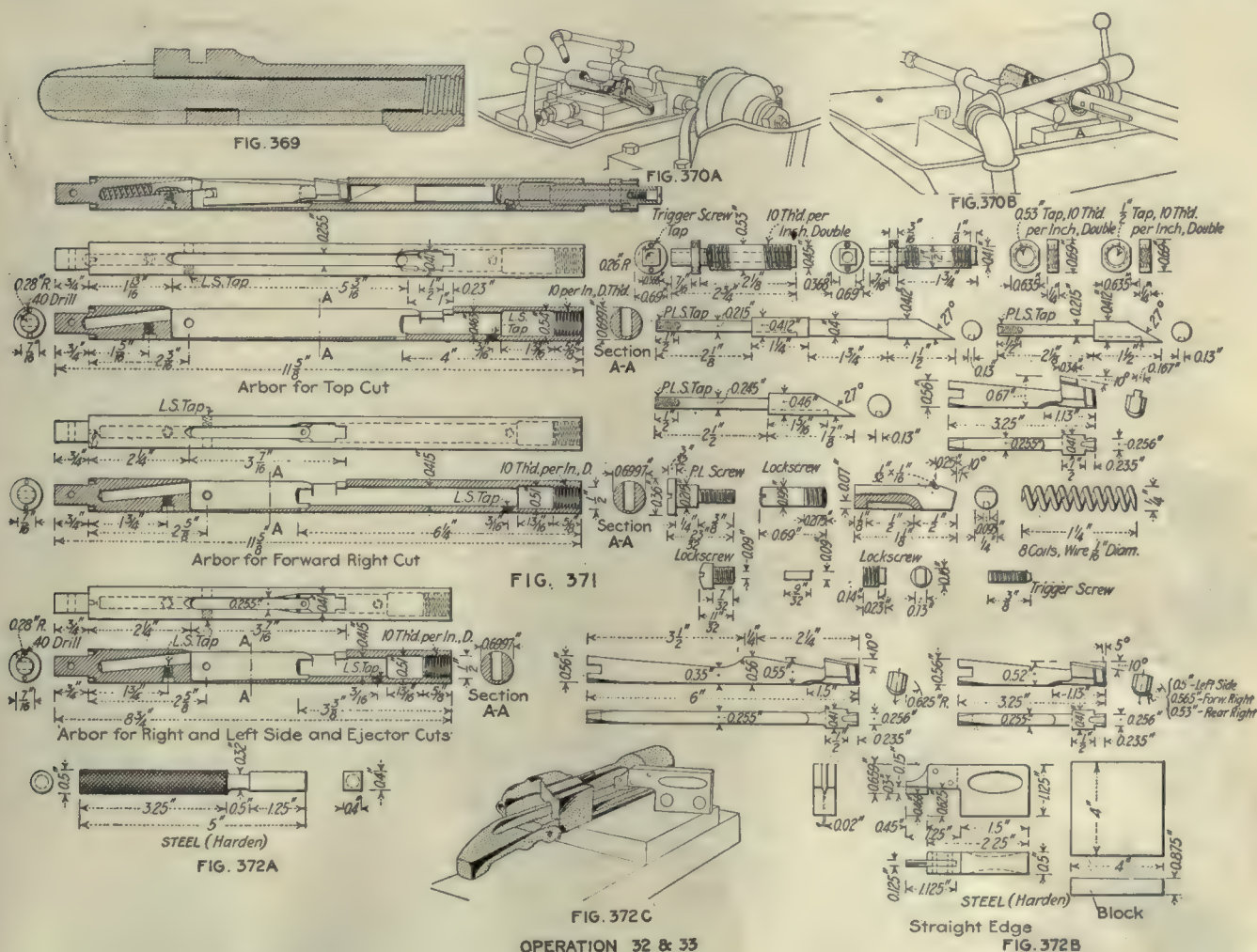


FIG. 372C
OPERATION 32 & 33

OPERATION 32. SHAVING LEFT LOCKING-LUG SLOT

Transformation—Fig. 369. Machine Used—Horizontal shaving machine, made at the shops. Number of Operators per Machine—One; two barrels at one setting. Work is held on angle plate; held by nose and sides, located against bottom, Fig. 374. Tool-Holding Devices—Threaded arbor. Cutting Tools—Side-milling cutters, Fig. 375. Number of Cuts—One. Cut Data—Speed, 60 r.p.m.; $\frac{1}{8}$ -in. feed. Coolant—Compound. Average Life of Tool Between Grindings—1,000 pieces. Gages—Fig. 376; A, depth from front end; B, width of slot and location from right side. Production—20 pieces per hr.

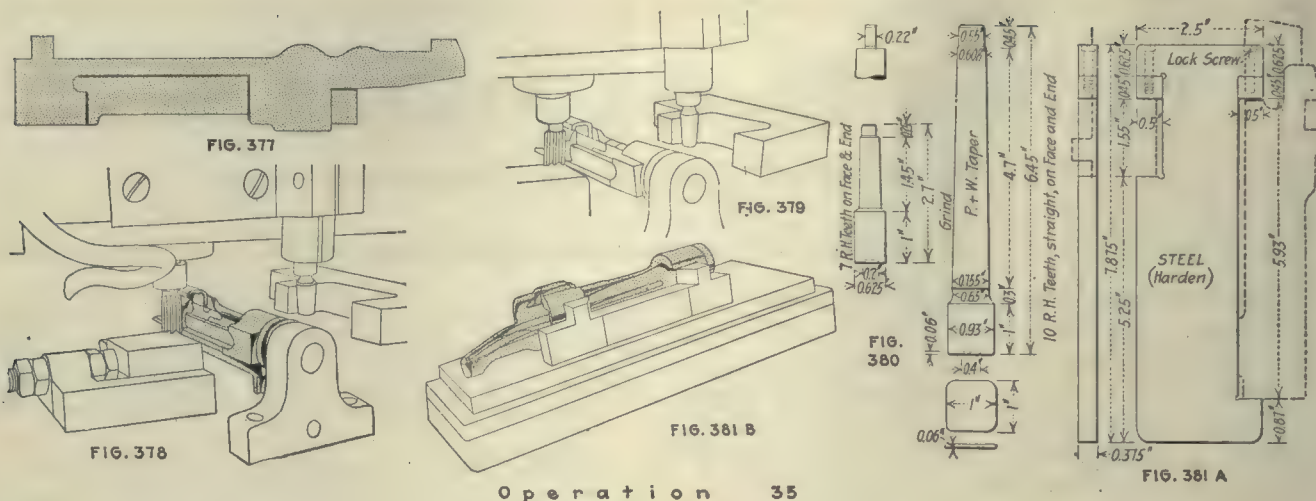
OPERATION 33. SHAVING RIGHT LOCKING-LUG SLOT

Transformation—Fig. 369. Machine Used—Horizontal shaving machine made in the shops. Number of Machines per

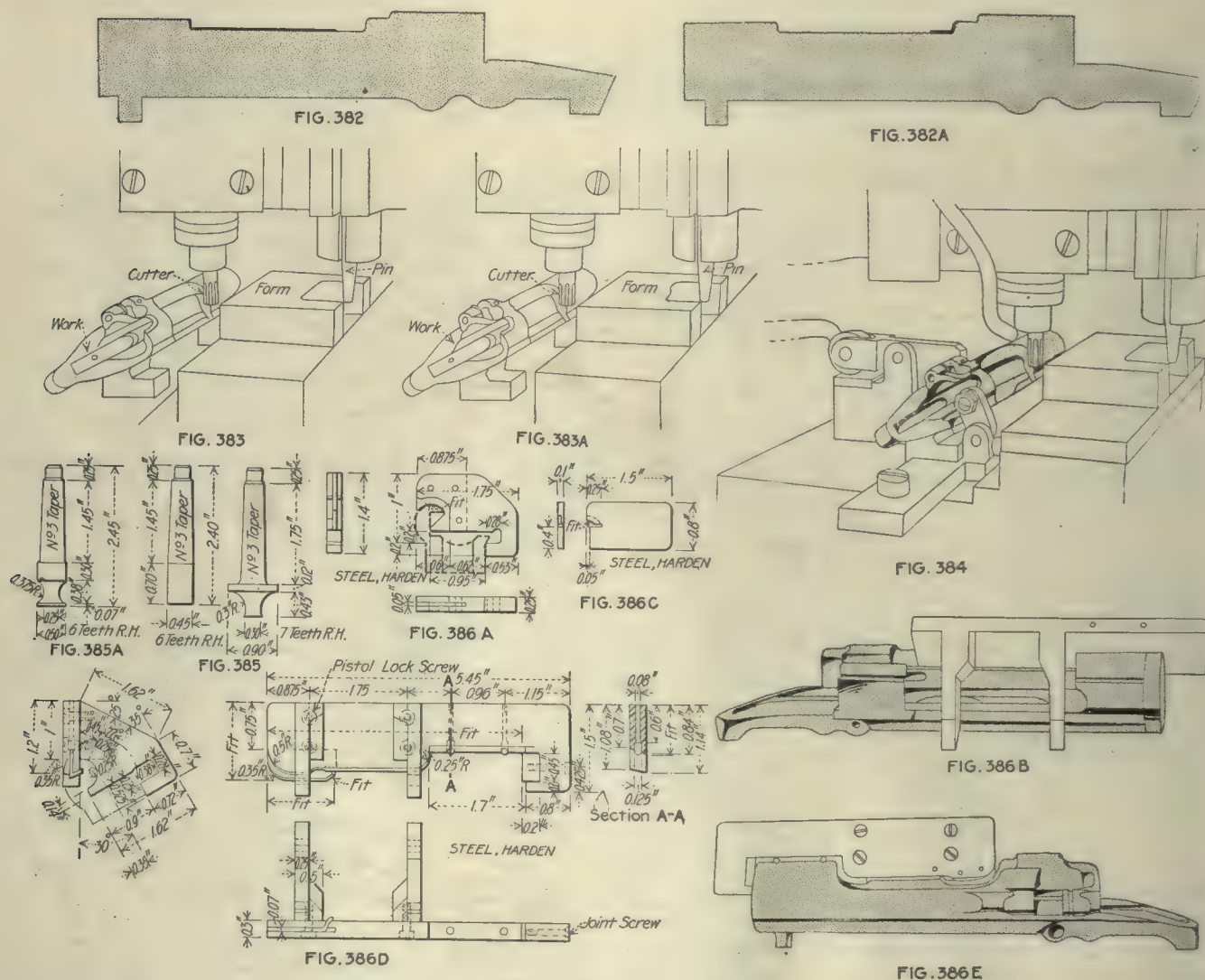
Operator—Two. Work-Holding Devices—Same as Fig. 370-A. Tool-Holding Devices—Same as operation 32. Cutting Tools—Same as Figs. 370-B and 371. Number of Cuts—One. Cut Data—Same as operation 32. Coolant—Cutting oil, $\frac{1}{4}$ -in. stream. Average Life of Tool Between Grindings—250 pieces. Gages—Same as Fig. 372. Production—20 pieces per hr., two machines.

OPERATION 35. PROFILING TOP OF RIGHT WALL, FRONT AND REAR SHOULDERS AND HANDLE SEAT TO FINISH

Transformation—Fig. 377. Machine Used—Pratt & Whitney profiler No. 2. Number of Operators per Machine—One. Work-Holding Devices—Work held in stud clamped by vise jaws, clamped on sides, located by nose and bottom, Fig. 378. Tool-Holding Devices—Taper shank. Cutting Tools—End-milling cutters, Fig. 380. Number of Cuts—Two. Cut Data—Speed,



Operation 35



OPERATION 36 & 37

1,200 r.p.m.; hand feed. Coolant—Compound. Average Life of Tool Between Grindings—120 pieces. Gages—Fig. 381; A, length and fillet gage; B, height from bottom and location of front and rear shoulders. Production—20 pieces per hr. Note—Machining diagram shown in Fig. 379.

OPERATION JJ. REMOVING BURRS LEFT BY OPERATION 35 (REAMER)

Number of Operators—One. Description of Operation—Filing burrs off top and sides and reaming burrs from hole. Apparatus and Equipment Used—Hand reamer, Fig. 388-A, and file. Production—250 per hr.

OPERATION 36. PROFILING TOP OF LEFT WALL

Transformation—Fig. 382. Machine Used—Pratt & Whitney No. 2 profiler; machining diagram, Fig. 383. Number of Operators per Machine—One. Work-Holding Devices—Work held on stud by finger clamp, Fig. 384. Tool-Holding Devices—Taper shank. Cutting Tools—Special milling cutters, Fig. 385. Number of Cuts—Two, one with straight cutter for front end; formed cutter, Fig. 385, for second cut. Cut Data—Speed, 1,200 r.p.m.; hand feed. Coolant—Compound, ¼-in. stream. Average Life of Tool Between Grindings—300 pieces. Gages—Fig. 386; A, position and shape of left wall; B, gage in position. Production—50 pieces per hr.

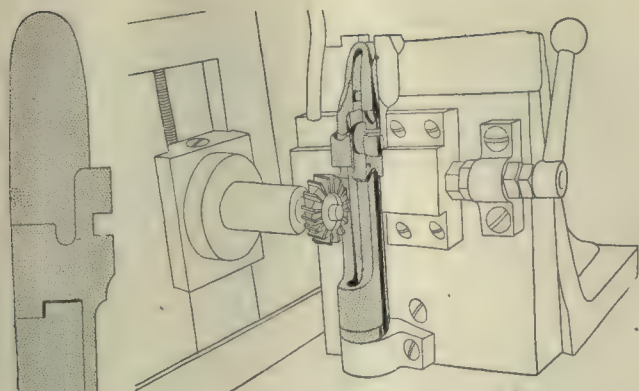


FIG. 374

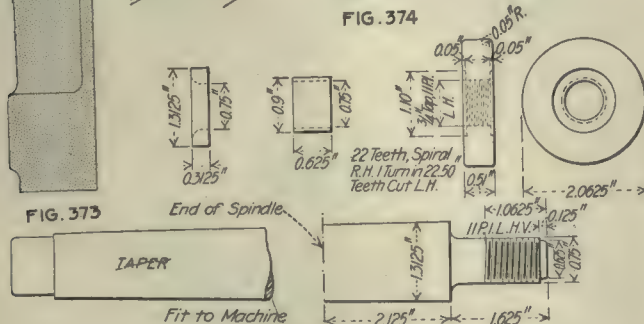


FIG. 373

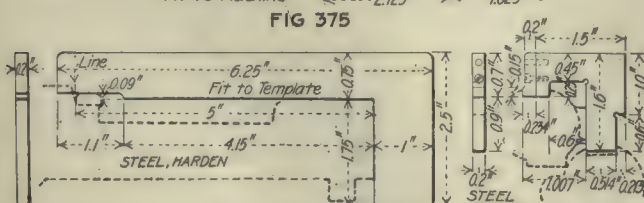


FIG. 376A

OPERATION 34.

FIG. 376B

OPERATION 37. PROFILING THUMB CUT OVER LEFT WALL

Transformation—Fig. 382-A. Machine Used—Pratt & Whitney profiler; machining diagram, Fig. 383-A. Number of Operators per Machine—One. Work-Holding Devices—Same as Fig. 382-A. Tool-Holding Devices—Taper shank. Cuts—Tools—Special milling cutter, Fig. 385-A. Number of Cuts—One. Cut Data—Speed, 1,200 rpm.; hand feed. Coolant—Compound, 3-4-in. stream. Average Life of Tool Between Grindings—300 pieces. Gages—Fig. 386; C, shape and location from lug slots; D, location of cut; E, use of gage. Production—80 pieces per hr.

OPERATION 38. SHAVING CLIP SLOT

Transformation—Fig. 387. Machine Used—Bement, Miles Co. slotter, 20-in. table. Number of Operators per Machine—One. Work-Holding Devices—Work held on stud at A, Fig. 388, and between two jaws located by thumb-screw C. Tool-Holding Devices—Tool held in double tool post. Cutting Tools—Shaving tool screwed to holder, high-speed steel, Fig. 389. Cut Data—Speed, 50 strokes per minute; feed, 0.003 in. per stroke; hand feed. Coolant—Cutting oil put on with brush. Average Life of Tool Between Grindings—400 pieces. Gages—Fig. 390; A, width and location from right side; B, distance from front end; plug goes in bore with finger A resting on the right side; finger B is raised to drop in slot, then the end of plug is measured by a straight-edge across the front end of the receiver. Production—40 per hr.

The operations shown herewith involve not only some interesting machinery but also give a further insight into the methods of gaging difficult and intricate work, which have been developed during long years of experience in making the same class of work. The shaving of the locking-lug slots in operations 32 and 33 is done in a special machine using hook cutters which are fed into the work in the same way as the cutters in the rifling machine. The details of this cutter and feeding mechanism are shown in Fig. 371. This shaving might even be called an intermittent broaching; in fact the broaching of such a piece as the receiver at one cut, even with a long broach, would be a difficult problem; both as to holding against the cut and supporting the sides against bulging or springing which would be a very serious drawback indeed.

The measuring of these slots is also of interest, the mandrel, which plays such a part in machining the receiver, being also used in measuring many of the operations performed. In the case of the locking-lug slots the mandrel is first inserted in the hole, then the gage blocks, mounted on handles bent at an angle of about 30 deg., are slid into place beside the mandrel.

OPERATION 39. MILLING CORNERS OF CLIP SLOT

Transformation—Fig. 391. Machine Used—Woodward & Rogers 14-in. three-spindle upright miller. Number of Operators—One. Work-Holding Devices—Drill Jig, Fig. 392; located by front studs and at tang and sides; supported on the bottom; two leads, and B, carrying bushings, swing over receiver to guide milling cutters. Tool-Holding Devices—Drill chuck. Cutting Tools—Special chuck, Fig. 392-A. Number of Cuts—Two. Cut Data—Speed, 600 r.p.m.; hand feed. Coolant—Cutting oil. Average Life of Tool Between Grindings—450 pieces. Gages—Fig. 393, stand gage with hardened plugs in bushings. Production—40 pieces per hr.

OPERATION 40. DRILLING HOLE AT FRONT END OF EJECTOR SLOT

Transformation—Fig. 394. Machine Used—Woodward & Rogers three-spindle upright drilling machine, 14 in. Number of Operators per Machine—One. Work-Holding Devices—Drill jig, Fig. 395, A and B; A, jig empty; B, with work; work is held by jaws A against stop B; swinging stop C; bushing held in D, which slips into well and is held by pin E; arm F clamps it down, and screw G steadies it sidewise. Tool-Holding Device—Drill chuck. Cutting Tools—0.182-in. twist drill, high-speed steel. Number of Cuts—One. Cut Data—600 r.p.m.; hand feed. Coolant—Cutting oil, $\frac{1}{2}$ -in. stream. Average Life of Tool Between Grindings—400 pieces. Gages—Fig. 396, position from front end. Production—100 pieces per hr.



FIG.387

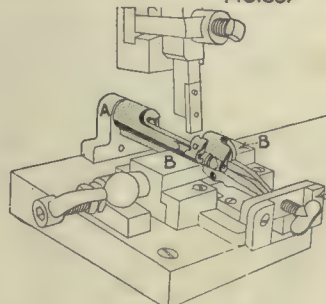


FIG. 388

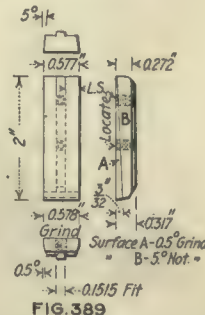


FIG. 389

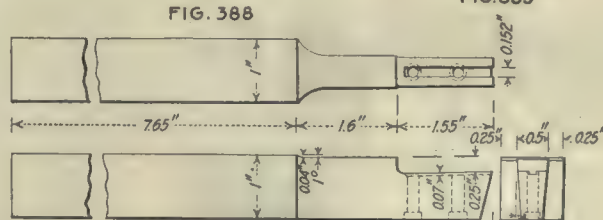
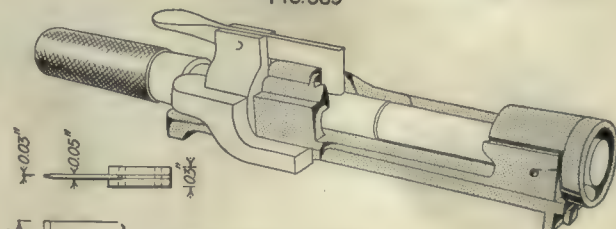


FIG. 389



STEEL (Harden)

FIG. 390A

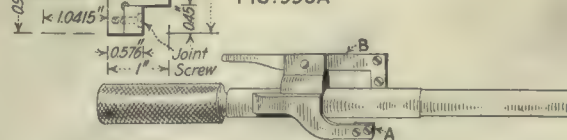


FIG. 390B

OPERATION 38

The straight-edge is also used to a considerable extent in gaging the various parts. An example of this is shown in Fig. 381-B. Here the bottom of the receiver rests on a steel support and against the side templet shown. This templet is broad enough to steady a straight-edge, which, when laid across it, shows whether the side of the receiver matches the gage or not.

A different type of gage for a somewhat similar purpose is seen in Fig. 386. Here the contour of the

opportunities for error in shifting from one to the other. This is of course necessary at times, as in the case of the receiver under consideration, but should be avoided when possible.

In most cases it is necessary to have three working points to the piece, either a hole and one side or two sides at right angles, and one end. The hole makes a good working point as can be seen in this instance, and can in addition be used to advantage for measuring.

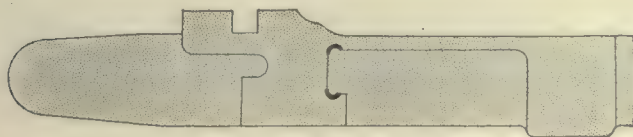


FIG. 391

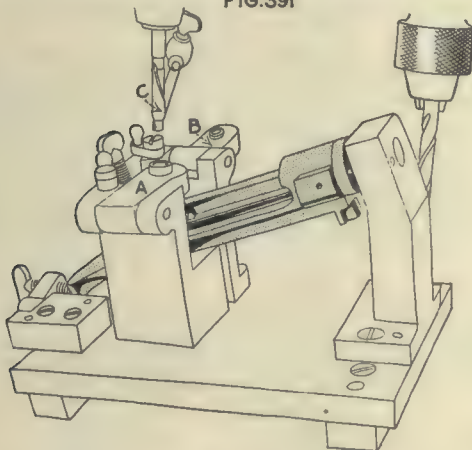


FIG. 392

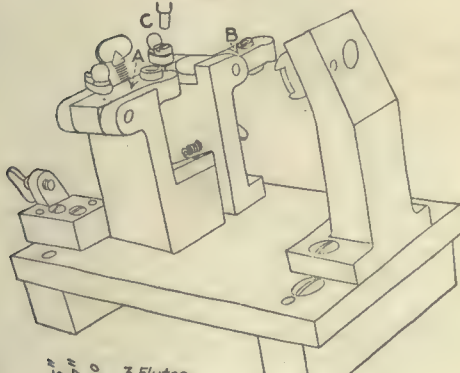


FIG. 392A

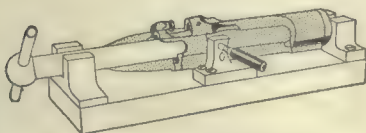


FIG. 393

OPERATION 39

other side is being gaged as well as the relation to the lower right side, one of the important gaging points.

This brings up the importance of so planning the progress of work through the shop that points can be established from which to locate work and also as points for gaging. The same points should be maintained through all its operations if possible as there are always

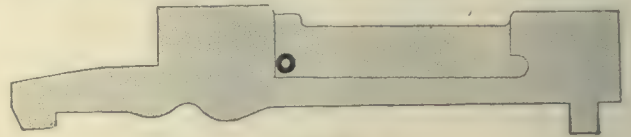
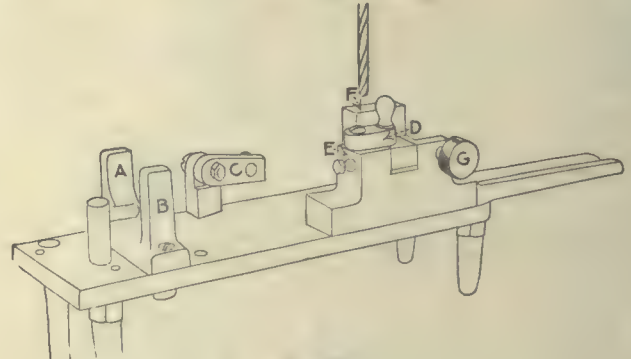


FIG. 394



G. 395A

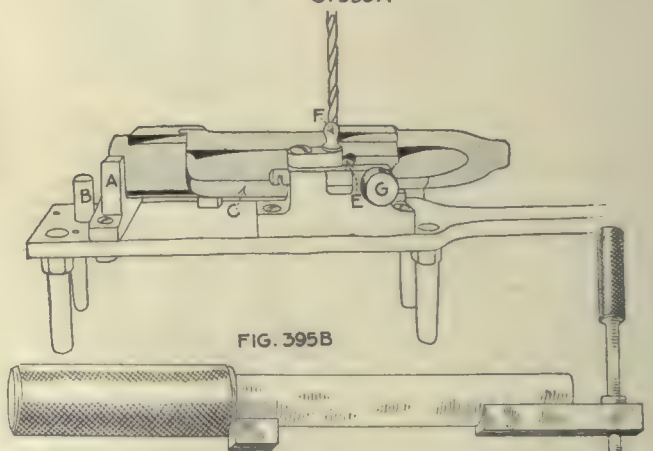


FIG. 395B

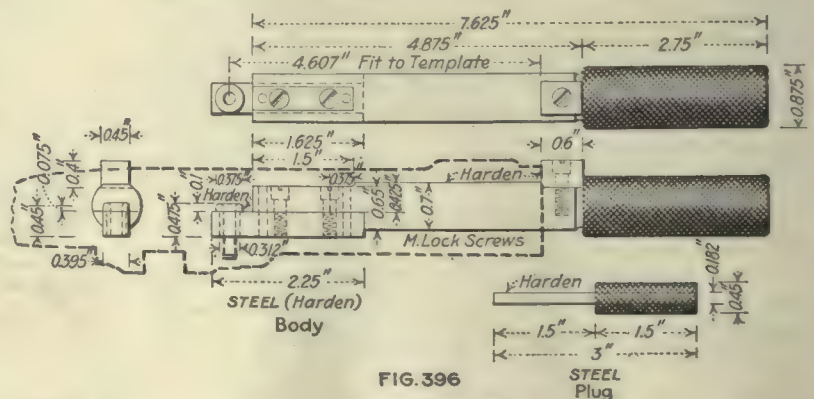
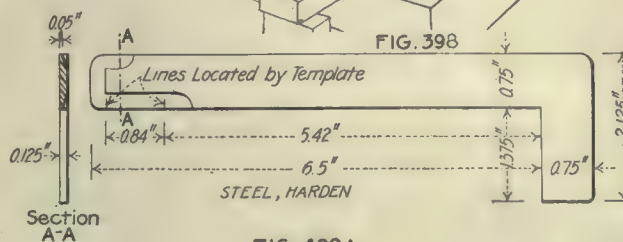
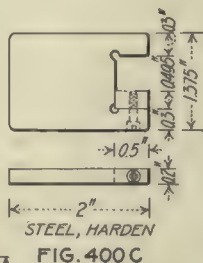
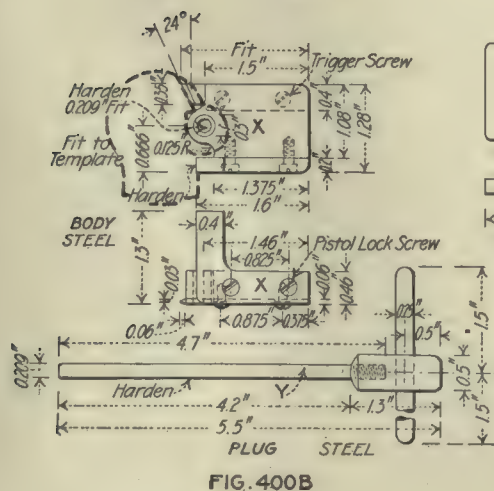
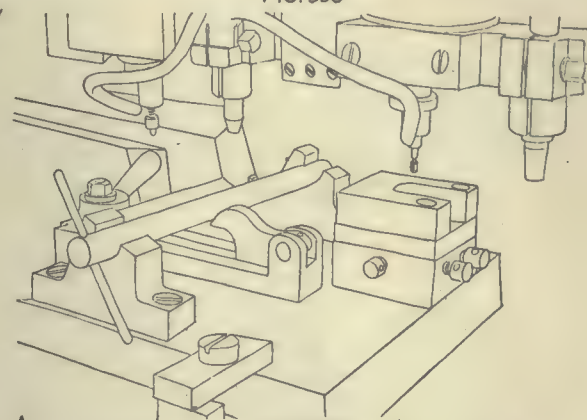
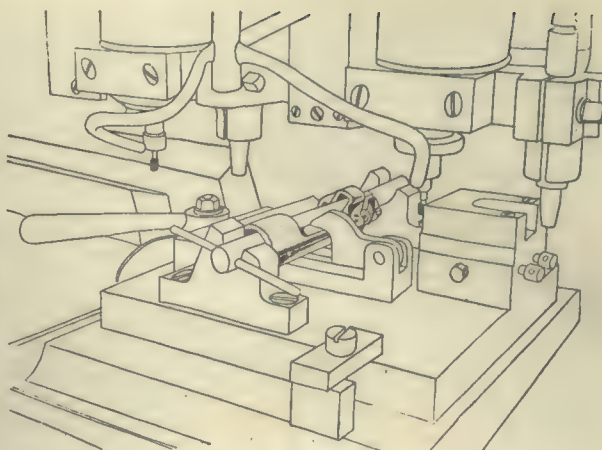
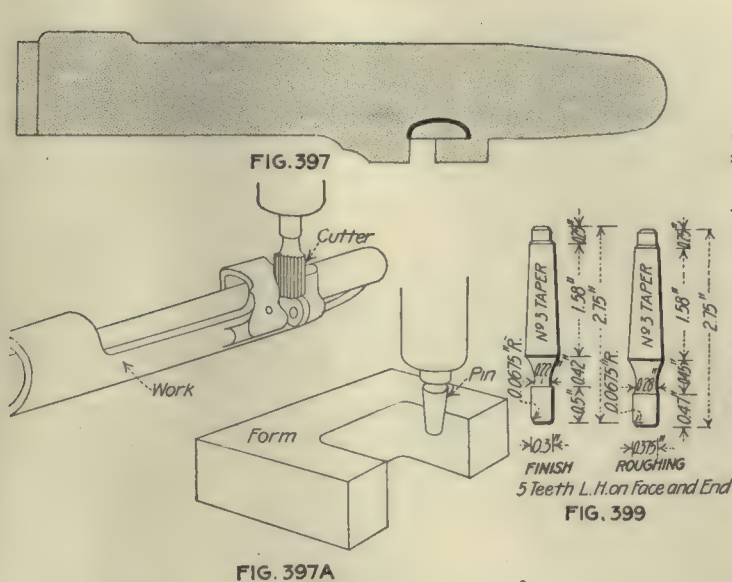


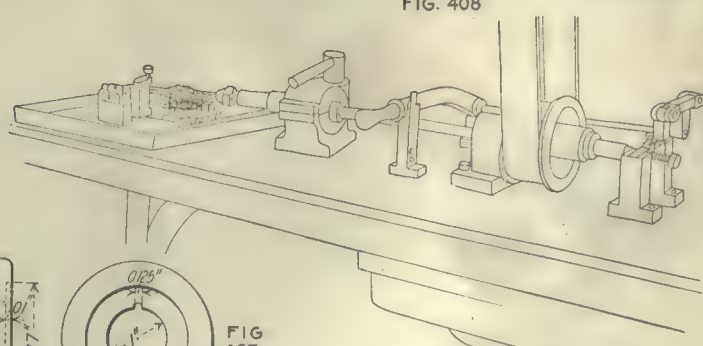
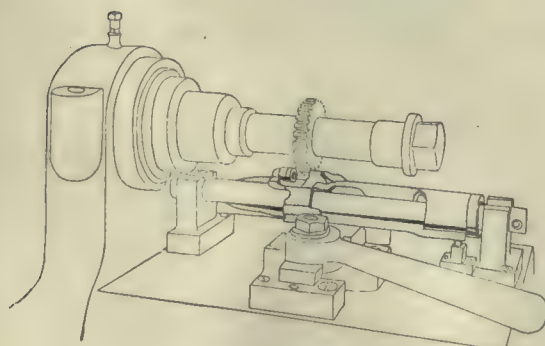
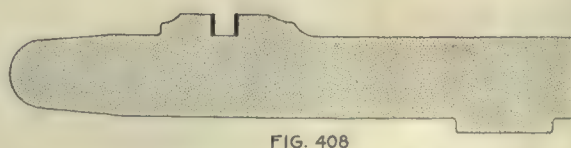
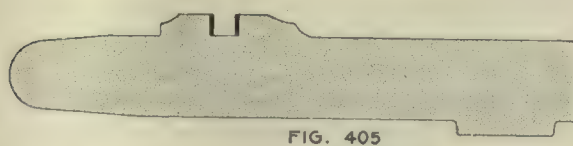
FIG. 396

OPERATION 40

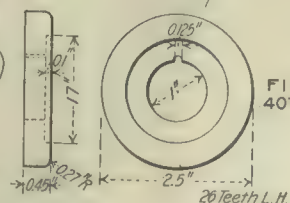
The uses to which the hand milling machine are put in this class of work are full of suggestions that should be applicable to many other lines of work. They show work held in both horizontal and vertical positions as in Figs. 374 and 421. In the latter case, however, the principles of the profiler are applied in a very simple manner. This principle gives almost any desired form



OPERATION 43



OPERATION 44



OPERATION 43. PROFILING FOR CUTOFF THUMB-PIECE

Transformation—Fig. 397. Machine Used—Pratt & Whitney No. 2 profiler; machining diagram, Fig. 397-A. Number of Operators per Machine—One. Work-Holding Devices—Work held on mandrel clamped by finger clamp, Fig. 398. Tool-Holding Devices—Taper shank. Cutting Tools— $\frac{1}{4}$ -in. end mills; two cutters, rough and finish, Fig. 399. Number of

Cuts—Two. Cut Data—1,200 r.p.m.; hand feed. Coolant—Compound, two $\frac{1}{4}$ -in. streams. Average Life of Tool Between Grindings—500 pieces. Gages—Fig. 400; A, location from front end; B, depth, measured by putting the body in the cut-off slot and slipping the rod through the gage; C, height. Production—75 pieces per hr.

OPERATION 41. HAND MILLING TOP AND BOTTOM OF CUTOFF CAVITY COMBINED WITH OPERATION 42

Transformation—Fig. 401. Machine Used—Whitney Manufacturing Co. No. 6. Number of Operators per Machine—One. Work-Holding Devices—Rotating fixture, Fig. 402. Tool-Holding Devices—Taper shank. Cutting Tools—Milling cutter, Fig. 403. Number of Cuts—One. Cut Data—Speed, 700 r.p.m.; hand feed. Coolant—Cutting oil, $\frac{1}{8}$ -in. stream. Average Life of Tool Between Grindings—1,000 pieces. Gages—Fig. 404; A, bottom of cutoff cavity; B, top of cutoff cavity. Production—100 pieces per hr. Note—Bottom and hole are working points.

OPERATION 44. HAND MILLING TO REMOVE BURRS IN CUTOFF THUMB-PIECE CAVITY

Transformation—Fig. 405. Machine Used—Reed hand miller No. 2. Number of Operators per Machine—One. Work-Holding Devices—Work held on mandrel, held by finger clamp, Fig. 406. Tool-Holding Devices—Cutter arbor. Cutting Tools—Facing mill with one round corner, Fig. 407. Number of Cuts—One. Cut Data—Speed, 360 r.p.m.; hand feed. Coolant—Cutting oil put on with brush. Average Life of Tool Between Grindings—4,000 pieces. Gages—Not gaged till after operation 44½. Production—175 pieces per hr. Note—Right side of receiver is the working point, two pins in bottom plate of fixture locate cut.

OPERATION 44½. MILLING FRONT AND REAR OF CUTOFF CAVITY

Transformation—Fig. 408. Machine Used—Special machine built at Hill shop. Number of Operators per Machine—One. Work-Holding Devices—Work held on mandrel using right side as centering point, Fig. 409. Tool-Holding Devices—Drill chuck. Cutting Tools—Special cutter and special arbor, Fig. 410; pin in cutter locks bayonet joint in arbor; stops on machine determine width of cutoff opening. Number of Cuts—One. Cut Data—70 r.p.m.; hand feed. Coolant—Cutting oil put on with brush. Average Life of Tool Between Grindings—2,000 pieces. Gages—Width, Fig. 411. Production—45 pieces per hr.

OPERATIONS 49½ AND 79. HAND MILLING TO REMOVE STOCK REAR OF SAFETY-LUG SLOT

Transformation—Fig. 412. Machine Used—Garvin No. 3 hand miller. Number of Operators per Machine—One. Work-Holding Devices—Rotating fixture; work held on stud and by tang, supported on bottom, Fig. 413. Tool-Holding Devices—Milling cutter arbor. Cutting Tools—Two milling cutters, Fig. 414. Number of Cuts—One. Cut Data—400 r.p.m.; hand feed. Coolant—Cutting oil, two $\frac{1}{8}$ -in. streams. Average Life of Tool Between Grindings—4,000 pieces. Gages—Fig. 415; A, shape and location; B, round corner over clip slot. Production—40 pieces per hr. Note—Working points, bottom and hole of receiver.

OPERATION 45. MILLING TANG

Transformation—Fig. 416. Machine Used—Pratt & Whitney No. 2 belt-drive Lincoln type. Number of Operators per Machine—One. Work-Holding Devices—Vise fixture, Fig. 417; locates by front end and bottom, clamps on sides; fixture raises work to give proper contour, by what is known as "bridge" milling. Tool-Holding Devices—Taper shank. Cutting Tools—One form cutter, Fig. 418. Number of Cuts—One. Cut Data—50 r.p.m.; $\frac{1}{2}$ -in. feed. Coolant—Compound, $\frac{1}{4}$ -in. stream. Average Life of Tool Between Grindings—2,000 pieces. Gages—Fig. 419; contour gage with fingers; locates from front end, sides and bottom. Production—40 pieces per hr. Note—Working points, bottom, sides and hole.

without the use of complicated and expensive formed cutters. It is well worth careful consideration and will often save the use of more expensive machines. The elevating fixture also has its place in this work, operation 45, milling the tang, being an example of this. Here the table is raised as it is fed forward by power, a cam

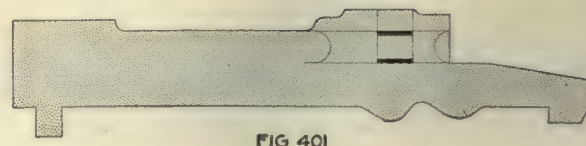


FIG 401

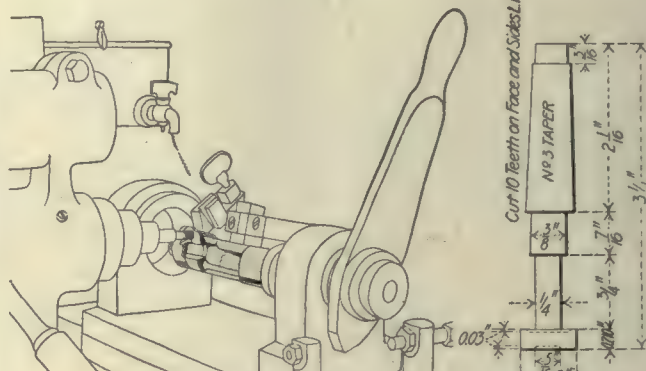
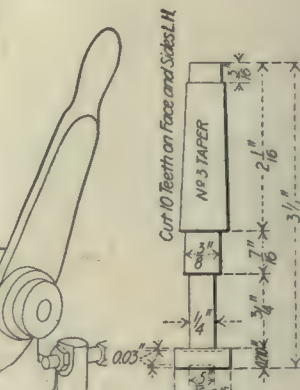


FIG 402



Cut 10 Teeth on Face and Sides L.H.

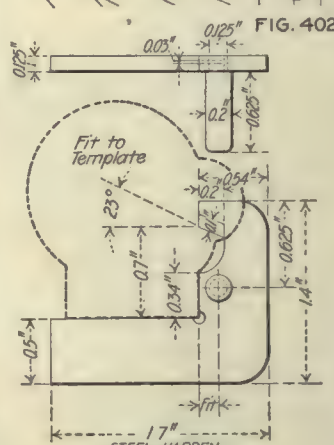


FIG 404A

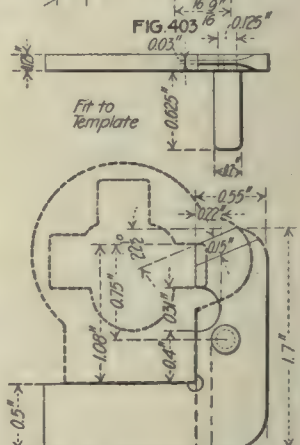
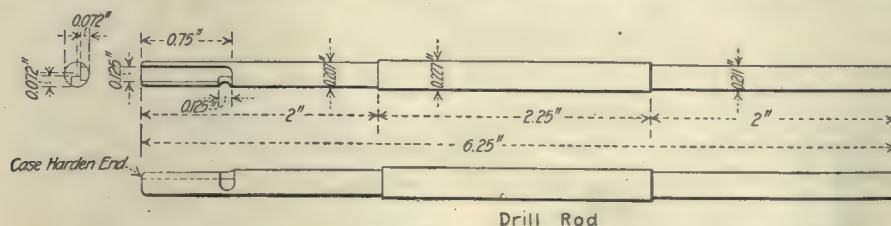


FIG 404B

OPERATION 41

beneath giving the table the proper elevation at each point. In other cases, the fixtures are elevated simply to bring the work against the cutter in the proper position, this being preferred to raising the table of the machine. The weight raised is much less and it is easier to "feel" the stop than where a heavier weight is being handled. A valuable feature is the use of the profiling machine and cutter for securing slots of the desired



Drill Rod

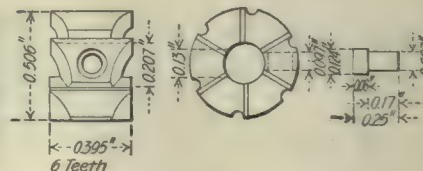


FIG 411

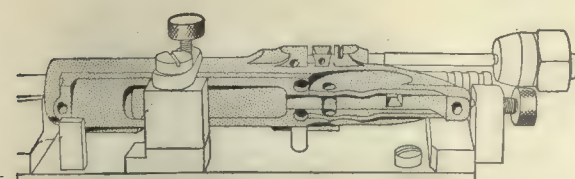
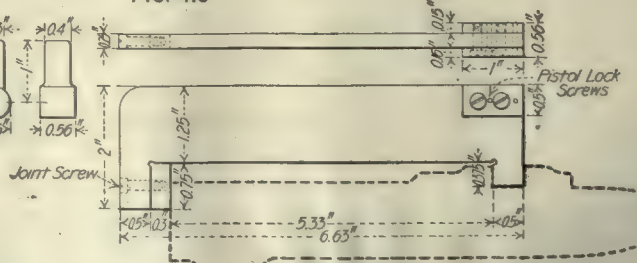


FIG 412



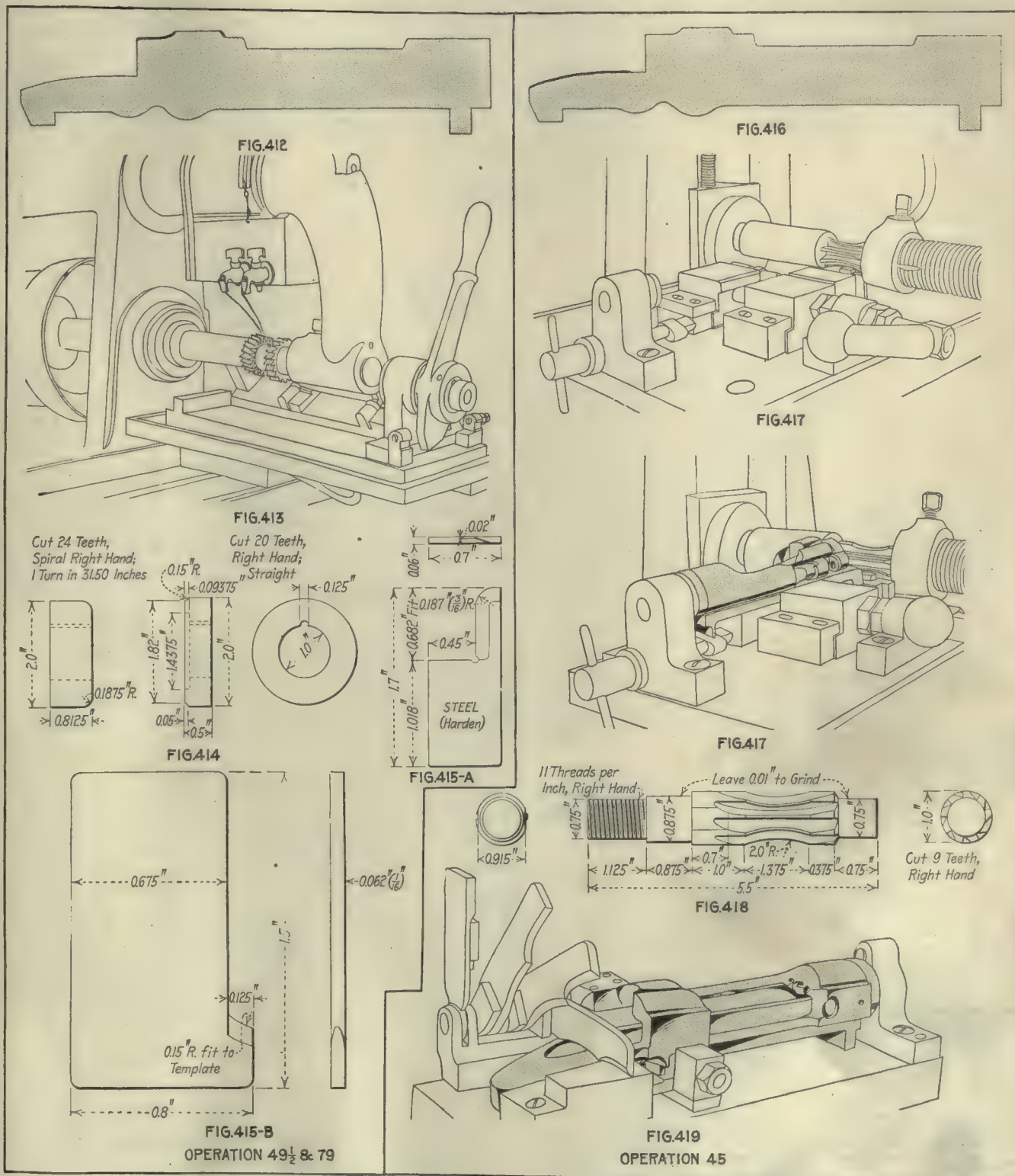
OPERATION 44½

FIG 411

width, such as the cocking-piece groove shown in operation 51, Figs. 444 and 445. Even where the end of the groove does not need to be rounded as in this case, the use of the profiling cutter and guide makes it possible to secure the desired width with more certainty than with the usual milling cutters. Cutter wear can be easily counteracted by simply moving the taper guiding

insure correct seating of the part in the next operation, for milling cutters, drills and other cutting tools will throw up burrs and these interfere with properly locating work in a fixture. And this is a big factor in securing accurate and duplicate work.

This, in fact, is one of the "personal" elements which enter into this sort of work and which are too often over-



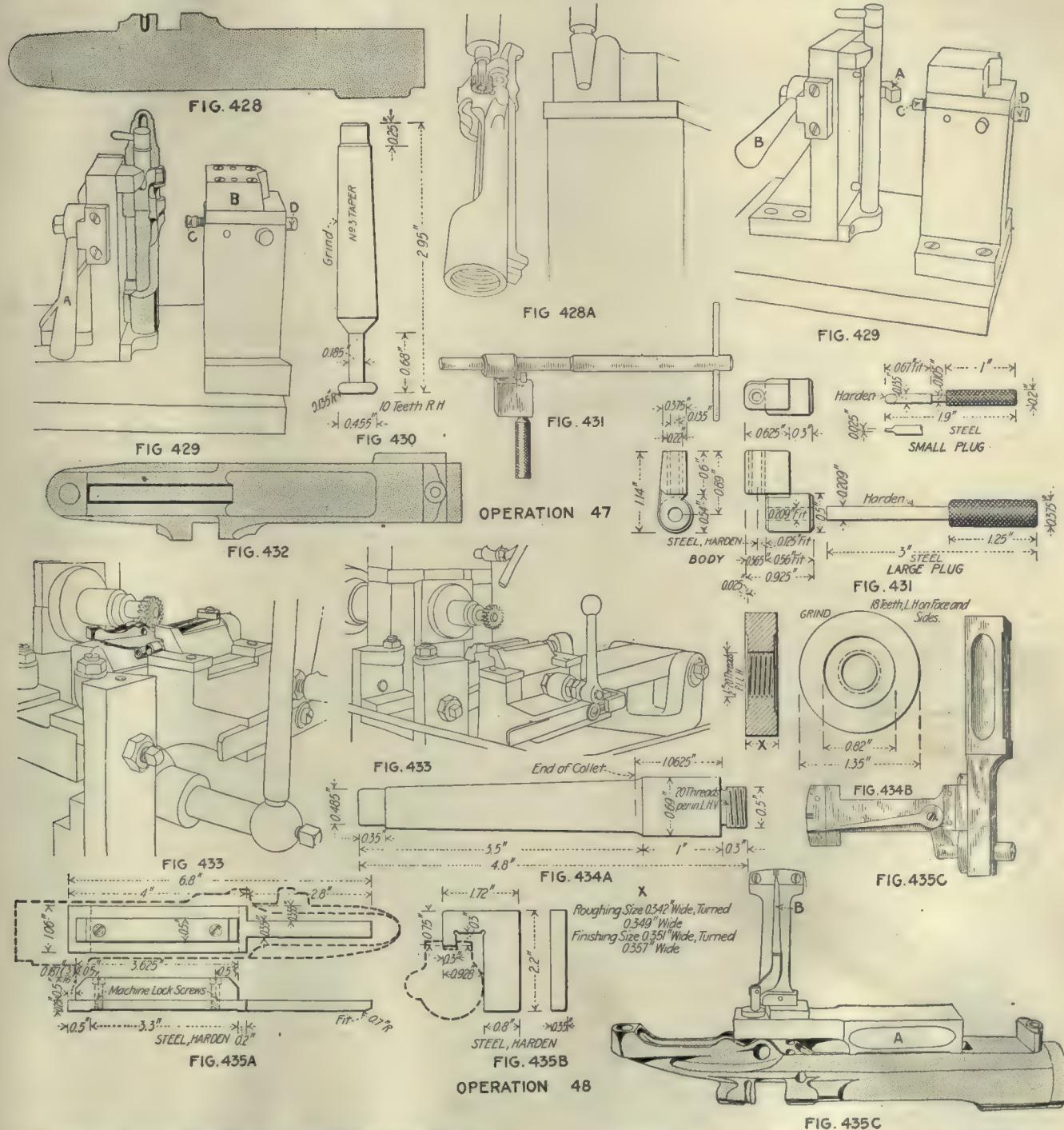
pin down toward the profiling form, while it is extremely difficult to maintain accuracy in the width of cut with a solid milling cutter.

The numerous filing and burring operations, trivial in themselves, are in reality quite necessary in order to

looked in trying to find reasons for new men spoiling work. It also affords a suggestion for fixture designs, pointing out the advantages of so designing fixtures that burrs and similar discrepancies will not affect the location of the work in the fixture.

The shaving operations typified by operation 38 are done on slotters or punch presses. The cutters and cutter holders are made so as to be readily removable and easily kept to size. The feed in such work is something of a problem, owing to the possibility of distortion of the piece, as it is difficult to support the rear of the receiver for this work. This necessitates a very light feed per stroke, about 0.003 to 0.005 in. being found best from all points of view. At 50 strokes per minute,

however, the clip slot can be finished at a fair rate of speed. It is gaged from the front end as in many receiver operations. The finger is lifted to allow the gage to be put in place, then the lug is drawn back and front end measured across receiver, instead of gaging from the rear end as might be surmised from the form of the gage. Shaving operations such as these are often the most feasible means of cleaning up out-of-the-way surfaces hard to get at by any other means.



Transformation—Fig. 428. Machine Used—Pratt & Whitney No. 2 profiler; machine diagram, 428-A. Number of Operators per Machine—One. Work-Holding Devices—Held on vertical mandrel by finger clamp, operated by lever A, Fig. 429; the profiling form B is adjustable by screws C and D. Tool-Holding Devices—Taper shank. Cutting Tools—Round-edge milling cutter, Fig. 430. Number of Cuts—One. Cut Data—1,200 r.p.m.; hand feed. Coolant—Compound, ¼-in. stream. Average Life of Tool Between Grindings—300 pieces. Gages—Fig. 431. Production—80 pieces per hr. Note—Working points, hole, front end and right side.

Transformation—Fig. 432. Machine Used—Pratt & Whitney No. 2 Lincoln type miller. Number of Machines per Operator—Two. Work-Holding Devices—Held on stud at front end, vise jaws and plug at rear end, Fig. 433; fixture raises work against cutter, as in Fig. 366. Tool-Holding Devices—Taper shank, Fig. 434-A. Cutting Tools—Side-milling cutter, Fig. 434-B. Number of Cuts—One. Cut Data—Speed, 70 r.p.m.; ¼-in. feed. Coolant—Compound, ¼-in. stream. Average Life of Tool Between Grindings—2,000 pieces. Gages—None. Production—20 pieces per hr. per machine. Note—This is an example of the use of a fixture with auxiliary feed.



FIG. 440

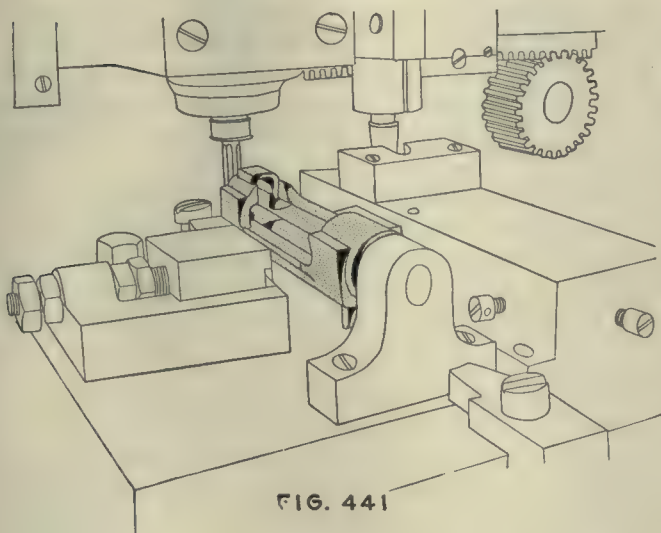


FIG. 441

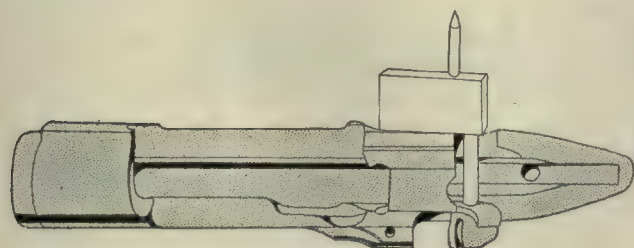


FIG. 443 A

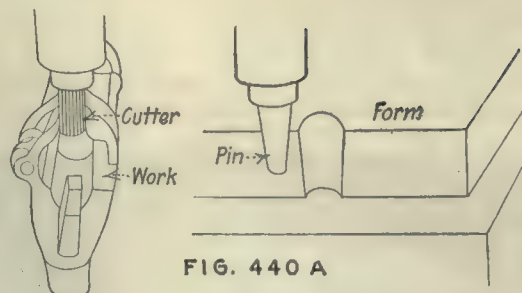


FIG. 440 A

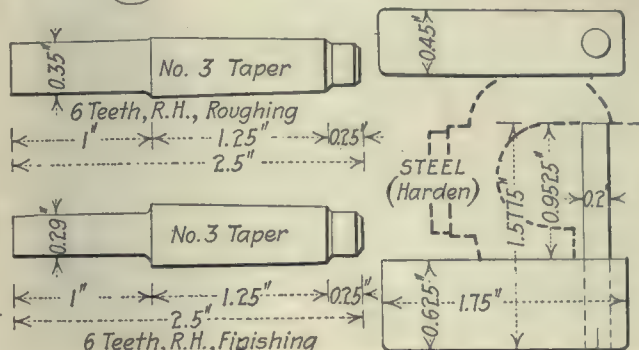


FIG. 442

FIG. 443 A

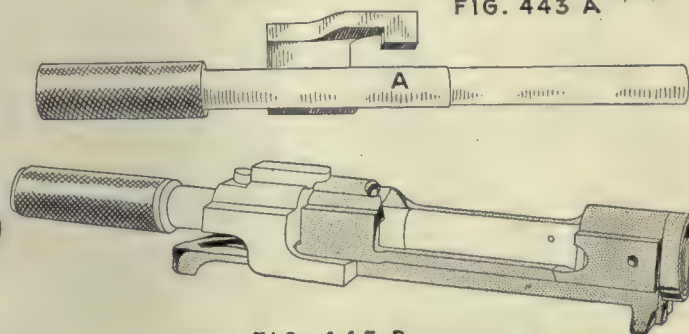


FIG. 443 B

Operation 50

OPERATION 48½. MILLING SEAR SLOT, FINISH

Transformation—Same as Fig. 432. Machine Used—Pratt & Whitney No. 2 Lincoln type miller. Number of Machines per Operator—One. Work-Holding Devices—Same as Fig. 433. Tool-Holding Devices—Same as Fig. 434-A. Cutting Tools—See finish-cutter dimensions in Fig. 434-B. Number of Cuts—One. Cut Data—Speed, 70 r.p.m.; $\frac{1}{8}$ -in. feed. Coolant—Compound, $\frac{1}{4}$ -in. stream. Average Life of Tool Between Grindings—2,000 pieces. Gages—Fig. 435; A, centering gage, locates from right side; B, width of slot; C, depth; base A is set across bottom of receiver and point B indicates by multiplying lever; bottom of both sear slot and receiver should be the same. Production—40 pieces per hr.

OPERATION 49. MILLING COCKING-PIECE GROOVE IN RECEIVER

Transformation—Fig. 436. Machine Used—Pratt & Whitney No. 2 Lincoln type miller. Number of Machines per Operator—Two. Work-Holding Devices—Held on stud and in vise jaws, Fig. 437; locates by stud and top of sear lug. Tool-Holding Devices—Taper shank, Fig. 438-A. Cutting Tools—Side-milling cutter, Fig. 438-B. Number of Cuts—One. Cut Data—Speed, 70 r.p.m.; $\frac{1}{8}$ -in. feed. Coolant—Compound, $\frac{1}{4}$ -in. stream. Average Life of Tool Between Grindings—200 pieces. Gages—Fig. 439; A, length from front end of receiver; B, width, depth and location from right side. Production—20 pieces per hr., one machine. Note—Working points, hole and top of sear flange.

OPERATION 50. PROFILING REAR OF SAFETY-LUG SLOT

Transformation—Fig. 440. Machine Used—Pratt & Whitney No. 2 profiler; machining diagram, Fig. 440-A. Number of Operators per Machine—One. Work-Holding Devices—Held by stud and vise jaws, Fig. 441. Tool-Holding Devices—Taper shank. Cutting Tools—End mills, Fig. 442. Number of Cuts—Two. Cut Data—Speed, 1,200 r.p.m.; hand feed. Coolant—Compound, two $\frac{1}{4}$ -in. streams. Average Life of Tool Between Grindings—400 pieces. Gages—Fig. 443; A, location from right side; B, plug goes in receiver, finger A, locates against right side, while a block on top fits the slot; a straight-edge across front measures correct distance. Production—75 per hr. Note—Working points, hole and bottom.

OPERATION 51. PROFILING COCKING-PIECE GROOVE

Transformation—Fig. 444. Machine Used—Pratt & Whitney No. 2 profiler; machining diagram, Fig. 444-A. Number of Operators per Machine—One. Work-Holding Devices—Held on stud and vise jaws, Fig. 445. Tool-Holding Devices—Taper shank. Cutting Tools—End mill, Fig. 446. Number of Cuts—Two. Cut Data—1,200 r.p.m.; hand feed. Coolant—

Compound, two $\frac{1}{4}$ -in. streams. Average Life of Tool Between Grindings—200 pieces. Gages—Fig. 447; A, width of groove; B, depth; under side is curved to fit a plug, outside to fit radius of groove; the gage must slide between plug and receiver wall; C, location; finger A rests on right side when block B is in groove. Production—40 pieces per hr. Note—Working points, hole and bottom.

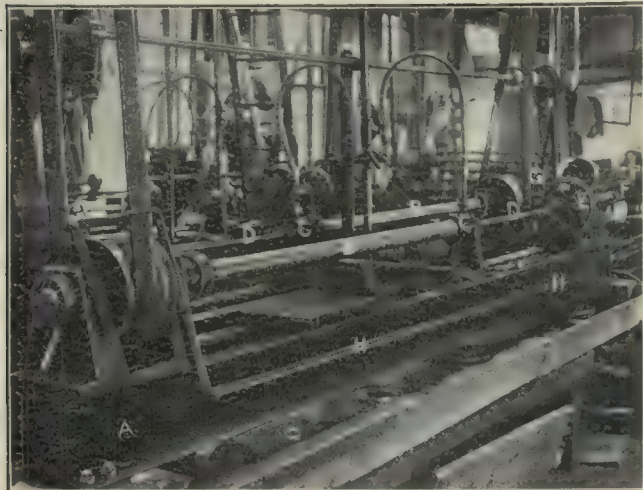
Drilling a Long Camshaft

The Curtiss camshafts are made hollow in order to reduce weight, and also for lubrication. They are of 0.15 carbon steel, 41 in. long and about $2\frac{1}{2}$ in. in diameter, with a $\frac{3}{4}$ -in. hole bored the whole length. The boring of these camshafts led to some interesting experiences, both in the machine to use, in the best drill for the work, the kind of lubricant, the pressure required and last but not least, the quantity which would give the best results.

Special drilling machines were built by the Fay & Bowen Co., Geneva, N. Y., as none could be purchased at either a reasonable price or delivery. These machines were built up of a pair of channel beams, A, spaced by substantial cast-iron blocks at each end and having lighter braces at different points along the bed. A substantial headstock, carrying a suitable chuck and driven by a heavy belt, is mounted at one end of the bed. At the other end is the tailstock, or boring head, while E is a central support for the outer end of the camshaft. This also guides the drill into the work and carries the lubricant to the cutting edge around the outside of the drill. Standard hollow drills are used.

The illustration shows the camshaft at B, the drill at D, the ratchet wheel and feed at E, the screw being at F.

The rod *H* controls the belt shifter on the headstock. In the beginning, before the problem of proper lubrication was thoroughly realized, a small, single-cylinder pump was used. This delivered about 1 gal. per min. at



SPECIAL MACHINE FOR CAMSHAFT DRILLING

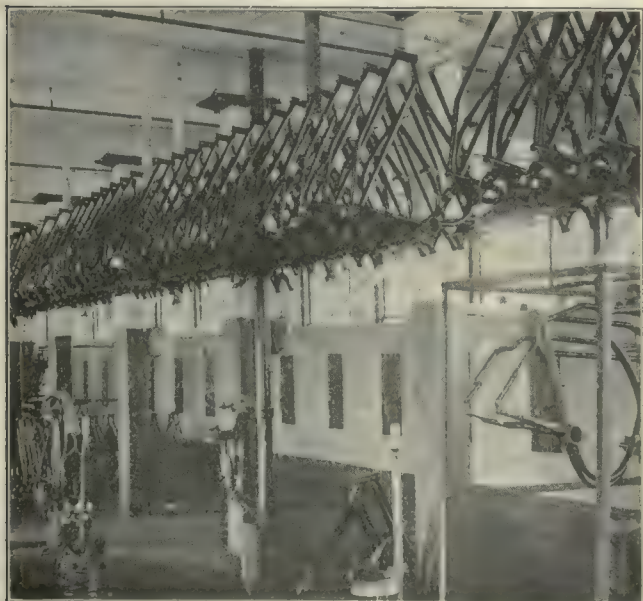
150 lb. pressure. Experience soon demonstrated that this was insufficient, and both the pressure and the amount of the lubricant were greatly increased. Oil was first tried, but it was found too heavy to allow of a sufficient quantity being pumped through the drill. The water lubricant, solvent, has been found much more satisfactory.

The speed of the camshaft revolution is 270 per min. and the feed of the drill about $\frac{1}{8}$ in. per min. The holes are drilled halfway through and the camshaft then turned end for end, the holes meeting with very little variation.

Spraying Enamel Upon Metals

BY PETER F. O'SHEA

In a short time it will be as hard to get hand-painted metal parts as it is now to find hand-painted china. The spraying method is far quicker and may be done by unskilled labor, and if the conditions are properly regulated, the result is just as good. This applies also, if especial



THE ENAMELING ROOM

care be taken, to enameling. It is therefore timely to give a description of one company's spraying arrangements.

Two galvanized iron hoods are arranged side by side and two more placed back to back with them. An exhaust air pipe, branching into each of the four hoods, leads away from this cluster to carry off the flying vapor of the enamel. The front of each hood is open, as the exhaust is expected to, and does, keep the enamel from entering the room. In the center of the floor of each hood stands a rack, or holder, for holding the article firmly, yet allowing all parts of the surface to be reached by the spray.

The spray is applied from a reservoir holding about a quart of enamel and shaped like the usual gasoline torch. At the top is a nozzle fed by compressed air, which blows over the top of the reservoir and ejects the spray of enamel with sufficient force to make it adhere. It takes the workman but a short time to learn how much to put on so that the enamel will not crack or peel.

For large special pieces a long, high, shallow hood is provided, flat against a wall or partition.

The work is dried in a battery of ovens shown in the illustration. The pieces are taken out after an hour and hung on pegs in the air. For pieces which have to be assembled, enameled and rushed through in a hurry, special racks made of angle iron are provided, as shown at the right-hand end of the picture, where the piece is suspended by bent wire through holes.

Straightening Thin Hardened-Steel Gages

BY C. A. MACREADY

That metal can be straightened by peening it with a hammer is well known. It is not so well known, however, that this peening effect shows itself on hardened steel when ground in a surface grinder. The curling of thin work in the surface grinder is usually attributed to local heating of the surface in contact with the wheel. While this local heating may have some slight influence, and cause slight stretching and consequent distortion of the whole piece, the principal cause of distortion is the peening effect of the millions of abrasive grains striking the surface at high speed, and each one peening and stretching the surface by a very minute amount.

One may ask, How do you know that it is the peening and not the heat, when both conditions are concurrent? Take a piece of thin hardened steel, such as used for thickness gages, and grind it to say 0.005 to 0.010 in. thick. Such a strip when taken from the magnetic chuck is curled, but of even thickness throughout.

Now take an india oilstone pencil and stone the concave surface. The heat generated is so slight that its effect is negligible, but the piece of steel is curled by the stretching or peening of the concave surface. The stoning should be carried on till the piece is curled in the opposite direction, then turned over and stoned on the new concave side to bring it straight, thus straightening the piece and eliminating the curling caused by grinding. If carefully done the work is just as thick after stoning as before.

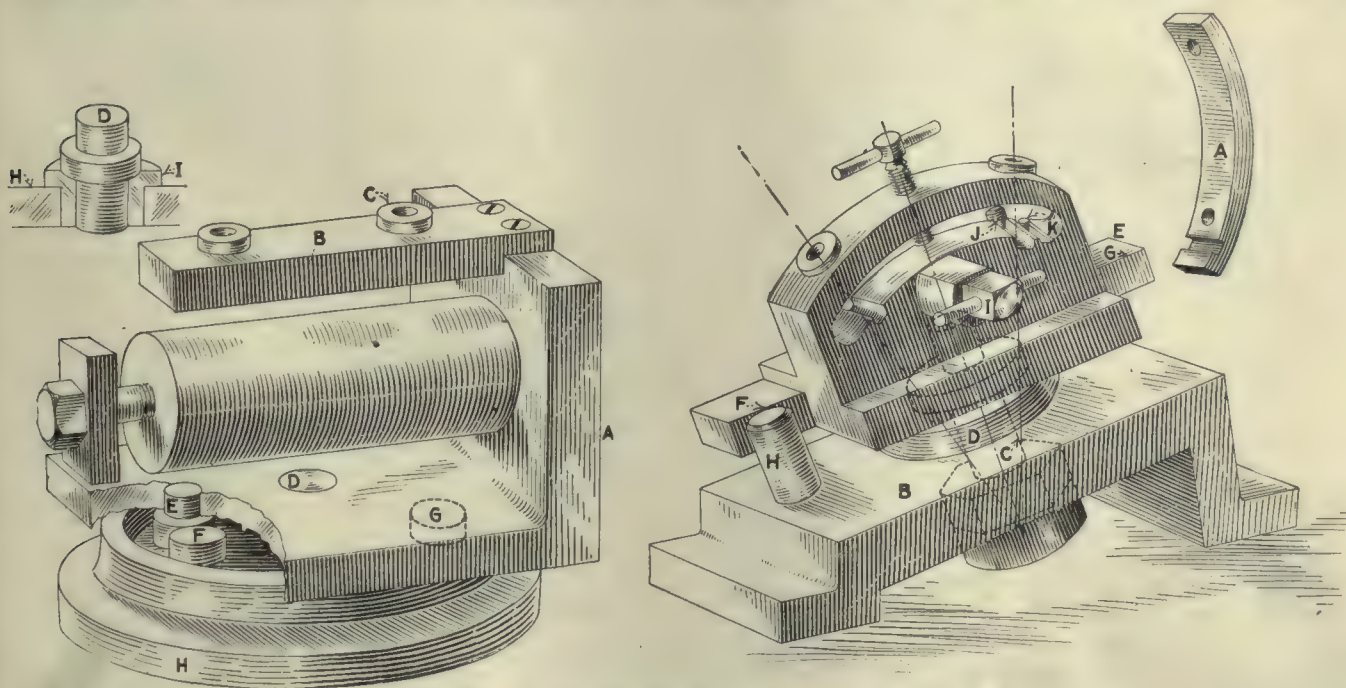
A piece of emery cloth wrapped round a piece of board was used in this way to peen the distortion out of a piece of tin 14 in. in diameter. It acted as if a million peening hammers were operating on the surface.

Letters from Practical Men

Properly Located Drill Jigs

Larger production, greater accuracy, reduced drill breakage, and a more even-tempered operator are some of the profitable results to be realized by clamping drill jigs to the drilling-machine table when practicable to do so, yet these facts are often overlooked. The majority of the jigs used for one hole only can be fastened in this way, often without change in design, yet we see small holes drilled in pieces that are difficult to line up quickly with the drill on account of the combined weight of the

pressed in the base *H*, and the plug *D* is pressed in *A* and is a turning fit in *I*. The base *H* may be clamped to the table by the projecting rim. As *A* is easily removable from the base *H*, other jigs of the same type may be used on the same base by making the pin *E* and the plug *D* uniform on all. In Fig. 2 is shown another type of indexing jig that may be clamped into position, this jig being used for drilling the strap *A*. The base plate *B*, as shown, has lugs on each end for clamping purposes. The hole *C* is at an angle from the vertical equal to one-half the angle included between the holes



FIGS. 1 AND 2. EXAMPLES OF SIMPLE INDEXING JIGS

work and the jig. The drill not being stiff enough to pull the jig into exact position, both drill and bushing are worn excessively, the hole is not drilled straight, and drill breakage is frequent. Many drilling machines of the sensitive type have no provision for clamping anything to the table. A false table with T-slots, tapped holes, or both, bolted to the machine table, will be found in many cases to be very inexpensive compared with the benefits derived from its use. A wide piece of cold-rolled steel with a few tapped holes for clamp screws, and attached to the machine table by C-clamps or pattern-makers' clamps, will often answer the purpose where the job is light and small production requires that expense be kept at a minimum.

Modifications of the type of jig shown in Fig. 1 may often be used where two small holes are to be drilled in a comparatively large piece. The jig illustrated consists of an angle plate *A*, and a strap *B* carrying bushings *C*, which are placed at equal distances on each side of the center plug *D*. The pin *E* in the angle *A* stops against pins *F* and *G* in the base *H*, thus bringing the bushings alternately into drilling position. The bushing *I* is

in the strap *A*. The center stud *D* is pressed into part *E* and is a turning fit in the hole *C*, end movement being taken up by the washer and nuts as shown. The surfaces *F* and *G* may alternately be brought against the pin *H*, thus bringing the bushings into drilling position. The screw *I* has a flat to permit the removal of the work. Pins *J* are stops, while the pin *K* locates in a slot in *A*.

For light drilling, these types of jigs will be found just as satisfactory as a lock-indexing jig, more rapid to handle and less expensive to make. The bushing heads may be ground so that the jig may be positioned exactly by an indicator.

LEROY M. CURRY.

Anderson, Ind.

Mouth-Annealing Cartridge Cases

One of the important operations in the manufacture of brass cartridge cases is the partial annealing of the mouth of the case before tapering.

The object is to anneal the part of the case to be tapered, so that the metal will be soft enough to compress

without wrinkling and yet be sufficiently hard so that the specified tensile strength is obtained after tapering.

A number of devices have been made for this operation, among which are a red hot chamber in which the case is held at a fixed depth and for a length of time determined by experiment, an arrangement of gas jets playing on the side of the case, which is slowly revolved, and variations of these.

A method which the writer has not seen described in the columns of the *American Machinist* is annealing by immersion in a molten mass.

The apparatus is simple, consisting of a common iron sink with a holding device for the cartridge cases, the whole

at a temperature of 750 deg. F. for 2 min. is satisfactory for use with a given set of tapering tools. Using a sink with 15 holders, one case is put on and removed every 8 sec. The cases are quenched by rolling into a tank of water. The cleaning has not been done in the quench tank, because the concentration of saltpeter increases rapidly from drippings carried over. C. R. BARTON.

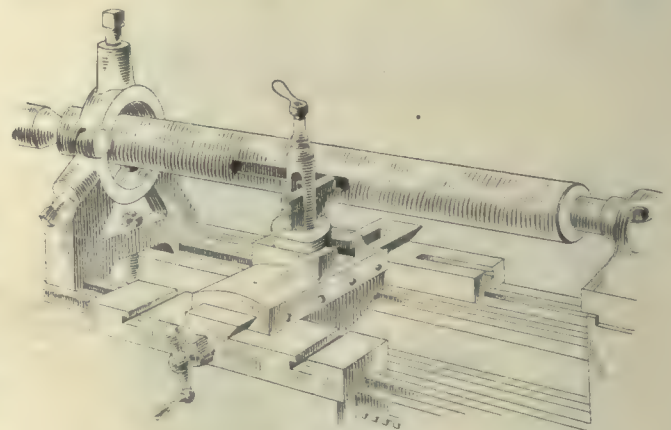
El Paso, Tex.

✽

Cutting Keyways in the Lathe

When cutting keyways in the lathe it is customary to center the shaft and then work the carriage back and forth by hand. This is slow and hard work. If the keyway is not to be the full length of the shaft, the following method can be used:

The shaft is placed between centers with the steadyrest clamped near the live-center end. The steadyrest guides should be carefully tightened, so that they clamp the shaft and prevent it from turning. The live center, however, should turn freely. A cutting tool is held on its side in the tool post; a follow rest should be clamped to the carriage at the rear of the cutting tool.



LATHE SET UP FOR CUTTING KEYWAYS

The tool should lead the follow rest. A hardwood block held in the rest in place of the metal guide will save the shaft from being cut.

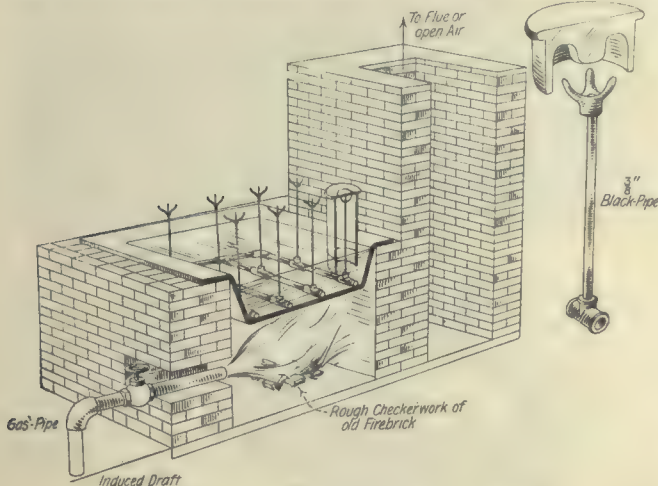
The lathe is started up and the carriage given quick feed, the cutting tool being fed into the cut by hand. The carriage should preferably be run back by hand with the tool out of the cut. If the lathe is small, then light cuts should be taken; otherwise the shaft may be forced up against the live center and cause binding. It is best to rough out the cut with a narrow rounded tool and then finish with a square-cornered one the full width of the required keyway.

H. H. PARKER.
Oakland, Calif.

✽

Fuse Plant in Japan

The Natsude Works in Osaka, Japan, were recently founded to make fuses for Russia. The shop is equipped with about 1,000 machine tools, with from 2,000 to 2,300 men. The entire works were completed and started to make fuses in three months after the order was signed. They have about 2,700,000 fuses on hand, the contract price being about 4.10 yen (about \$2) each.



THE MOUTH-ANNEALING OUTFIT

set in brickwork over a gas burner, as shown. The holder is made of 3/8-in. black pipe screwed together. The fork to hold the case is a three-fingered brass casting made for the purpose. It will be noted that one of the uprights is left blank, this because the joints usually leak and gas is formed inside the pipe, the gas being vented through the unused upright.

To secure a material for the liquid which is satisfactory in every respect has been difficult, and perhaps some of the readers may suggest something better than saltpeter, or commercial sodium nitrate, which has proved to be the most economical so far as it melts easily and does not volatilize appreciably within the range of temperature used, 700 to 850 deg. F. The main disadvantage is that it sticks to the case after quenching and must be removed before tapering. A dip in the sulphuric-acid pickle tub is sufficient, but the attendant rinsings, washings and dryings are troublesome and expensive. However, it has been found that a certain amount of cleaning is necessary on the case before tapering, in order to avoid the scratches that are so objectionable to the inspectors.

A pyrometer registers the temperature, which can easily be kept constant after work has started, and the number of cold cases dipped in the liquid per minute is constant.

The procedure is to remove and put on a case at such intervals that each one is properly annealed during the time all the others are being changed. By keeping one man on the job this interval can be judged accurately without a watch.

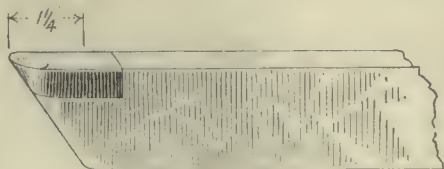
The Russian 3-in. cartridge case has a double taper. It has been found that an immersion of 3 1/2 in. in liquid

Discussion of Previous Question

Construction of Tip-Welded Cutting Tools

I read an article on page 300 of the *American Machinist* that told how to braze a piece of high-speed tool steel onto a piece of iron with an electric welding plant. Here is a method that may be employed by the small shop that does not possess an electric outfit:

The tool is made of common wrought iron $\frac{1}{2} \times 1\frac{1}{2}$ in., with a $\frac{1}{2}$ -in. square piece of high-speed tool steel brazed



THE BRAZED-TIP TOOL

into the gap cut on the end. The work is done by simply heating the iron and cutting out a gap large enough for the point. The steel is put on the bar of iron, which is laid in the fire with the steel side up.

A slow blast is used, and when the iron and steel are at about the heat required to forge the steel, the compound is put on top of the steel, and when it melts the work is taken out of the fire. As soon as the steel adheres, the tool is tempered under a blast. The compound used is a mixture of fine brass shavings and pulverized borax. There is no special rule for mixing.

Aldrich, Ala.

JOE GILLELAND.

✂

Standard Size Holes--Why?

I have read articles in the *American Machinist* lately that discussed the subject of standard size holes from many angles, but the man who uses cold-rolled shafts has not as yet testified.

The man who makes harvesters, haying machinery and kindred lines, as well as the makers of certain motor-car parts, uses cold-rolled or drawn shafting with no further finish on its outside diameters. He has no choice but to bore holes of varying sizes, which are used progressively on smaller holes until they become useless, or perhaps are staved out and reground to the original size if no use exists for them when smaller.

Poughkeepsie, N. Y.

H. W. JOHNSON.

✂

The Metric System

I have read with interest all the numerous articles for and against the metric system. There are two—one by Mr. Osborne, page 560, and the other by Mr. Dew, page 564—that I should like to answer.

Mr. Osborne's remarks in regard to the length of the meter in terms of the earth, and inches, are amusing; but they are beside the point, which is that a decimal system is fundamentally better than any other and that this particular system is now established in a number of countries. Further, a good many of our manufacturers

are already using the metric system in filling foreign orders, and I believe that it has become so much the international standard that no foreign buyer asks for any other.

I will agree that a 40-in. meter would be a little easier for us (only a little, however), but how about the poor unfortunates who happen to live in the countries where the meter originated and who do not know an inch from a furlong? By the way, can Mr. Osborne tell me offhand how many inches, or feet, in a furlong or in a rod? But even he can tell, without looking at a table, how many meters in a kilometer.

Can and will the editor kindly tell us some of the principal systems that the metric has superseded?

I hardly think that Mr. Osborne is justified in saying that it is a life's job to learn to think in terms of the metric system and handle it easily. I have never happened to run across it in any of my work in the shop; but when I was in college, some years ago now, I was required to use it altogether in the laboratory. I remember very distinctly that it did not take me long to become perfectly familiar with such of the dimensions as we used. It was certainly not over a month or so before I could think in centimeters as readily as in inches; that is, estimate the length of anything in centimeters or millimeters as readily as in inches and fractions—and without any translating of one into the other. This, be it understood, was not after using it all the time in everything, but only in the laboratory three afternoons a week.

Of course, as I have not used the system since then, I have forgotten what I learned. I am very sure, however, that if I were to begin to use it for all my work, that it would not take me two weeks to be able to think, as you might say, fluently in the metrics; that is, estimate distances in centimeters or millimeters without going through any translating. As I do not consider myself any different from the majority in this respect, I think that this difficulty of making the change is very much overestimated.

In regard to Mr. Dew's questions also, I think the trouble is not nearly so great as people think it will be. He mentions pipe, for instance, and asks if the sizes will have to be changed, necessitating changing all the tools, or if the names only will be changed to odd decimals of the metric table. I say neither.

Pipe, it strikes me, is more easily changed than almost anything else; it is so rough. It is sold in sizes that by courtesy are said to vary by even fractions, $\frac{1}{8}$, $\frac{1}{4}$, $\frac{3}{8}$, etc. But is by courtesy only that it is called by these sizes, for as a matter of fact it is so rough and uneven that it is impossible to measure an ordinary piece of pipe closer than $\frac{1}{16}$. Now $\frac{1}{8}$ in. = 3.2 mm.; and as 0.3 mm. is a much smaller variation than can be seen, all that will be necessary to change our system to metric is simply to change the names of sizes to the nearest even millimeter, thus:

$\frac{1}{8}$ in. = 3 mm.
 $\frac{1}{4}$ in. = 6 mm.
 $\frac{3}{8}$ in. = 9 mm.

$\frac{1}{2}$ in. = 13 mm.
 $\frac{5}{8}$ in. = 16 mm.
 $\frac{3}{4}$ in. = 19 mm.

$\frac{7}{8}$ in. = 22 mm.
1 in. = 25 mm.

All pipe, fittings and tools could remain exactly as they are. The change could be made in the same way with rough bar iron and steel, and rough bolts.

I do not know what the standard sizes are abroad (perhaps the editor will enlighten us), but I take it for granted that the above will not agree with them. I cannot see that this will make any difference. The manufacturers who get foreign orders have to make the foreign standards anyway. Even if we come to the foreign standard eventually, my suggestion will make the change more gradual and easier. Of course, the selling prices will have to be changed to so much per meter and per kilogram.

Cold-rolled and drawn bar stock and shafting will have to be changed to even metric sizes, as will also cap-screws, fractional-sized smooth rod, drills and reamers, taps and dies. These items will be most troublesome.

All the various thickness gages (including tin plate), numbered and lettered screws and drills, wire, rod, etc., will be unchanged, unless by some good fortune some of the various gages might be lost altogether in the shuffle. All that would be required would be new tables giving the sizes in metric terms.

The more I read—both sides—and think of the matter the less fear I have of the trouble to be caused by the change. The advantages of a decimal system are so great as to be worth, I think, much more effort than it will take to get it.

W. B. GREENLEAF.

Plymouth, Mich.

[The metric system is *not* established to the exclusion of all others in any country that we know. In Germany the inch (*Zoll*) is still largely used, and in France the inch (*pouce*) is also extensively used. "The Metric Fallacy," will give Mr. Greenleaf a lot of information on the different standards used in so-called metric countries.—Editor.]

✽

Does Technical Writing Pay?

Assuming that Mr. Jacobs' interesting article on page 544 was meant to encourage occasional contributors by giving them an inside look at the writing business, I doubt if he has reached his goal. The assertion that one should acquire the knack of writing without rewriting, is not encouraging by any means. Moreover, the suggestion is not a logical one. I was born and brought up in the quaint fisher village of Volendam (Holland), which for years has been the gathering place of the world's most eminent painters, authors and composers, America's included. I had free access to their ateliers and never noticed that any of these men would attempt to produce anything worth while without first making a preliminary lay-out. The very difficulty of a task furnishes the greater part of the pleasure of successfully working at it to a finish, and there is not the slightest reason for a struggling contributor to refrain because he has to rewrite his thoughts a few times.

Though I am hampered by a substantial lack of English, and jump through my treasure of words like a fellow from stone to stone while crossing a creek, still it has paid me from the very beginning to work for the Hill publications, notwithstanding the fact that the editor once in a while returns my short articles. In such a case a man should not accuse the editor, but show some common-

sense in finding out his own faults and try to discover the sore spot himself. One cannot expect a busy editor to run an educational department as a side line.

Besides editor's checks, many other advantages are to be derived by writing. In the gathering of information one comes in contact with many people and the interest shown is rewarded with friendliness. One becomes wide awake to the small things, and the owner-writer of a small shop will see his plant improve by leaps and bounds. The employee-writer increases his value to his employer. A sufficient amount of data on hand to write short articles, when out of a position for a month, has proved to me to be much better than an offer of a new position.

In my opinion a beginner should write for the publications of one house only, and these should be the best on the market.

JAN SPAANDER.

Brooklyn, N. Y.

✽

Efficiency in the Pattern Shop

In the *American Machinist*, Vol. 44, p. 956, John J. Eyre, in his article, writes: "Too often the foreman of the pattern shop thinks that he knows the best way to mold patterns and make up some complicated work without talking the matter over with the foundry foreman."

Very true, but let us put it in another way: Too often the foreman of the pattern shop *does* know the best way to make the pattern, because *he has already talked the matter over with the foundry foreman*, but in a great many instances this information is not conveyed to the pattern maker who makes the pattern, until the pattern is completed and handed over to the foreman pattern maker for inspection.

There is nothing that will aid, encourage and put confidence into a pattern maker, when he is given a pattern to make, like a short talk and exchange of ideas with the foreman pattern maker.

There is a right way and there is a wrong way, so we are told. This rule does not apply to the making of patterns. If there is a standard right way to be followed in the construction of a pattern, I do not know of any such rule. If, however, a standard way could be applied in the construction of patterns, it would benefit both the pattern maker and the molder. "Standard pattern construction" might be thought out, but I never expect to see it.

Speaking about talking the matter over with the foundry foreman, let me relate an experience. I made a set of master patterns for a patented hardware article cast in malleable iron. When the patterns were finished and delivered to the owner, I suggested to him that he have the gated metal patterns made at the foundry where he intended having his stock malleable castings made. This he did not do.

He thought that the proper place to have these patterns made was in a general jobbing shop where metal-pattern making was a specialty. It was in one of these shops that he had the work done at a cost to him of \$208.

Upon delivery of these patterns at the malleable foundry the foundry foreman was called to talk the matter over and learn if they were made to answer the foundry requirements and were practicable for molding.

When the foundry foreman had finished his inspection of the patterns, he decided that they were well made, but a few changes would be necessary to make them

conform to the foundry requirements. There was no way out of it, so the owner of the patterns agreed to have the changes made in the foundry's own pattern shop.

Note the practical way in which the information was conveyed to the pattern department. The foreman of the pattern shop was not called into the office to consult with the foreman of the foundry regarding the changes that were to be made, but the patterns were taken to the bench of the workman who was going to make the changes. Here the matter was talked over, not only with the foundry foreman, but with the workman as well.

Right there and then confidence was instilled into the workman. He was given a right start; he was positive; he did no guessing as to what was wanted or how the work should be done; he was present when the foreman pattern maker talked the matter over with the foundry foreman. The job was done and finished in a way that was satisfactory to all except the owner of the patterns, who was presented with a bill for \$46.50 for correcting the patterns.

The foreman pattern maker is at liberty to visit in the drawing room when he desires. There he can talk the matter over with the draftsman and keep posted on every detail as the work progresses. The same is true regarding the foundry, but what about the fellow who is going to make the pattern? Does he derive any benefit from the foreman of the pattern shop who has talked the matter over with the foundry foreman?

Kenosha, Wis.

M. E. DUGGAN.

✱

To Prevent Wheel Loading When Grinding Aluminum

The practice of using grease or oil to prevent wheel loading while grinding aluminum, as suggested by E. J. Hansen on page 646, *American Machinist*, gives excellent results. To apply the oil effectively to a vitrified wheel, it is necessary to soak the wheel over night in a tub containing just enough oil to submerge it. When the soaked wheel is first run, it will throw off a regular shower of oil. After the superfluous oil has come off, the remainder will usually keep the wheel in working condition for a full working day.

Another simple method that gives equally good results is to provide the countershaft with a reverse belt. After the wheel is loaded with aluminum particles, it should be run in the other direction. This necessitates a work rest at the back as well as one at the front of the wheel. When using this method it is necessary to provide an extra jam nut on the wheel spindle. Otherwise, the reversal is liable to loosen the nut.

Any old wheel picked up at random will not successfully grind aluminum. Coarse wheels, 16 to 24 grit, in medium hard grades give the best results. The bond also has much to do with the successful working of the wheel. The open vitrified bond, while excellent for steel, is too porous for aluminum, and shellac or elastic bond will be found to give better results. These latter wheels are comparatively expensive when first cost only is considered; but in the long run they are the most economical, as they cut fast and do not load over readily.

Some grinding-wheel manufacturers who have made a special study of the requirements for successful aluminum grinding have developed wheels solely for this purpose. The exact composition of these wheels is somewhat of a

trade secret. They are comparatively heavy, and notwithstanding the fact that they are made with shellac bond—the strongest known bond—it is a very good plan to use safety flanges with them to guard against possible accidents.

F. B. JACOBS.

Indianapolis, Ind.

✱

The Factory Inspector

Your editorial on page 609 calls to mind an experience of the writer, somewhat more amusing and less exasperating than the case you cited. I had planned and supervised the installation of considerable electrical apparatus, including a generator and several motors, in a factory in one of our large cities, and the official factory inspector arrived to approve or condemn the work.

I went over the ground with him, and his only comments were "Very good" and "That's all right," until it seemed to occur to him that he should be more critical to prove that he was "on the job." He pointed to some wires that were far above his head, and the following conversation ensued:

"I am afraid those wires are too small."

"They are the proper size, according to the rules."

"What size are those wires?"

"They are No. 6, B. & S. gage."

"Well, they may be No. 6, but they don't look to me to be any larger than No. 4."

Without commenting on the relative sizes of No. 6 and No. 4, I assured him that they were No. 6, and he left, apparently satisfied both with himself and with the installation that he had inspected.

The requirements for inspectors who are supposed to safeguard the interests of the general public should certainly include more technical knowledge and common-sense, if not less political pull.

FRED B. COREY.

Barberton, Ohio.

✱

Spring-Operated Reaming Jig

I am prompted to write a comment on the spring-operated reaming jig shown on page 455, because it is scarcely a month since I crushed the end of one finger in a jig of this type. The danger point is where the bushing plate lets down and rests upon the jig frame columns. The man who introduced this style of jig into a factory manufacturing agricultural implements is now having tubular guards put on the lower side of the bushing plate in such a way as to cover the gap when the jig is opened. Any doubt as to the value of this improvement can be instantly dispelled by allowing one of these jigs to close down on your finger.

H. W. JOHNSON.

Poughkeepsie, N. Y.

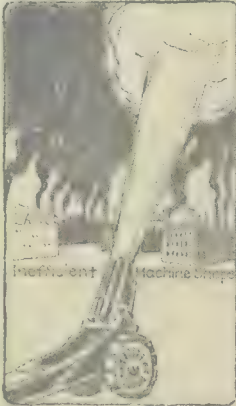
✱

Questions of Lathe Design

On page 692, J. H. Davis, referring to American lathes, asks why the handwheel of the carriage is on the left-hand side of the apron. It seems to me that caliper work with the left hand and operating the handwheel with the right hand, or operating the handwheel and crossfeed simultaneously, would be rather inconvenient, should the handwheel be on the right-hand side of the apron.

GEORGE F. KUHNE.

Rutherford, N. J.



*Anihilate the
Feeling of
Self-sufficiency*



*Barren Earth is
Made Prolific
by Dynamite*



**OUT
OF
THE
ASHES..**



*American Manu-
facturers are
Going to School Again*



*A Successful
Lawyer Must Burn
Midnight Oil*

Editorials

Out of the Ashes

On the opposite page is a picture of what one might be tempted to call complete destruction. Heavy projectiles have smashed their way through the walls of this French shop, leaving havoc behind them. Fire has followed and completed the little needed to perfect a total loss. One who says, however, that this French shop has been annihilated would be speaking rashly. It has been obliterated, but not annihilated. Within the ashes and twisted bits of iron and steel that represent what is left of a once-busy machine shop, there remains a germ of life from which will spring a more impressive edifice. The physical destruction of a shop is one of the least dreadful things that can happen to it. Dry rot is much more common and invariably fatal. Shops that decay have no hope of resurrection.

It is safe to say that the wholesale destruction of machine shops in Europe will prove to be a powerful vitalizing influence in the coming industrial period. When these shops rebuild—and ninety-nine out of a hundred will—it will be with new buildings and new equipment. There will be no hesitation to cast aside a machine which is a back number, but which is kept simply because a few more years of service can be coaxed from it. The precedents that have lived with these machines are gone, as are the old-time records in the fire-devastated office. Such a shop has been refined by fire; and when its activities recommence, it will have a vitality such as can only accompany a resurrection from the ashes.

The American shop manager has always considered himself progressive and indeed has been so considered by others. When one is in the self-complacent frame of mind accompanying such reflections, he is usually on slippery footing. As a matter of fact the American manufacturer needs a stimulus. The will power, soothed by habit and by fixed routine, is lulled to sleep. Human nature needs a sudden shock to jar it out of its rut. Are the advisable improvements in your plant neglected by reason of your not perceiving them or because it is easier for you to postpone them? The latter tendency is the first symptom of dry rot.

When a man is not really a "dead one," the results of shock are decidedly effective. The down-and-out club is naturally larger in membership than the come-back club, but the latter usually draws its membership from the former and does not as a rule give them back. One result of a moral or physical upheaval is the complete forgetting of past limitations. Reconstruction is not gaged by the remembrance of former accomplishments, nor limited by the thought of past failures. San Francisco benefited by its earthquake. The time to come back is before you are down and out.

As a matter of preparedness some American shops would do well to build 42-centimeter guns. Not to be used as weapons of warfare these, but to blow up the plants that built them—to reduce them to a state similar to that of the French machine shop here pictured—to burn up the records of the past and to annihilate the feeling of self-sufficiency with which they are permeated. No more paying investment could be had by many shops than one that would necessitate their complete rebuilding and also furnish the stimulus for it. But unfortunately those very shops that need it most cannot be induced to spend enough to buy the powder with which to blow them up! Barren earth is made prolific by dynamite.

One can feel the evidence of an unseen stimulus at work among the live shop managers and business executives in America. In the past two years American manufacturers have begun to go to school again. It is evidenced in their eager search for information about other countries, other industries and the other fellow's business. It is evidenced in the apparent and increasing desire to keep posted on the last word in shop equipment and to find better ways of doing things.

A successful lawyer must burn midnight oil and become familiar with the ins and outs of half a dozen trades and professions that touch upon the circle of his daily work. He finds it necessary to know something about medicine, manufacturing, merchandising and many kindred arts, in order that he may sell his commodity—service—to those outside of his own profession. In this respect he may be held up as an example worth studying by the shop executive. The old-style manager who knows his own business and little else outside of it will soon be as obsolete as the dodo, with the adverse distinction that no museum will consider it worth while to stuff his remains.

The man who solves the other fellow's problem gets the other fellow's business. That is the way the builders of electric motors developed their great industry. That is the way the manufacturers of motor trucks, now that the saturation point with regard to pleasure vehicles is said to be in sight, are planning to enlarge their outputs. That is the way that the chemical industries in Germany made themselves so necessary to manufacturers in this country, and the fact that we over here have not fully realized this principle accounts for our sudden and unpleasant awakening when many of these chemical supplies were cut off.

Let us return to the electric motor a moment. Not only is it a typical machine-shop product, but it is also a fine example of the result of solving the other fellow's problems. There was nothing about the electric motor in its early days to make it an easy-selling article. On the contrary, there were many things about it which placed obstacles in the way of its use: It was unknown, untried; it was considered dangerous, and worst of all, using it necessitated an expensive electrical installation.

The man who owned a textile machine or a laundry machine or in fact any other kind of machine found no fault in particular with the then-in-vogue belt drive. He did not come to the motor manufacturer, hat in hand, and beg him to develop a motor suitable for his machines. It was the other way about. The motor manufacturer burnt midnight oil, studying the problems of these men in other fields. He sent his experts to learn the other fellow's business, realizing that the productive basis of sales is helpful suggestion. The whole business of selling electrical machinery is based on the word *service*.

✱

Yes, the American shop executive and the American business executive must go to school again if they are to keep up with the progress that will arise from the European stimulus of war. They must study the other fellow's problems, not only in foreign countries, but also at home, for the home market is often overlooked in the glamour of the fascinating foreign market, in spite of the pot of gold being more often found near home than at the foot of the rainbow. The other fellow's problems might be next door to you. Many of them can be dug out week by week from the pages of the *American Machinist*.

✱

Progressive machine-tool builders have, for a number of years, typified the art of solving the other fellow's problems. They have demonstrated beyond a doubt the possibility of generalizing distribution while specializing the product. They have widened the field of each type of machine tool while restricting each one more closely to type. Special attachments and modifications that depart from the standard are to be regarded with disfavor. It requires less brains to change a machine to do work the other fellow's way than to change the other fellow's way of doing work. Combining unlike functions in design have met with small success. Even the small-shop man who has need for but one tool of a kind, wants each one to stand on its own legs. Hybrids are more interesting than useful. Lathe and planer marriages are usually childless.

✱

Two things are necessary if you wish to be a specializing generalist. The first is a clear knowledge of the possibilities and limitations of your machine; the second, a knowledge of what your potential customer is trying to accomplish. When you walk through his shop, primed with a knowledge of what your machine is best fitted to do, and seeing what he aims to do, the places that your product can best fill become at once visible. They become apparent to you as vacant areas even though they may be crowded with machines. And seeing these vacant spaces you can make him see them too. For knowledge is power. Anyone can see the star after the astronomer has pointed it out.

✱

The future executive will not permit the existence of a state of uncertainty as to whether or not his product can find a place in the other fellow's business. And in order to know he must have under control a knowledge of the other fellow's problems. The future executive must be a cosmopolitan—not a provincial. He must travel and visit the plants of his competitors, not with a view to underselling and undermining, but with a fixed purpose of up-

building and serving. Heretofore, his journeys have been to see what he needs of the other fellow—now they must be to see what the other fellow needs of him. It is addition and not subtraction that makes the big sum total.

✱

And there are a number of industries outside of your own, Mr. Machinery Builder, to which you are or can be tributary. What do you know about the paper-pulp industry or the textile industry or the marble and stone-working business or the production of cement or of bakery products? What do you know about the mechanical needs of the lumber industry—the largest single industry in America? You who are expert at lifting the burden from human shoulders and placing it on wheels, who make machines to do the work of men—are there not problems to be solved in these great industries that offer opportunity for both your brains and your product? Problems, perhaps, that are unknown to those most familiar with the industry, but who are without your knowledge of mechanical applications.

✱

This is an age of specialists, but it is also an age of generalists. Specialization must apply to the product, which for profit must be restricted to a rather small variety and have a large output. Knowledge of how to make this product must be broad, and broader still the knowledge of how to apply the product. A man who knows all there is to know about one simple mechanism is a rare and valuable man. But without the knowledge of where and how the other man can use this mechanism in his business such knowledge is, in its present-day industrial value, on a par with that of the coin collector or antiquarian. Perhaps in the past the public made a beaten path to the door of the chap who made a better mouse trap—that was before competition became so severe in the mouse-trap business. Nowadays it is not enough to make the trap—you must go out and find the mouse also.

✱

The large manufacturing plants and some small ones have for a number of years placed young men, often graduates of technical schools, in their shops for a period of training, recruiting the more promising of these for sales and engineering vacancies. Nine or ten hours a day of perspiration and grimy contact with the materialistic, rounds the corners left sharp by college professors and textbooks and gives these young men an insight into the details of things and makes of them valuable executive material.

The special apprentice of the future, after having absorbed the elements of machinery building at first hand, will be sent to study the other fellow's problem in the same intimate way. Given an organization in which are a dozen or more of capable young men, each trained to a knowledge of the parent industry and one *other*, you have a combination hard to beat—one that will solve the other fellow's problems and get the other fellow's business.

✱

Get to work on the other fellow's problems, specialize in production and generalize in distribution, and out of the past, as from the ashes of a war-wrecked shop, will arise the winged success that will bear your product to the earth's four corners.

Shop Equipment News

Backing-Off Machine To Give Relief to Formed Cutters

The machine shown was designed to give straight or periphery, side and end relief for all work within its capacity. It is a recent product of the Becker Milling Machine Co., Hyde Park, Mass.

The construction is of the box type with special ways. The alignment of the tailstock is maintained by two T-

to the camshaft. A micrometer stop is attached to the relief slide to give accurate resetting of the tool at the change of work. The peripheral relief and the side relief are obtained by the same cam. End relief is obtained by a separate cam at the end of the bed. The tailstock is made to take either collar bearing or center bearing, whichever is better suited to the nature of the work—that is, collar bearing for a heavy cut on a long arbor to insure rigidity by supporting the arbor near the work, and center bearing in cases where short arbors are used on small work.

In giving hobs a clearance the cam may be thrown out in reversing. The gearing for cutting hobs and worms is easily detached when not in use.

The tool-holder block is made to hold tools from $\frac{1}{4}$ to 1 in. in thickness. The holder block is set on a 30-deg. slide plate and operated by a handwheel at that side to raise or lower the tool to the required adjustment. The tool is fed to the work by a differential handwheel, giving accurate control, using the differential for fine feed and throwing it out to give direct quick adjustment.

■

Rotary Oil Pumps

The rotary oil pumps shown were designed to be especially adapted for pumping compounds and oils to metal-working machines. Two styles are made: One operates in either direction, thereby making it particularly suitable for screw machines and automatic machines that reverse; the other operates in only one direction, for application to machine tools in general.

The pumps are designed to produce an even flow and a steady power demand on the driver. The foot is made in two styles and can be swiveled about the pump to 360 deg., by which adjustment it is possible to locate the pumps on almost any form of machine tool. Each style is made in two sizes.

Both styles are equipped with a relief valve and bypass built in the cover. This feature is planned to permit the operator to control the amount of oil or cutting compound and also to protect the pump against any

BACKING-OFF MACHINE FOR RELIEVING CUTTERS

Capacity, cutters up to 13 in. in diameter; flutes, 3 to 12 in. inclusive; even number of flutes, 12 to 40 inclusive; maximum adjustment of tailstock, 24 in.; maximum longitudinal adjustment of carriage, 12 in.; pulley diameter, 14 in.; 4-in. belt; motor drive, 3-hp. motor; weight, 6,500 lb.; floor space, 67x47x64 in.

slots at the back of the bed. The tailstock is locked in any desired position by four clamping bolts.

The spindle is crucible steel, $3\frac{3}{4}$ in. in largest diameter. It is driven through a spur gear mounted directly on the spindle. The spindle bearings are solid phosphor bronze provided with means of compensation for wear. The taper hole in the spindle is No. 13 B. & S., and the spindle is bored to accommodate a $\frac{3}{4}$ -in. draw bolt. A clutch drive is provided to insure positive rotation of the tool to be relieved.

The drive is arranged for a single pulley with provision for three speed changes through a set of spur gears. A single-throw cam at the back of the machine gives from 0 to $\frac{1}{4}$ -in. relief. Wear on the cam rolls is taken up by a tapered gib.

The cutter to be relieved can be placed in proper relation to the forming tool without loosening bolts or nuts by operating a worm meshing with a wheel secured

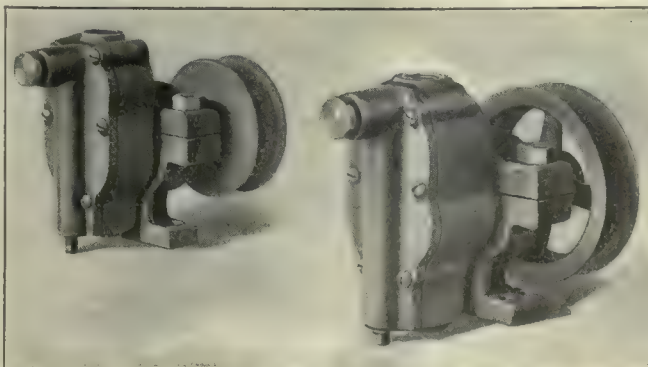


FIG. 1. REVERSING ROTARY OIL PUMPS

Capacities, $\frac{3}{4}$ to $1\frac{1}{2}$ and 2 to 5 gal. per min.; lift and force, 25 ft.; weights, 14 and 16 lb. Capacities of single direction, $1\frac{1}{2}$ to 4 and 4 to 10 gal. per min.; lift and force, 50 ft.; weights, 10 and 19 $\frac{1}{2}$ lb.

excess pressures that might be developed owing to the closing of the oil pipe or valve. The principal mechanism constitutes a pair of cams that run together in a tight case. The cams are especially designed for pump duty

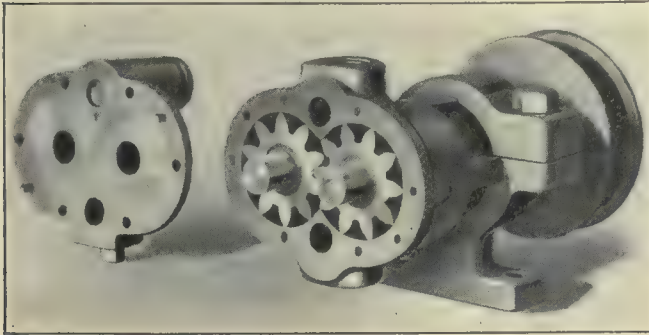
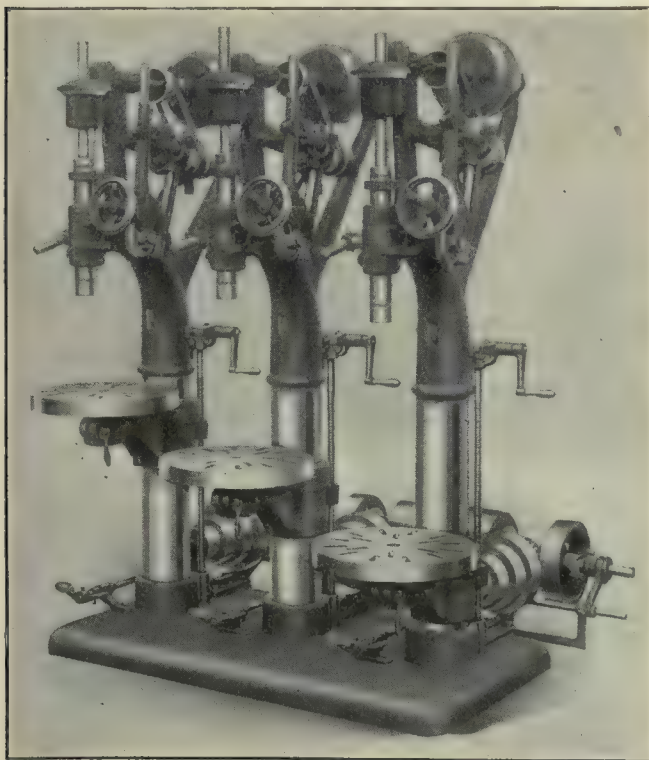


FIG. 2. CONSTRUCTION OF ROTARY OIL PUMPS

and are generated on a shaper to secure a rolling contact. The two forms shown are recent additions to the line made by the Goulds Manufacturing Co., Seneca Falls, N. Y.

Gang Drilling Machine

The illustration represents a line of 20-in. swing gang drilling machines recently developed by the Silver Manufacturing Co., Salem, Ohio. The machines are made in four styles, with plain lever feed, lever and wheel feed, power feed and automatic stop, and back gearing, and



SWING GANG DRILLING MACHINE

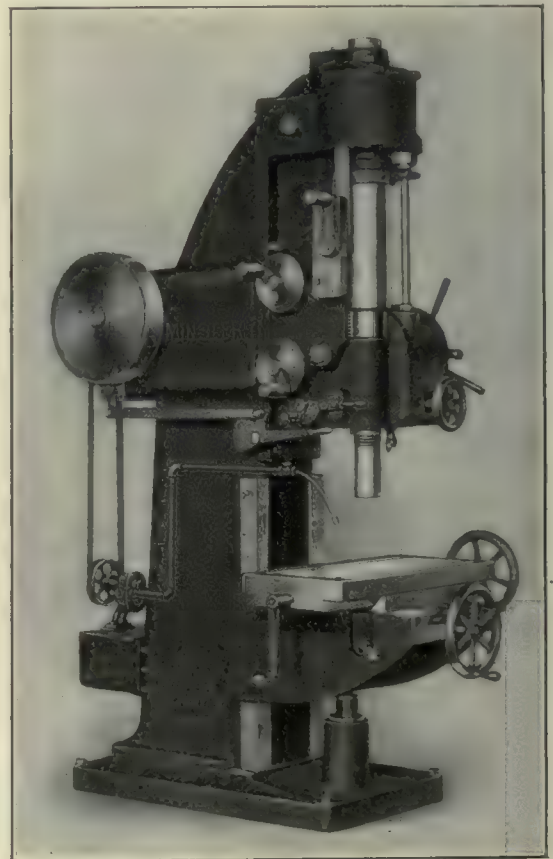
Height, 68 1/4 in.; diameter of column, 5 1/2 in.; diameter of round table, 16 in.; diameter of square table, 16 1/2 x 16 1/2 in.; diameter of square-table planed surface, 13 1/4 x 13 1/4 in.; diameter of spindle, 1 3/8 in.; vertical travel of spindle, 10 in.; vertical travel of table, 16 in.; distance from column to center of table, 10 1/4 in.; distance from spindle to base, 41 1/2 in.; distance from spindle to table, 26 5/8 in.; distance between spindles center to center, 18 in.; diameter of large pulley on cone, 9 1/4 in.; diameter of small pulley on cone, 4 in.; belt, 2 in.; floor space, including countershaft, two-spindle, 41 1/2 x 42 1/2 in.; floor space, including countershaft, three-spindle, 41 1/2 x 60 in.; floor space, including countershaft, four-spindle, 41 1/2 x 78 in.; countershaft drive pulley, 10 x 6 in.

are also available in two, three or four gangs made in any combination desired.

The countershaft is made for two, three or four drills. It has but one drive pulley placed in the center of the shaft, which is designed not only to save floor space, but also to effect economical belting costs. Each spindle is independent of the others, so that each may be operated individually or all simultaneously. Each gang includes one friction tapping attachment, as shown at the left. The spindles have individual tables, adjustable up and down or to either side, thus permitting a wide range of work to be accommodated. The tables are made in either round or square form.

Vertical Drilling Machine

The drive of the high-duty vertical drilling machine shown is through a large single pulley running at a constant speed and thence through high-carbon steel shafting and heat-treated stub-tooth transmission gearing to the main spindle. A simple gear box is provided wherein six initial speed changes are obtained through sliding gears.



VERTICAL DRILLING MACHINE

High-speed drill in solid steel, 2 1/2 in.; center of spindle to face of column, 14 in.; end of spindle to plain table, 35 in.; end of spindle to base, 50 in.; size finished surface (plain table), 20 x 26 in.; vertical adjustment of table, 18 in.; driving pulley, 20 x 3 1/2 in.; compound table size over all, 17 x 38 in.; net weight, 5,300 lb.

Ball bearings are provided throughout the transmission gear box. The transmission gears revolve in flooded lubrication, which is circulated over the gears by a gravity-feed system of oiling.

The two cranks engaging the holes in the dials seen at the left side of the head obtain the six changes of speed. The crank seen above these, nearer the front, engages the direct drive and back gears. By this construction all the

high speeds are obtained through a smaller gear on the spindle sleeve, thus obviating the high tooth velocities. There are no gears having a tooth velocity of over 800 ft. per min., and this arrangement is designed to insure not only durability but quiet running.

The lever below the speed dials operates an expanding band friction inside the gear box, which runs in oil. The up-and-down movement of this lever controls the direction of rotation of the drill spindle and forms a convenient braking device as well as a tapping attachment. An opening in the gear box, over which is secured an oil-tight cover, supplies a ready means of adjusting the driving frictions.

The machine is supplied with either the rear drive or the side drive, and either style of drive may be applied readily even after installation. The upper plate at the rear of the main housing is removed, thus making room for a flanged bearing carrying the side drive pulley mounted on annular ball bearings. The entire transmission gear box, including rear or side drive arrangement, tapping attachment and the six initial gear changes, is contained within a single transmission casing, the rear end of which flanges to the back of the main housing, and the forward end pilots directly into the main head casting. In the main spindle drive a large cylindrical sleeve is driven direct by the gearing, and this sleeve has wide and deep key-seats diametrically opposite which engage the two hardened driving keys, mounted into the driving head, keyed rigidly to the main spindle, but of course arranged to move up and down within the sleeve. This arrangement is designed to overcome all trouble occasioned by the binding of the spindle when sliding under extreme pressure and is also invaluable when heavy tapping is done. The spindle is provided with a ball thrust bearing. The feed is imparted to the spindle by the vertical shaft at the front, and this shaft is arranged to be driven at various speeds by the changing of the gearing, mounted upon a swinging quadrant at the upper end of the spindle sleeve. It is only necessary to change this gearing to suit the feed to some special lead that occasion may require, and 12 regular feeds are provided to take care of all reaming and drilling needs. The steel stub-tooth feed gearing is contained within the feed box, cast integral with the head at the right of the spindle. The feed gearing is of the sliding-gear type, no pull pins being used at any point.

The 12 changes of feed are transmitted to a large worm-wheel keyed to the pilot shaft, upon which is cut a coarse wide-face pinion engaging the wide feed rack cross-keyed to the spindle sleeve. The small levers are used for obtaining the speed changes, and a suitable index plate designates the proper position of all the levers both for feeds and speeds. An automatic knockout for the feed gives a positive and accurate depth gage for drilling, and a safety stop prevents the spindle from feeding beyond its proper traverse. Pilot handles are provided for quickly traversing the spindle.

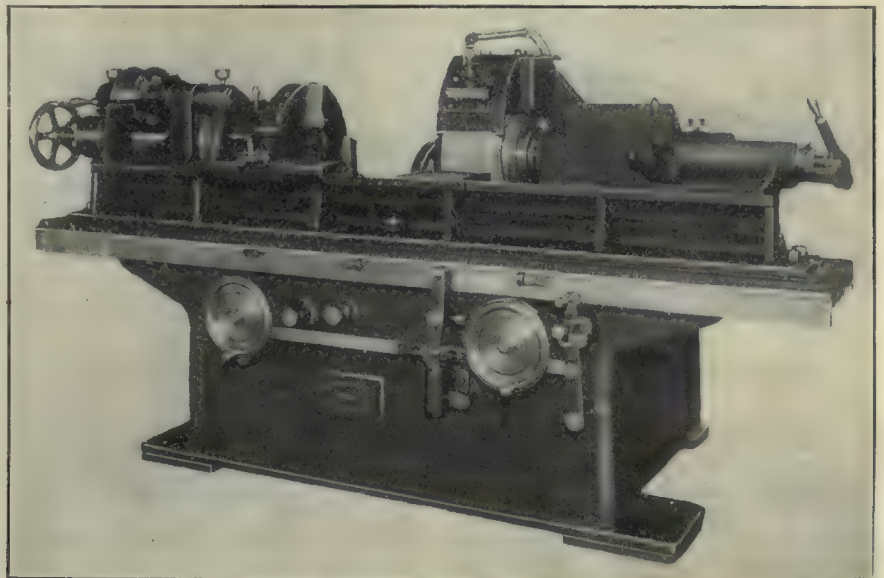
The plain table is provided with an oil groove and is reinforced to permit a 3-in. boring bar to pass entirely through it. Telescopic screws are used to give the table vertical adjustment. The compound table is of heavy construction. The cross-saddle has a tongued taper gib adjusted from the front. All adjustments are made by accurately cut screws engaging bronze nuts, the screws being provided with micrometer collars and large handwheels.

The machine is a recent development of the Minster Machine Co., Minster, Ohio.

■

Combination Traverse and Form Grinder

The illustration shows a combination traverse and form grinder recently placed on the market by the Ford-Smith Machine Co., Ltd., of Hamilton, Canada. While this machine is designed for standard cylindrical work, the headstock is so arranged that special shapes can



TRAVERSE AND FORM GRINDER

Capacity, 18 in. in diameter, 5 ft. long; wheels, 22-in. diam., 8-in. width; 20 hp required for form grinding, 10 to 15 hp. for traverse grinding; floor space, 6x15 ft.; weight, 14,000 lb.

be ground. The machine has proved successful in grinding formed punches used in the manufacture of shrapnel and high-explosive shell forgings. These punches range from 3 to 6 in. in diameter, and in length up to 5 ft. Used punches can be re-dressed and kept in repair without annealing.

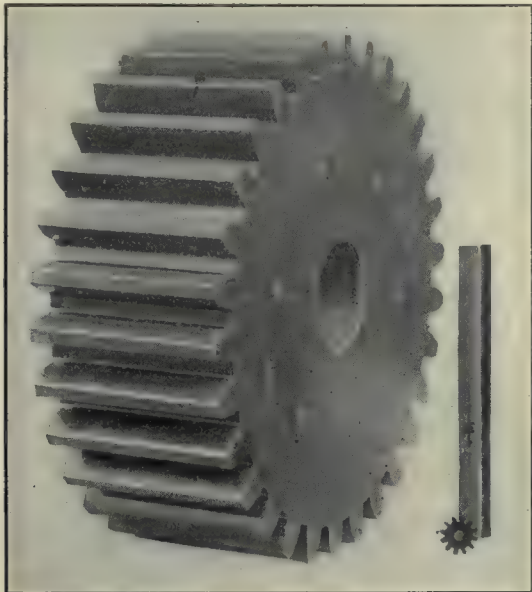
Work is held by means of a universal chuck, in combination with a special interior centering arrangement within the hollow spindle. Numerous changes of speeds and feeds are provided, all levers being situated at the front of the machine within easy reach of the operator in working position.

A special wheel-truing device is attached to the machine table. Water is supplied to the wheel by a pump of ample capacity. The wheel hood is convenient in use and permits the ready changing of wheels. The drive is self-contained, and the machine may be direct connected to a motor or lineshaft, as required. Adjustment for taper grinding is provided. This is graduated to read in degrees.

Large Noiseless Pinion

While the pinion illustrated may possibly not be the largest one of the noiseless type ever produced, it is certainly large enough to be of interest from the size viewpoint.

As shown by the comparison with the foot rule at the right, this pinion is 21 in. in diameter and has an 8-in.



A LARGE BAKELITE-MICARTA PINION

face. It is designed to transmit 100 hp. at 425 r.p.m. and is made out of Bakelite-Micarta. As will be noticed, no metal shroud is necessary.

Edward Thomas Hendee

Edward Thomas Hendee, whose rise to the important position of secretary of Joseph T. Ryerson & Son distinguished him as one of the most successful men of the younger set in the steel and machinery trade, died suddenly on Nov. 12 in Minneapolis, Minn., while on a business trip. Mr. Hendee's charm of personality, business enthusiasm and capacity for executive work gained for him wide recognition.

Mr. Hendee was born February 22, 1880, at Claremont, N. H. He graduated from the New York University in 1900 with the degree of B. S. and received the degree of Sc. D. at Columbia University in 1901. From 1901 to 1902 he was assistant professor of mechanical engineering at New York University.

In 1902 he became associated with Joseph T. Ryerson & Son of Chicago as advertising manager and was conspicuous in the upbuilding of the machinery department of which he became manager. He was made assistant to the president in January, 1911. In 1913 he assumed charge of the railway supply department of the firm. In 1913 he was elected secretary of Joseph T. Ryerson & Son and continued so with increasing executive responsibilities, until the time of his death.

Under his able leadership both the domestic and foreign machinery business and the railway supply business of the company were widely extended.

Mr. Hendee was also vice-president and director of the Lennox Machine Co. and director of the American Clyco-Metal Co. He was a member of the American Society of Mechanical Engineers.

Mr. Hendee was married October 12, 1907, and leaves a widow and two sons.

Personals

Thomas Crowther has sold his interest in T. Crowther & Co., Inc., Boston, Mass., in order to establish his own business under the name of the Thomas Crowther Co., 19 Pearl St., Boston, Mass.

R. H. Wood, for a number of years connected with the Buffalo office of the Warner & Swasey Co., has been appointed Chicago district manager of the Modern Tool Co., Erie, Penn.

Leo C. Steinle has taken over the direct representation of the Modern Tool Co., Erie, Penn., in France. Mr. Steinle is actively connected with the Steinle Turret Machine Co., Madison, Wis., whose foreign interests he is looking after.

M. M. Cory has become manager of the Giddings and Lewis Mfg. Co., Fond du Lac, Wis., succeeding C. E. Cleveland, recently resigned. Mr. Cory resigned his position with the Concrete Steel Co., Chicago, Ill., in order to join the Giddings and Lewis organization.

B. A. Brennan, previously contract manager of the Westinghouse Machine Co., and later sales manager of the power department of the Bethlehem Steel Co., has resigned the vice-presidency of the Mercantile Trust Co., St. Louis, Mo., to accept the presidency of the Citizens Co., Inc., Baltimore, Md., to which office he has recently been elected.

Business Items

The Hess-Bright Manufacturing Company corrects a misleading rumor that had gained some circulation to the effect that it had been absorbed by another ball-bearing company. Its announcement states: A group of bankers including Frank A. Vanderlip, Philip W. Henry, Thatcher M. Brown and Franklin B. Kirkbride, of New York, and Marcus Wallenberg, of Stockholm, have recently acquired from the American group of stockholders, a controlling interest in the shares of the Hess-Bright Manufacturing Co. This group of bankers owns also a substantial interest in the S K F Ball Bearing Co., of Hartford, Conn. The two companies will be operated quite independently of each other. The former

policy of the Hess-Bright Manufacturing Co. will be continued except that its manufacturing facilities will be increased somewhat more rapidly to meet the constantly growing demand for its product. B. D. Gray, who retains his former stock holdings, will continue to manage the business as president. F. E. Bright retires from active participation in the company's affairs, but remains identified with the company as chairman of the Board. Aside from these two changes, the organization remains as before.

Trade Catalogs

Three-Wheel Transfer Truck. The Geo. P. Clark Co., Windsor Locks, Conn. Circular No. 51. Illustrated.

Friction Clutches for High Speeds. The Moore & White Co., Philadelphia, Penn. Catalog. Pp. 64; 6x9 in.; illustrated.

Small Forging Furnaces—Oil or Gas Fuel. Tate, Jones & Co., Inc., Pittsburgh, Penn. Circular No. 150. Pp. 4; 8x11 in.; illustrated.

Lubrication of Pneumatic Tools. Chicago Pneumatic Tool Co., Fisher Building, Chicago, Ill. Bulletin No. 130. Pp. 8; 6x9 in.; illustrated.

"Rockford" Railway Motor Cars. Chicago Pneumatic Tool Co., Fisher Building, Chicago, Ill. Bulletin No. 266. Pp. 12; 6x9 in.; illustrated.

Lathe, Universal Milling Attachments. High-Speed End Mills. The Porter-Cable Machine Co., Syracuse, N. Y. Catalog. Pp. 16; 8½x11½ in.; illustrated.

Large and Medium Sized Forging Furnaces—Oil or Gas Fuel. Tate, Jones & Co., Inc., Pittsburgh, Penn. Circular No. 149-A. Pp. 4; 8x11 in.; illustrated.

Motors, Dynamos, Converters. H. Boker & Co., Inc., 101 Duane St., New York. Price List No. E3. Pp. 24; 6x9 in.; illustrated. This shows the products of Ercole Marelli & Co., Ltd., Milan, Italy, which this company represents here.

"Red Devil" Tools and Hardware Specialties. Smith & Hemenway Co., Inc., 99 Chambers St., New York. Catalog. Pp. 182; 4x7 in.; illustrated. This is the seventh edition of what is known as the Green Book issued by this company, showing pliers, screwdrivers, hack-saw frames and blades, etc.

Forthcoming Meetings

American Society of Mechanical Engineers. Annual meeting, Dec. 5-8, Engineering Building, New York City. Calvin W. Rice, secretary, 29 West 39th St., New York City.

American Society of Mechanical Engineers. Monthly meeting, first Tuesday. Calvin W. Rice, secretary, 29 West 39th St., New York City.

Boston Branch National Metal Trades Association. Monthly meeting on first Wednesday of each month, Young's Hotel. W. W. Poole, secretary, 40 Central St., Boston, Mass.

Providence Association of Mechanical Engineers. Monthly meeting, fourth Wednesday of each month. J. A. Brooks, secretary, Brown University, Providence, R. I.

New England Foundrymen's Association. Regular meeting, second Wednesday of each month. Exchange Club, Boston, Mass. Fred F. Stockwell, 205 Broadway, Cambridgeport, Mass.

Engineers' Society of Western Pennsylvania. Monthly meeting, third Tuesday; section meeting, first Tuesday. Elmer K. Hiles, secretary, Oliver Building, Pittsburgh, Penn.

Rochester Society of Technical Draftsmen. Monthly meeting, last Thursday. O. L. Angevine, Jr., secretary, 857 Genesee St., Rochester, N. Y.

Superintendents' and Foremen's Club of Cleveland. Monthly meeting, third Saturday. Philip Frankel, secretary, 310 New England Building, Cleveland, Ohio.

Western Society of Engineers, Chicago, Ill. Regular meeting, first Wednesday evening of each month, excepting July and August. J. H. Warder, secretary, 1785 Monadnock Block, Chicago, Ill.

Philadelphia Foundrymen's Association. Meetings first Wednesday of each month. Manufacturers' Club, Philadelphia, Penn. Howard Evans, secretary, Pier 45 North, Philadelphia, Penn.

Technical League of America. Regular meeting, second Friday of each month. Oscar S. Teale, secretary, 35 Broadway, New York City.

Plants of Remington Arms Co.--II

BY HUGH M. WHARTON

SYNOPSIS—This article, the second of two describing the plants of the Remington company, shows the construction of the drop-forging and barrel-rolling buildings, one of the heat-treating and annealing buildings, lavatory fixtures, heating equipment, provisions for power and artificial lighting, and the oil-handling appliances for barrel drilling.

When the new work at Ilion was started only three units were contemplated for the immediate need. It was assumed then that if more space should be required later

neeting this building with the main portion of the plant by means of bridges over the street.

The plot of ground on which it stands restricted the width of the building to 42 ft. inside, and the legal requirements of the State of New York made it necessary to subdivide the floor space into relatively small areas; nevertheless this building is an interesting example of what can be accomplished under adverse conditions.

There was no room on either side for wings in which to place the stairways, lavatories and elevators. All of this permanent equipment had to be placed inside the main walls; consequently, at regular intervals of about 224 ft. fireproof sections 32 ft. long are built across the

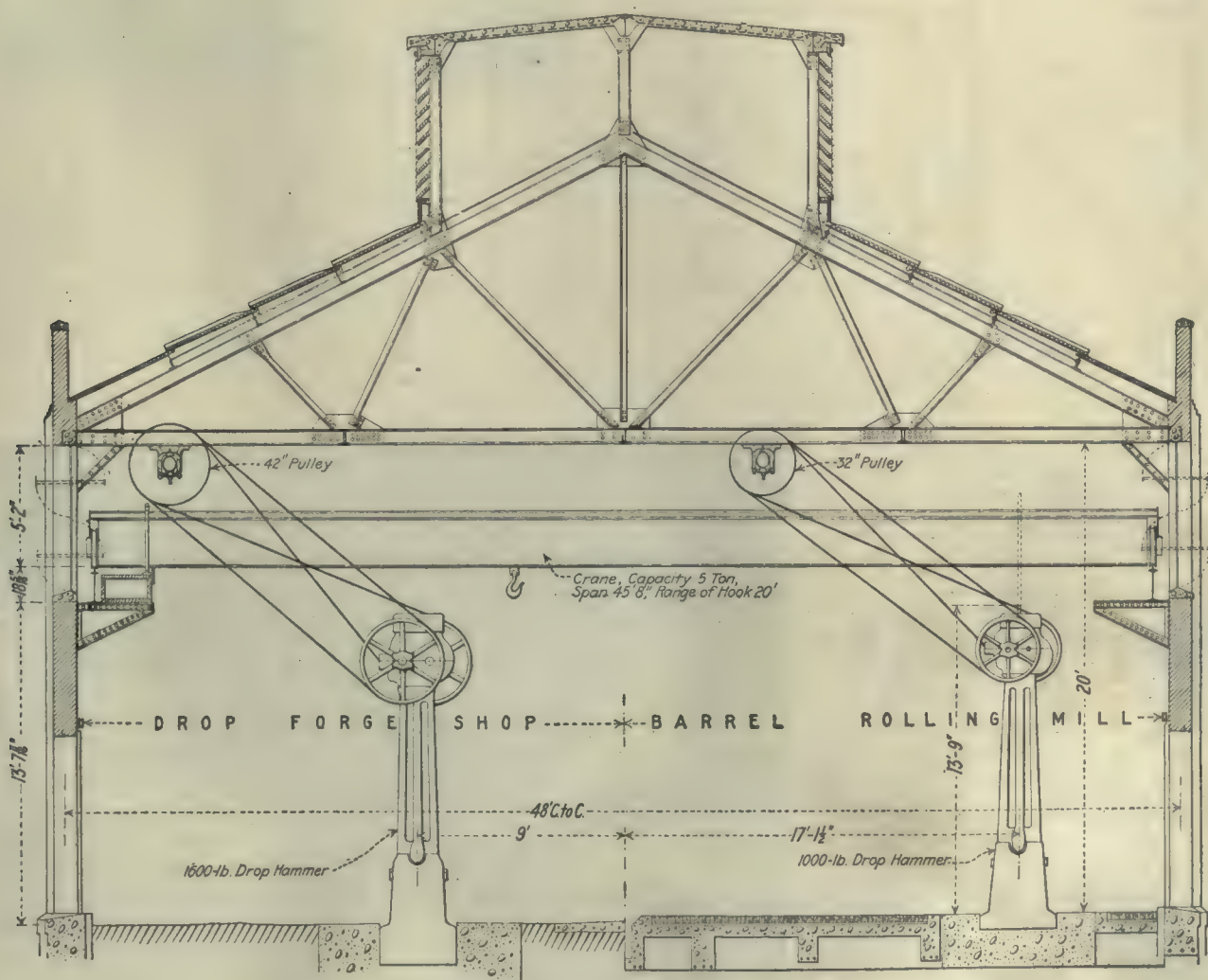


FIG. 12. PARTIAL CROSS-SECTION OF DROP-FORGE SHOP

it would be possible to remove some of the old buildings and replace them with additional units. Long before these first three were finished, however, the manufacturing demand became such that more space had to be provided without removing any of the old buildings.

The limited amount of ground available made this a rather difficult problem, but it was finally solved by placing a four-story building 912 ft. long on the narrow strip between the main street and the Erie Canal, con-

entire width between side walls. These sections accommodate all the permanent service equipment and at the same time, on account of their length, they serve as more effective fire stops than a plain fire wall.

The cross-section of this building is similar to that of the main units, but, owing to the decreased width, only one interior column is used and, in order to maintain the same physically defined central passage, the interior columns are set alternately to one side or the other of

the longitudinal axis of the building. These staggered columns look odd on paper, but their effect in the building is about the same as if they were placed in a double row. All operations on walnut stocks and all operations

prevent excessive vibration of the roof the trusses are made unusually heavy with very stiff lateral bracing. The contour of the ground made it necessary to set the floor at the level of the third floor of the other buildings.

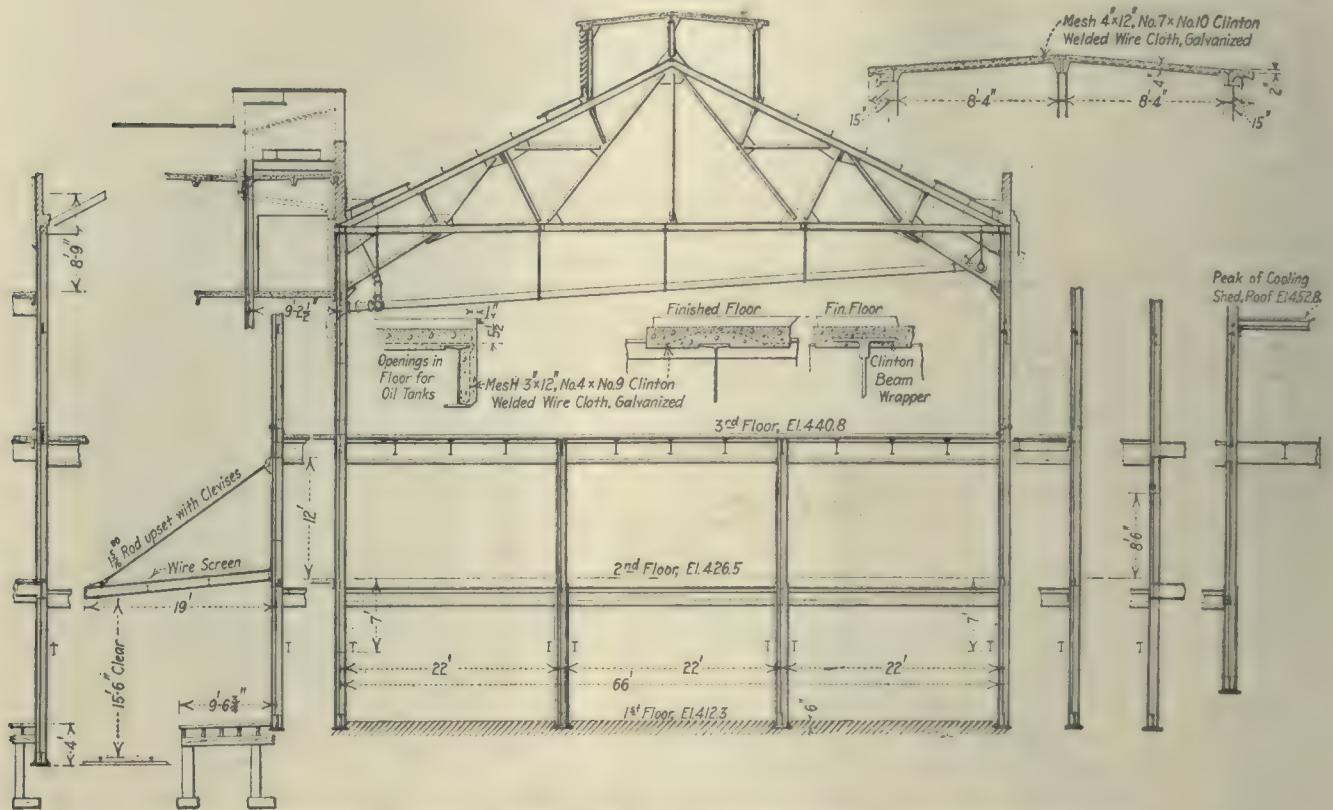


FIG. 13. PARTIAL CROSS-SECTION OF HEAT-TREATING AND ANNEALING BUILDING

on barrels are performed in this building except rolling the barrel blanks. It is particularly suitable for some of these operations as the light is unusually good because one side faces the northeast and the building is relatively narrow. The Ilion drop-hammer shop is shown in cross-section in Fig. 12. It is a one-story steel frame building 48 ft. wide with a clear height of 19 ft. under the bottom chord of the roof trusses. There is a row of drop hammers with the necessary furnaces and trimming presses along each side of the building with a passage for material in the middle. In order to obtain as much natural ventilation as possible there are sliding doors at the floor level along the whole length of both side walls and in the end walls. Above these is a line of swinging sash directly under the eaves and a continuous louver extends the full length of each side of the monitor. The main roof is of cement tile but the monitor roof was made flat to facilitate the escape of the heated air and gases through the louvers and, as tile could not be used, the roof is a thin reinforced-concrete slab.

Along each side and hung from the roof trusses is a heavy lineshaft to which the hammers are belted, and to



FIG. 14. THIRD FLOOR OF ANNEALING BUILDING

Lavatories, water closets and shower baths are in a connecting wing at one side of the main building.

One end of the building is designed for barrel-rolling and, as the ground slopes downward very rapidly toward that end, there is a basement under the barrel-rolling

floor in which are installed the sand-blast equipment and the blowers that supply air to the heating furnaces.

The heat-treating and annealing department would have been housed in a one-story building about like the



FIG. 15. A TYPICAL WASHROOM

hammer shop had there been sufficient level ground area available, as the requirements in both cases are almost the same, but, as this could not be done, this department was placed in the third story of the building shown in cross-section in Fig. 13. This third floor is level with and is a continuation of the barrel-rolling floor, the slope of the ground allowing another additional story.

The width of the building (66 ft.) was determined by the number of furnaces to be set in a row across the floor.

The ground floor is intended for steel storage and cold sawing, and is equipped with a small traveling crane in each bay. The second story is intended partly for manufacturing and partly for storage of machinery and of dies for the drop hammers. The floor is of wood, laminated like all the other manufacturing floors, but, to take care of the heavy live-loading (400 lb.) the joists are 2x10 in. instead of 2x8 in.

The third floor, which carries the annealing furnaces, is a 4-in. concrete slab supported on steel beams and covered with a wearing surface of very hard brick. To reduce the dead-load as much as possible, the bricks are very thin and are laid flat.

Above the third-floor level this building is practically the same as the hammer shop except that rolling steel shutters are provided, instead of horizontally sliding doors, for opening the sides near the floor level, and the roof trusses are relatively lighter as there is no shafting load to be supported.

The photograph of the interior for Fig. 14 was taken when only a few of the new furnaces had been installed and before the department was in operation.

Placing the drop-forging, barrel-rolling and heat-treating departments at the level of the third story tends to simplify rather than to complicate the problem of transporting material. The bridges between buildings are at the third-floor level and some at both third- and fourth-floor levels. The electric trucks carrying the rough barrels and small drop-forged parts can therefore pass directly to the machining departments in the other buildings without having to be lifted by the elevators and without having to pass outdoors either through a yard or across a street. Indoor transportation is preferable to outdoor with the snowstorms that are common

in central New York State. Washrooms and water closets are all placed in separate rooms removed from the manufacturing floor space. All have the same equipment, differing only in minor arrangements and in capacity. Fig. 15 shows a typical arrangement of one of the washrooms. Long porcelain enameled iron sinks are used with a double row of faucets directly above them, each faucet having a hot- and cold-water valve. This arrangement enables employees to stand along each side of a sink and wash with clean running water tempered to suit the individual taste. Hot water is supplied from a steam heater and storage tank in the top story of each building. Toilet rooms are separately inclosed from floor to ceiling, and all have windows for daylight and air. They are divided into stalls by heavy sheet-metal partitions, each stall being connected at the back to a ventilating duct leading to an exhaust fan directly under the roof. The buildings at

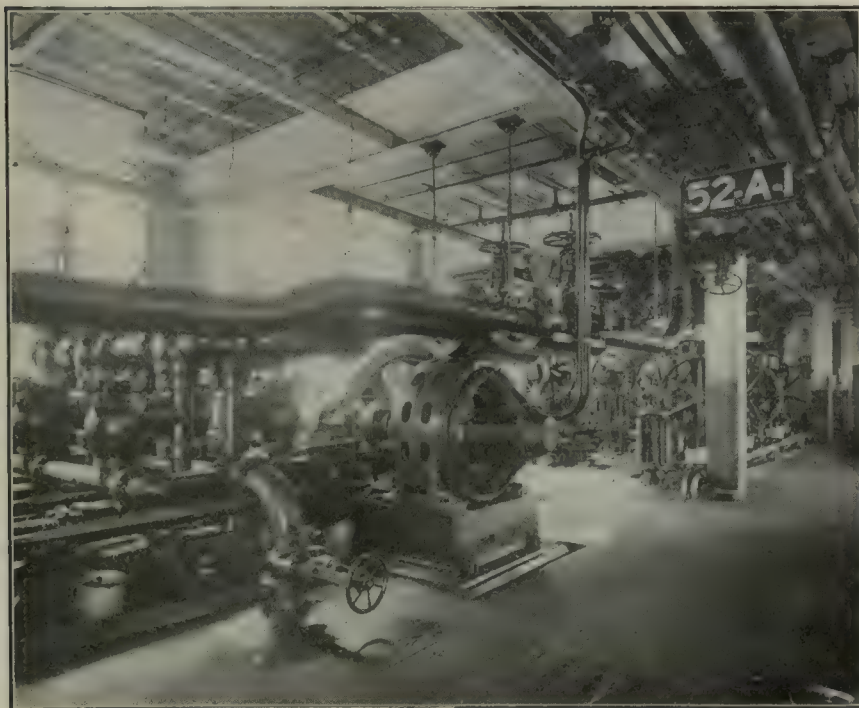


FIG. 16. PUMPING STATION FOR HIGH-PRESSURE OIL

Owing to the heavy live-loading of the second and third floors, the interior columns are spaced equally across the building, the arrangement with a double row of columns as in the main four-story units being impractical under the conditions.

both works are heated throughout by a direct hot-water system. None of the manufacturing processes require air conditioning, and the number of employees in any one inclosure is not great enough to require more fresh air in winter than would normally be

supplied by the leakage around the metal window sash and by the occasional opening of doors and windows. As the buildings are well separated from each other, the large window openings and reasonably high stories should allow sufficient natural ventilation in summer. For these reasons a system of direct radiation seemed to be the most satisfactory, and the hot-water system was chosen because the cost of operation is less than that of a direct steam-heating system, except perhaps in very cold weather, and because it affords better temperature regulation.

Most of the radiating surface in the manufacturing space consists of pipe coils placed along the walls below the windows. To counteract the excessive radiation from

Current is supplied by the central station at 2,300 volts to transformers in three substations at different places in the works. For power it is distributed overhead at 480 volts to the manufacturing buildings. Inside the buildings all cables are carried in metal conduits to the middle of the central passage on each manufacturing floor, and from this point the power cables are carried open the full length of each central passage. The open wiring is for the purpose of allowing motor connections to be made at any point without having to break into conduits.

Current for lighting is distributed at 240-120 volts, three wire, single phase, to the panel boards on each

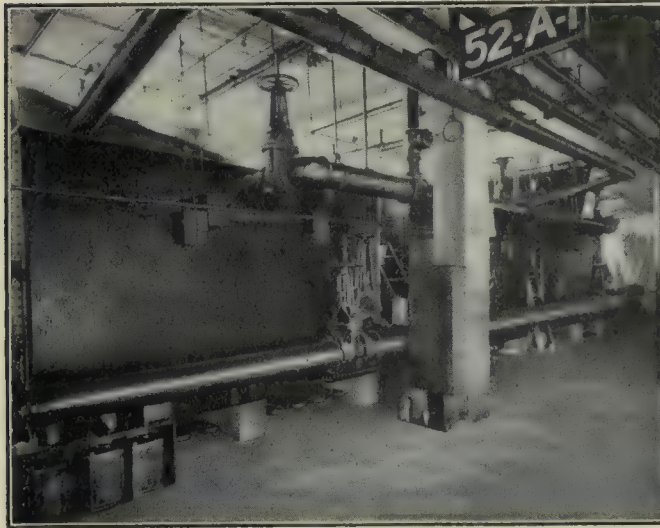


FIG. 17. OIL-STORAGE TANKS—HIGH-PRESSURE OIL SYSTEM



FIG. 18. CENTRIFUGAL OIL FILTERS—HIGH-PRESSURE SYSTEM

the roofs in the severe weather that is sometimes experienced at Ilion, where a temperature as low as -20 deg. F. is not at all uncommon, a small additional coil is placed overhead in the top story. In the stairway wells and washrooms the coils are placed overhead.

The ratio of square feet of radiating surface to cubic feet of building volume varies from 1:90 to a little less than 1:100.

In both the Ilion and Bridgeport works electric motors are used to drive the lineshafts from which groups of machine tools are operated. In only a few cases are the motors attached directly to the tools.

Electric power is supplied to both works at 60 cycles, three-phase, 480 volts. This voltage was chosen because 440-volt motors had previously been adopted as standard in the older plants of the Remington Arms Co. at Ilion and the Union Metallic Cartridge Co. at Bridgeport.

At the old Ilion works power had been purchased for some time from a large nearby central station, and when the plant was recently extended it was decided to continue to purchase rather than to make a large investment in generating machinery. The Ilion power plant, therefore, contains only the boilers necessary for heating and one noncondensing steam turbine coupled to an electric generator. This turbine can be operated continuously during the heating season, furnishing power to one of the buildings and exhausting into the heating system. It is intended also for emergency use for furnishing light and a limited amount of power in case of failure of the supply from the central station.

floor. From these the distribution is by means of 120-volt two-wire branch circuits to 100-watt lamps spaced uniformly over the manufacturing floors. For general illumination 1 watt has been allowed per square foot of floor area.

A number of extra outlets are provided for special lighting around some of the machines and over benches. Passages and stairways are lighted from circuits independent of the main floors. At the Bridgeport works a power station was built of sufficient capacity to operate the works of the Union Metallic Cartridge Co., as well as the new works of the Arms company.

Electric freight elevators are used throughout the Bridgeport works, but at Ilion, where electric power is purchased from a central station and delivered over a transmission line, it was deemed advisable to put in steam-hydraulic machines in order to make the operation of the elevators independent of conditions affecting the power supply.

The oil-handling system for the barrel- and body-drilling departments at Ilion is interesting in that the oil is supplied to the drilling machines at high pressure from a central pumping station. This station has a capacity of over 100 gal. of oil per minute at a pressure of 900 lb. per sq.in. There are two horizontal double-acting triplex pumps, each geared to a 200-hp. induction motor, and a group of smaller vertical single-acting triplex pumps belted to induction motors. The piping is so arranged that the pumps can be grouped to supply oil to each department at a pressure suitable for the work in that

department. The pumping station, Fig. 16, is in the first story of the building in which the drilling departments are located.

For the distribution system double extra-heavy pipe is used throughout. All pipes 4 in. or more in diameter have welded steel flanges with leather gaskets. Oil is pumped from one of the three supply tanks shown in Fig. 17. Only one tank is used at a time. The return oil is discharged by gravity into the same tank through strainer trays which remove the chips that are carried along with the return oil.

When the oil in one tank becomes too dirty for further use, which is generally in two or three days, the second tank is used, while the oil in the first tank is being filtered. The filtered oil is pumped to the overhead cylindrical tank shown in Fig. 18. From this overhead tank it is fed by gravity in a continuous stream to six centrifugal oil filters also shown in Fig. 18. From the filters the oil runs to a tank below the floor level and from there it is pumped back to the large supply tank which, in the meantime, has been cleaned and prepared to receive the clean oil. Fig. 18 also shows the centrifugal machine for separating the oil from the steel chips. The reclaimed oil from the separators is also pumped to the overhead tank and passes through the oil filters back to the supply tank.

Triple-Groove Miller for Shell Noses

By JOHN S. WATTS.

The British high-explosive shells are now being made with three semicircular, or triangular, grooves in the nose, instead of the $\frac{1}{4}$ -in. grub screw formerly used. The func-

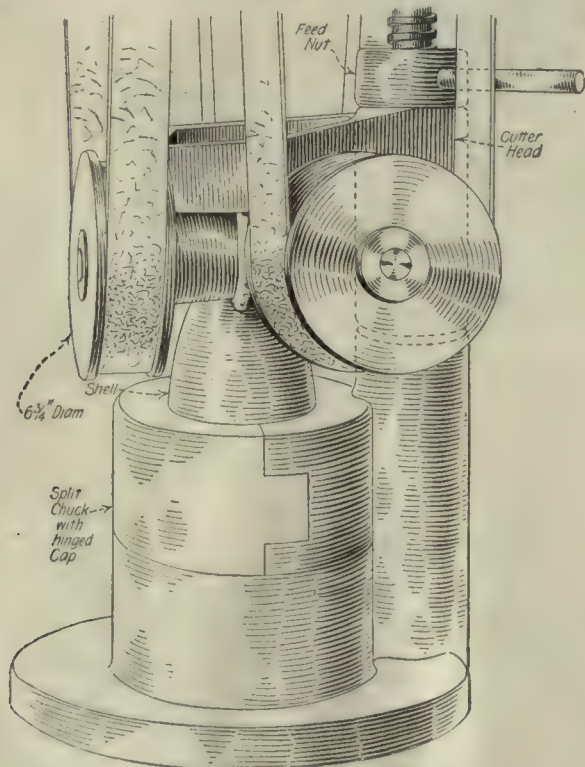


FIG. 1. THE MILLER AND THE WORK

tion of these grooves is to prevent the fuse plug from turning after being screwed into the shell. To lock this fuse plug, it is hammered or otherwise burred up at these

grooves so as to force some of the metal of the plug into the grooves and thus positively lock it in position. These grooves are at an angle of 60 deg. with the axis of the shell, $\frac{1}{16}$ in. deep by $\frac{1}{4}$ in. wide and 120 deg. apart. The machine shown in detail in the drawing herewith is designed to mill out all three grooves at once and has proved successful.

The shell, after being finish-turned on the outside and inside, is put into the hinged chuck. This chuck is not shown in detail, as it is the same as is used in all munition works for hand tapping and similar operations,

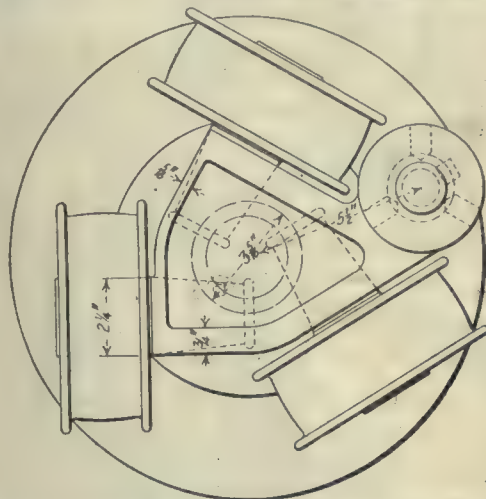


FIG. 2. PLAN OF CUTTER ARRANGEMENT

except for the addition of a boss to take the upright shaft carrying the cutter head.

The shell being in place and the chuck tightened up, the cutter head is fed down vertically by revolving the $1\frac{1}{2}$ -in. nut by means of the $\frac{5}{8}$ x6-in. bar until the stop on the cutter head comes down onto the nose of the shell. This stop is set to give the correct depth to the grooves.

Screwing down on the cutter head will stretch the belts slightly, but not enough to do any harm, as with the depth of cut only 0.1 in. the travel is very slight. Slackening back on the feed nut will allow the belts to lift up the cutter head sufficiently to remove the finished shell and put in another one.

The machine is intended to be belted to a shaft vertically over the center of the three pulleys. This overhead shaft should have three pulleys, one for each cutter shaft. This arrangement will give a straight drive for one of the cutter-shaft belts and a quarter turn (or to be exact, a 60-deg. turn) for each of the other two belts. This shaft overhead may be a lineshaft, as it is not necessary to stop the machine; and therefore a countershaft is not essential, if the correct speed can be obtained by a direct drive from a lineshaft.

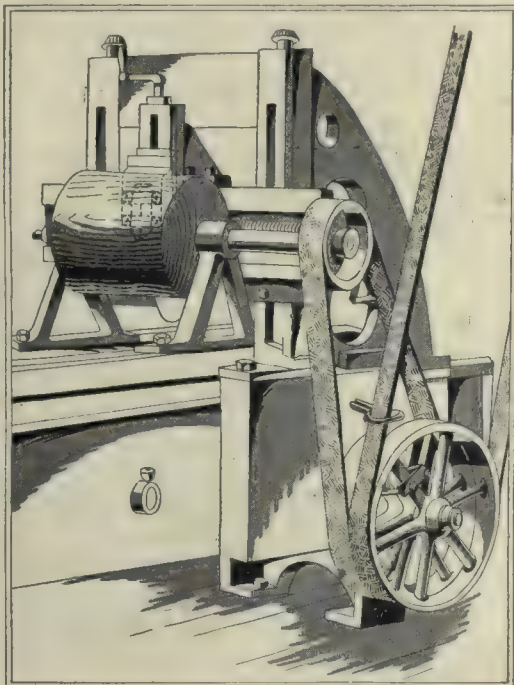
The upper side of the cutter head is made to form an oil reservoir, from which oil is allowed to drip onto the cutters through the small holes shown over each cutter. This oil is caught on the table on which the chuck is fastened and returned to the reservoir.

The Production of Coke Pig Iron in the United States for the first six months of 1916, according to statistics compiled by the American Iron and Steel Institute, was 19,347,935 tons as compared with 17,473,500 tons for the preceding six months. Including charcoal pig iron, anthracite and mixed anthracite and coke pig iron, the total production of pig iron for the first half of the current year amounted to 19,610,522 tons. The larger proportion was basic pig iron, to the amount of 8,830,085 tons.

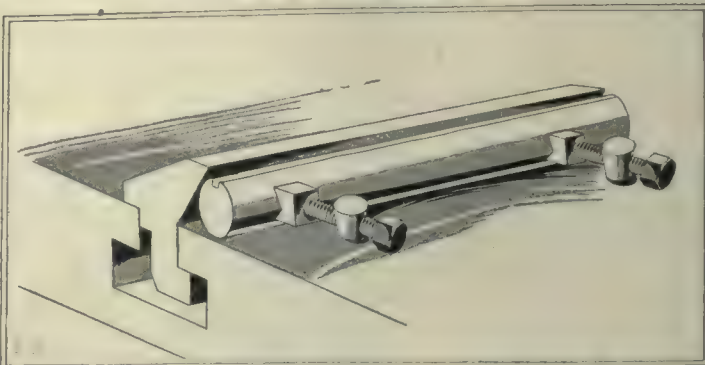
From a Small-Shop Notebook

By JOHN H. VAN DEVENTER

PATTERN TURNING ON THE PLANER

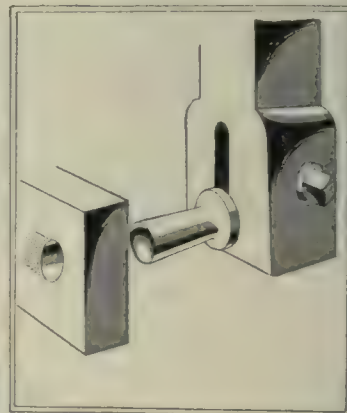
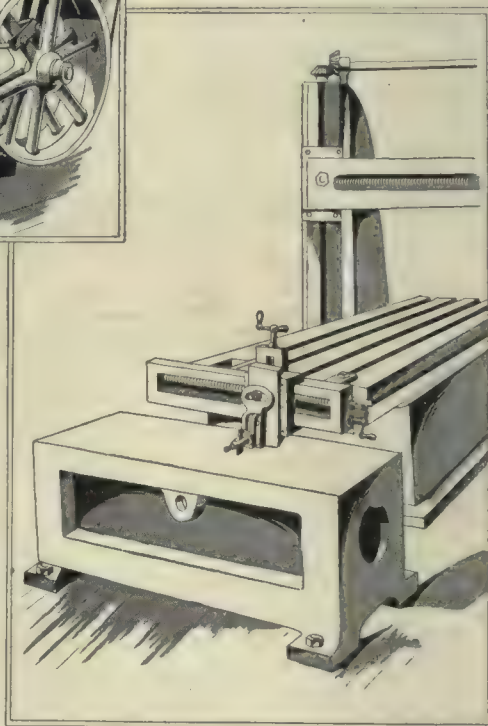


HANDY CLAMP FOR BAR KEYWAYING

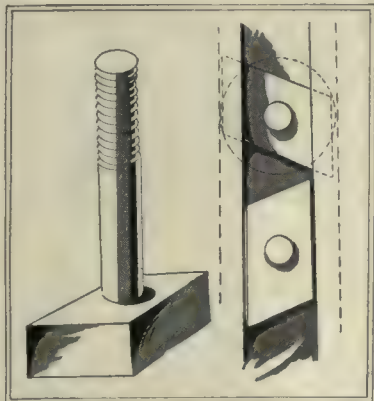


PLANING THE OVER-SIZE JOB

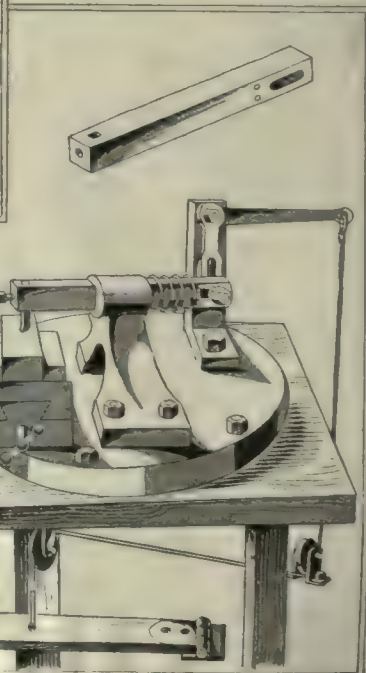
A TOOL THAT WILL CUT SLOTS



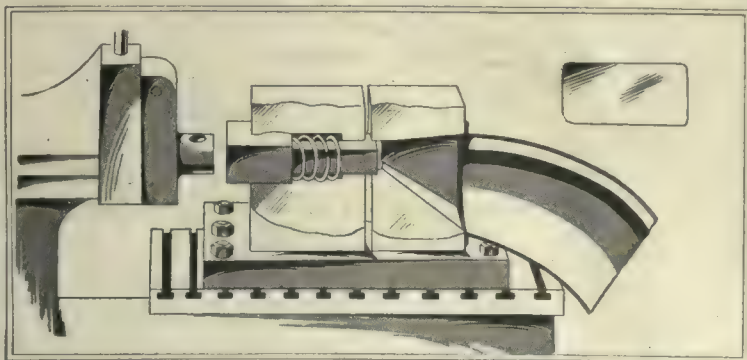
QUICK DETACHABLE PLANER BOLTS



A HOME-MADE FOOT-DRIVEN SHAPER



THE RAM OF THE SHAPER MAKES A FAIR PUNCH FOR THIN STOCK



PLANER AND SHAPER DEVICES THAT SAVE MONEY



A COLLECTION OF BELT-CUTTING DEVICES

Comparative Merits of Small Die Holders

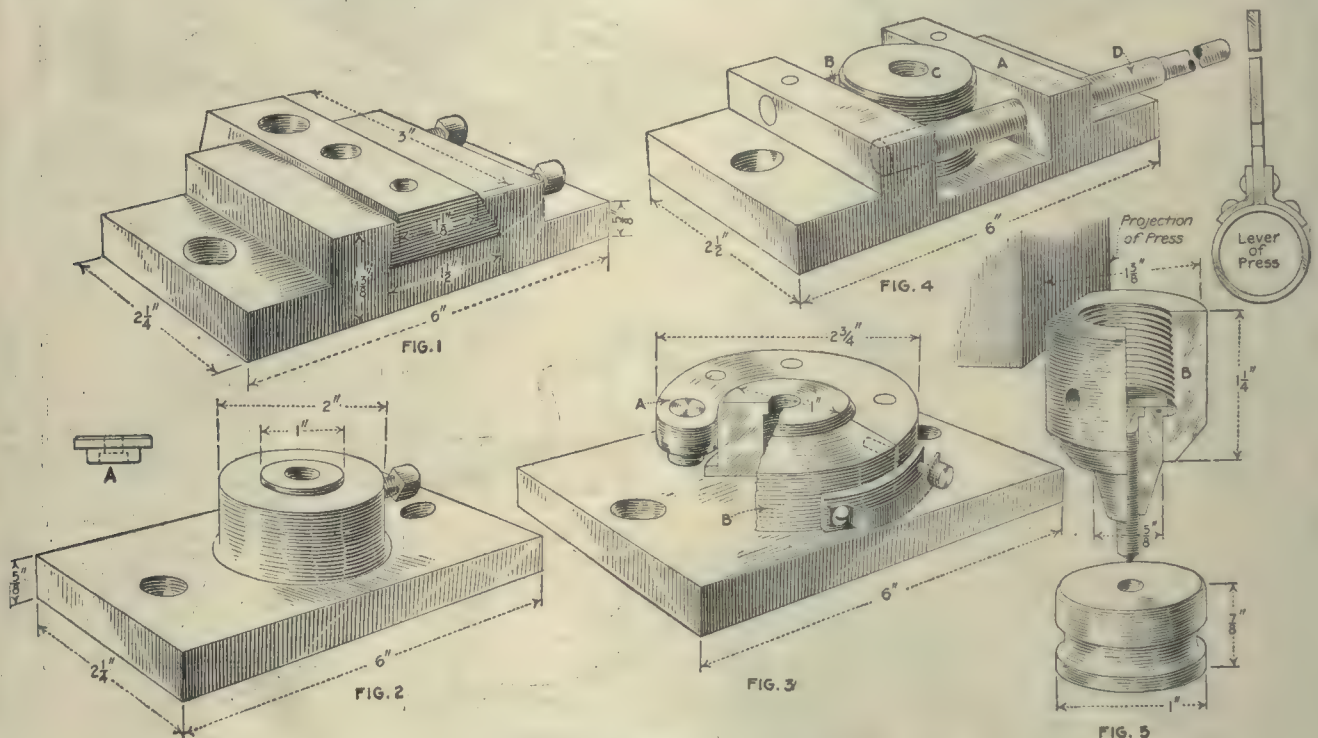
BY JAN SPAANDER

As one of our departments handled copper and other soft metal bars only, we thought it advisable to install half a dozen small hand punch presses instead of drill presses. It was the intention to allow the half-skilled help of that division to use the presses at will and to let them do their own punch and die setting. Each press was provided with a fixed die holder and suitable interchangeable dies and punches.

The first holder we used, the one supplied by the manufacturer, was a cast-iron block, Fig. 1, with a

changed rapidly and accurately. The ring can easily be kept clean, but as the operators once in a while forgot to lock the ring or did not mate the proper punch, smash-ups still occurred occasionally. Besides, the outfit is expensive.

The holder shown in Fig. 4 is not only inexpensive, but entirely trouble-proof, and its interlocking scheme is interesting. It consists of a base plate *A* on which two ribs form a slot of the exact width of the small circular die. At the back, the ribs are connected by a half-inch round rod, pinned in place. The round die is provided with a shallow round groove that fits the rod. The sliding bolt *D* fits the same groove and locks the die in place. The open design prevents the collection of dirt.



VARIOUS DESIGNS OF SMALL PUNCHES AND DIES

dovetail and two setscrews to hold the die. The die blocks contained three holes each and were not the cheapest by any means. These holders, in our specific case, proved to be unsatisfactory. On account of faulty setting, wrong punches, etc., the operators smashed the dies and punches incessantly. Burrs on the setscrews made changing difficult and much time was lost.

The second holder, Fig. 2, was more effective and cheaper, as the small dies could be cut out of round stock. These dies, however, jammed and nothing guaranteed that the punch mated with the die. At Fig. 2 *A* is shown a modification of the die. This one could be more readily removed, but on account of dirt under the shoulder the punches wear on one side, causing inaccurate holes.

Not being satisfied, we produced the holder shown in Fig. 3. It consists of a halved ring, one part *A* pinned to the base plate and part *B* to swing around a pin in part *A*. The pin, pressed down by the spring into a hole in the fixed part, is the means of locking the ring. A recess in the bottom of the latter forms, with the base, a circular groove, which fits the shoulder on the dies, this preventing them from going up. Dies can be

The sliding rod *D*, when in place, is barred from moving out by a semicircular flat sheet, riveted to the lever of the press. When this lever is entirely down, the thinner part of the sliding rod corresponds with a hole in this sheet on the lever, and it can be moved outward till its shoulder strikes the sheet. This locks the lever in place and opens up for the die, but it also locks the punch down in the die and therefore the latter cannot be removed without taking out the punch, and vice versa. The press cannot be operated before the sliding bolt is entirely back in the closed position. To prevent the removal of the punch while it is up and out of the die; the round punch holder *B*, Fig. 5, flat on one side, runs along a fixed projection of the press, which prevents turning as long as the punch is not down. The punches consist of a piece of drill rod with a head, fitting in a machinery-steel stiffener.

The Production of Pig Iron in Canada during the first half of 1916 was 507,750 tons, as compared with 366,825 tons in the first half of 1915. At the rate of production which prevailed in the first half of this year it is possible that the output for the whole year will exceed the high record established in 1913.

An Automatic Notching Die

BY FRANK A. STANLEY

SYNOPSIS—This is a punch-press development for cutting a series of notches in a sheet-metal part known as the type-bar comb. The work is carried on an indexing plate that is advanced step by step, with each stroke of the press, to present a fresh surface for the notching punch.

The illustration shows one of the special devices used by the Noiseless Typewriter Co., Middletown, Conn., in connection with punch-press work. This is an automatic in-

dexing die for notching the parts known as type-bar combs. One of these, the lower comb, is shown in Fig. 1 bent up to form, with the position of the notches therein fully indicated.

This typewriter part is made of phosphor bronze formed up to the shape illustrated and notched to form a guide for the 28 type bars used on the Noiseless typewriter. The sheet metal is 0.032 in. thick, and the outer radius of the blank, after bending up, is about 31½ in. The notches punched are 0.029 in. wide and have a total depth

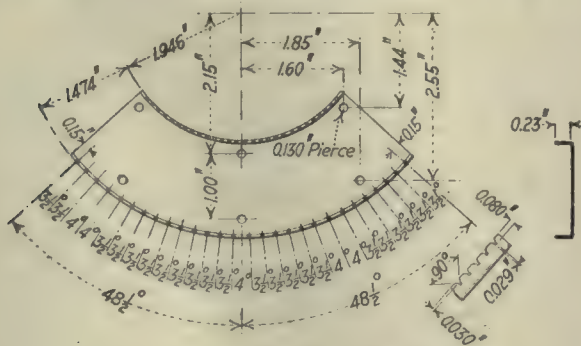


FIG. 1. DETAILS OF LOWER COMB

of 0.080 in. There is a flange turned up on each side of the piece, making a curved channelway between, and the notches have to be punched in both these flanges.

A special indexing fixture for this work is shown clearly in Figs. 2, 3 and 4, the first of these illustrating the work-



FIG. 4. INDEXING FIXTURE FROM REAR

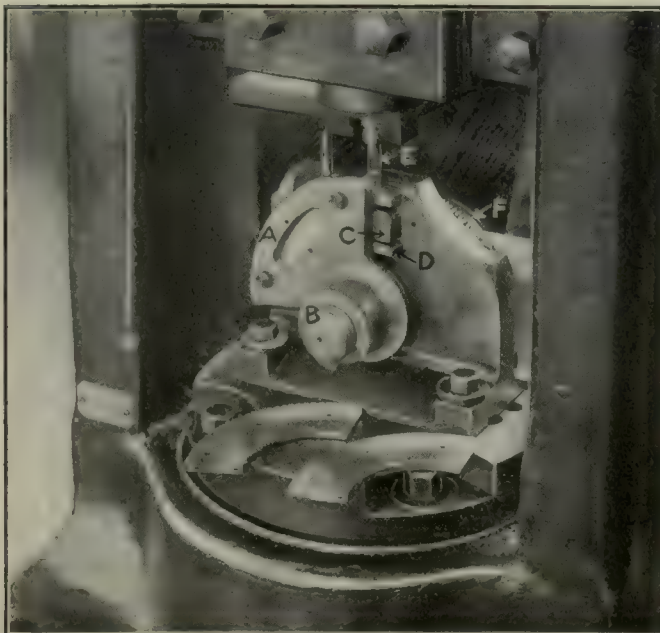


FIG. 2. AN INDEXING NOTCHING FIXTURE FOR THE PUNCH PRESS



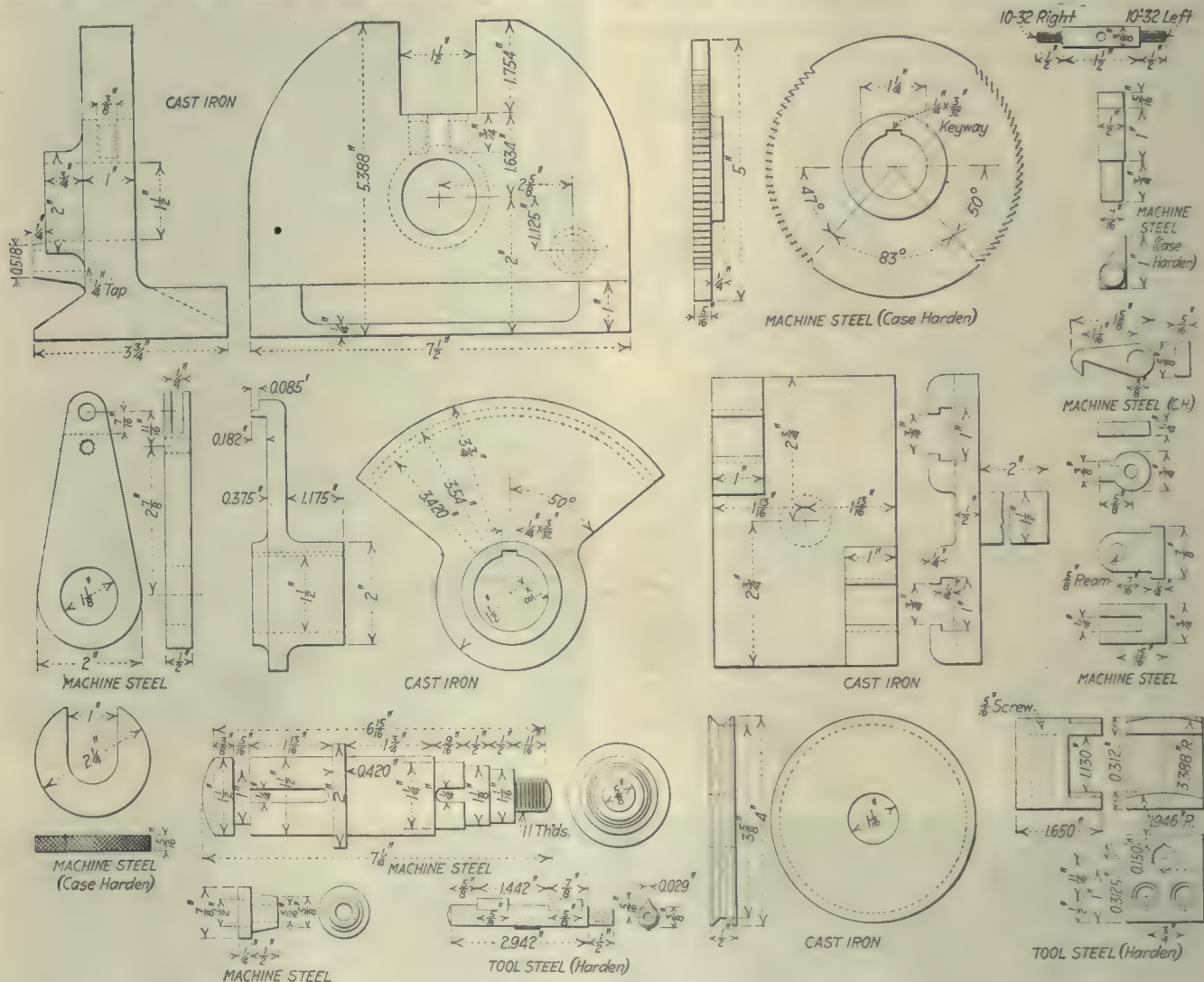
FIG. 3. INDEXING FIXTURE WITH WORK REMOVED

ing face of the holding fixture in position on its spindle and the machine ready for operation. The appearance of the comb before and after this punching operation is well brought out in Fig. 2, while the principal dimensions are included in Fig. 1. The details of construction of the fixture are shown in Fig. 5. The general method of operation will be obvious upon examination of the various illustrations.

Referring to Fig. 3, which shows the work-holding plate removed, it will be seen that the inner face of this plate is provided with a seat in the form of an arc, into

the upstroke of the punch. This advances the work one space farther ahead for the cutting of the next pair of notches, on the next downstroke of the press. The arrangement of this feed mechanism will be more clearly seen in the rear view, Fig. 4. It will be noticed from this and from the details in Fig. 5 that the ratchet wheel is provided with two sets of teeth on opposite edges. The fixture answers for both upper and lower combs by changing the ratchet wheel.

The details of the punches also are shown in this drawing along with the guide and supporting blocks for the



to be adjusted as required. Similar means are used for mounting the plunger that operates the indexing devices. This device is operated at the usual rate of the punching press, and it takes less than a minute's time to produce the complete series of 28 pair of notches.

Referring now to the punch *E*, Fig. 2, this will be seen to be of novel construction. It has a body which is about $\frac{3}{8}$ in. in diameter and which slides in a guide of the same size. The punch body is fitted with two cutting blades, each about $\frac{5}{8}$ in. long, and spaced longitudinally 2 in. apart so that they strike the outer and inner flanges of the work simultaneously.

These cutting blades are also adapted to form the angular portion of the opening at the top of the notch, which is formed to 90 deg. so that the cutting portions of the punch are similarly made at this angle. As indicated, the punch body is provided with a Woodruff key to prevent it from twisting in operation. The sleeve of the flanged head for securing the punch in the punch holder is made to fit over the neck on the punch and is connected thereto by a screw, so that it cannot be mislaid.

✽

Training Young Mechanics

By J. S. WILLIAMS

The training of young mechanics has interested me for a long time. For the past ten years, or more, I have been with firms well known for the high quality of their work. I have seen the arrival of many boys—brought by their parents, who, quite naturally, have thought what an excellent place it would be for their son to learn a trade—and yet I have invariably been sorry for the boys, feeling, as I still do, that the chances for a boy to develop into a first-class mechanic are very small. My reasons for thinking so are these:

The particular factory that I have in mind is, I think, fairly representative of the majority of modern manufacturing. It is divided up into various departments, carefully arranged for the production of fairly large quantities of accurate component parts. The new boy is set to operate one of the machine tools. This generally means taking one piece of work from the vise or jig and inserting another. The setting up of the machine is in the hands of a specialized "setter up." The result is that the boy has little or no opportunity of becoming really proficient in the use of the machine, except by the slow method of watching the setter.

In many cases it happens that a boy will be obliged to remain for a long time on the one type of machine, provided always that he is smart, for chargehands dislike constantly to be "breaking in" new boys.

The experience that a boy will gain during three or four years under these conditions, even though he may be periodically shifted into different departments, is small, and not of the kind to make him confident.

Supposing that after having made the round of the machine shops the boy is put to the bench. The conditions there are almost as bad for the boy. Filing and hand work in general are cut out as much as possible, and usually the variety of bench work is small.

Now, I come to a point which I think is of great importance. It is becoming more and more common to have the shops filled entirely with boys—with the exception of the chargehands. A boy starting work on the bench or elsewhere is probably put alongside another boy who

has been on the job a bit longer. As we all more or less learn by imitation it is desirable to have the best possible pattern to copy from. It is here that the modern boy is at a disadvantage, having, as is very often the case, only boys of a similar age to look to for guidance. However willing the chargehand may be to do so he has little time to act as manual instructor. Under these circumstances a boy in the kind of workshop that I have under consideration has not nearly so good an opportunity of acquiring experience and skill as one who has served his apprenticeship in the older type of shop, where the work was not split up to the same extent and where in all probability he had to act as mate to an experienced mechanic.

It is usually the ambition of an apprentice to be put into the toolroom, and in this position I believe he would have excellent opportunities. Unfortunately, however, many firms will not have apprentices in the toolroom. They prefer to obtain already qualified tool makers.

There are of course a few boys who ultimately "make good"—usually after a few shifts from one firm to another.

A far greater number would make good mechanics. I think, if they were given more opportunity of taking responsibility and also of watching good men at work, so that there would always be before them a pattern to follow and a high standard of skill to attain to.

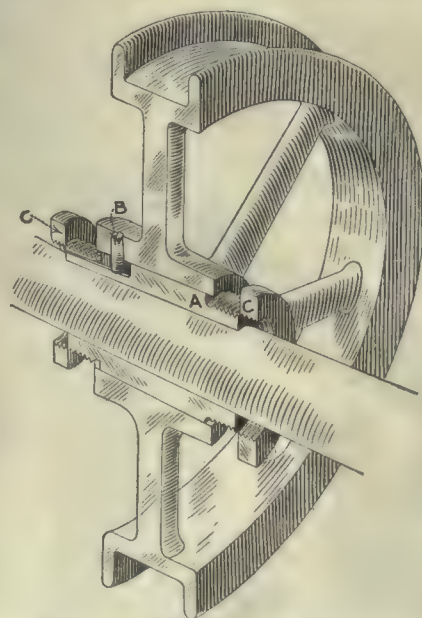
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Clamping Bushing

By J. W. CURRAN

The accompanying illustration shows a driving pulley for a grinding device. The pulley must run at a very high speed, about 3,000 r.p.m., and must be set in different positions on the 1-in. shaft shown, owing to the driven pulley being swiveled to various angles.

Having experienced some trouble in keeping this pulley from wobbling, and thereby causing vibration in



CLAMPING BUSHING FOR PULLEY HUB

the machine, I tried this scheme and it is working splendidly, driving by friction alone, as I did not want any keyways in the shaft. The bushing *A* is tapered outside to fit the pulley and is split endwise. The nuts *C* pull it in or out of the pulley. The pin *B* keeps it from turning in the pulley.

Jigs Used in the Machining of Motor Parts

By ROBERT MAWSON

SYNOPSIS—On this and the facing page are shown some jigs used when machining elements for commercial motors. The jig for the radiator filler bracket employs fixed and sliding V-blocks to locate the part. By this means the hole is drilled central in the bosses. The starting-post jig uses an open clamp tightened with a screw to hold the part securely. There are quick-acting hook bolts on the jig for the dumper gear-box cover, thus facilitating the insertion and removal of the part from the tool. In the jig for the dumper clutch fork a sliding V-block is operated with a knob through a screw.

In most shops where automobiles are manufactured for commercial purposes the jigs and fixtures are of a somewhat crude type. The International Motor Co., Mack Works, Allentown, Penn., where the tools shown in this article are used, believes in having high-grade jigs and fixtures. It will be observed that the tools are fitted with devices for locating and fastening the parts. The tools are of modern design and manufacture and are giving excellent results in practice. It is believed that a careful perusal of the article will furnish ideas to many shops using jigs and fixtures.

The use of bushings with pilot wheel pins to facilitate their operation is not so widely known as it should be. The knurled surfaces of such bushings form an easy and secure grip for the fingers when the resistance to turning is not great, but when a part must be forced to a seat in a jig the knurled surface is inadequate and

other means must be used to obtain the desired power. It is in such cases that the pilot wheel pins in the head of the bushings serve their purpose.

While the locating and fastening devices on the drilling jigs shown are effective, their design has been kept simple in order to permit rapid manipulation. In the jig for the dumper gear-box cover the work is located by two bosses. The work is held in place by three hook bolts which are operated by quick-acting handles.

The use of hook bolts in combination with quick-acting nuts is not so common as it might be. With this type of fastening, a half or even a quarter turn of the nut (depending on the lead of the screw) is often sufficient to release the hook-bolt head sufficiently from the work so that the bolt can be turned in the hole in the jig and the work removed. The handles pivoted to the nuts are also a great convenience and time saver and are always where they are wanted.

From the production times given in each case it will be observed that the practice is meeting the commercial requirements of the highly specialized automobile field.

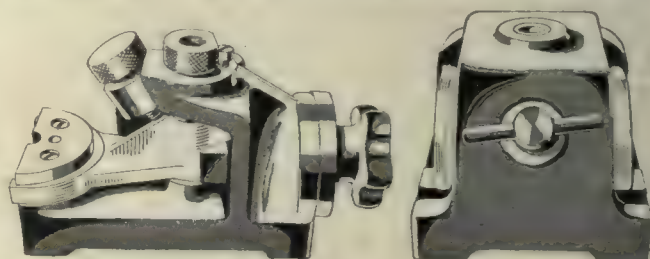


FIG. 8
FIG. 10
JIGS FOR CLUTCH FORK AND SPRING CLIP SPACER

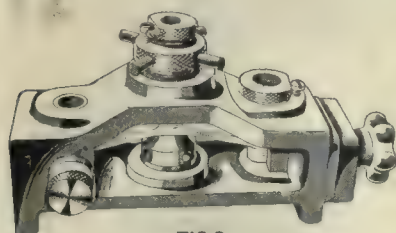


FIG. 2

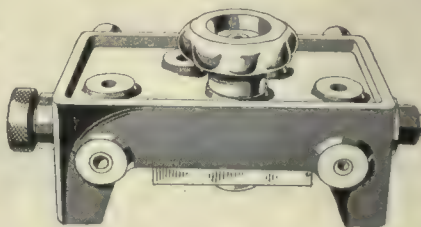


FIG. 4

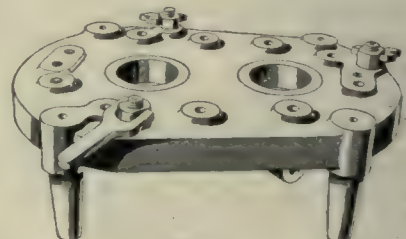


FIG. 6

DRILLING JIGS USED IN MACHINING MOTOR-TRUCK PARTS, WITH WORK SHOWN IN POSITION

FIGS. 2 AND 2-A

Operation—Drilling, tapping and countersinking radiator filler bracket, Fig. 1. The casting is located in a fixed V-block at one end and in a sliding V-block at the other. An adjustable screw post under the center boss holds the piece securely in place during the machining operation. A knurled head screw is tightened against the casting to prevent side motion and secure additional rigidity while the work is under cut.

Holes Machined—Three $\frac{11}{16}$ -in. drilled; one is then countersunk $\frac{1}{2}$ in. in diameter, one $\frac{11}{16}$ in. in diameter and the third tapped with $\frac{1}{2}$ -in. U. S. S. threads.

FIGS. 4 AND 4-A

Operation—Drilling steering post support, Fig. 3. The rough casting is located against an adjustable screw, being forced against it by a knurled head screw. A clamp tightened onto the piece with a knob-headed screw holds the casting in position during the machining operation and prevents springing of the piece.

Holes Machined—Five $\frac{3}{8}$ -in. drilled and one $\frac{3}{8}$ -in. drilled.

FIGS. 6 AND 6-A

Operation—Drilling dumper gear-box cover, Fig. 5. The casting, which has been previously bored, is located by two bosses that fit into the large bored recesses. Three hook bolts operated by quick-acting handles hold the piece in place.

Holes Machined—Ten $\frac{11}{16}$ -in. drilled and two 0.219-in. drilled.

FIGS. 8 AND 8-A

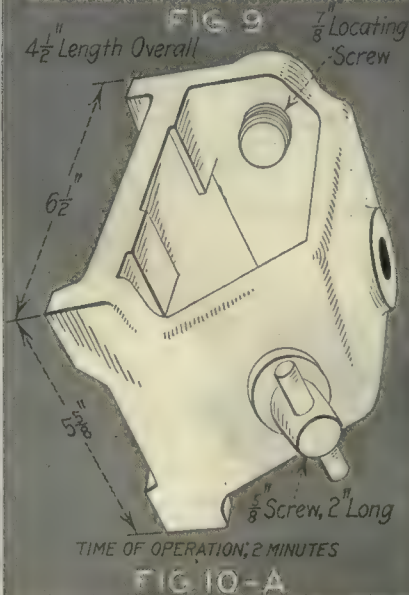
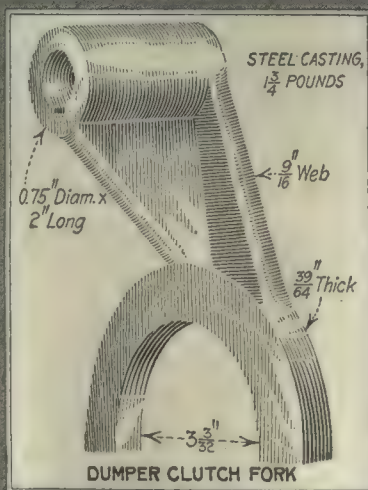
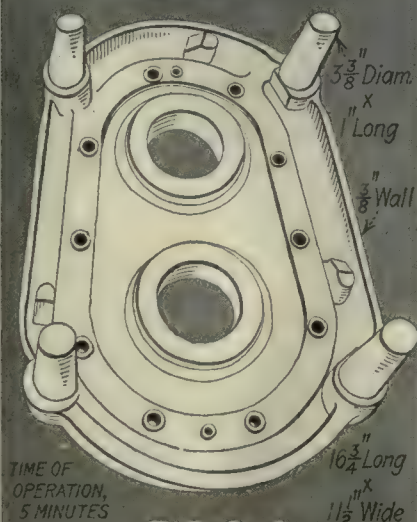
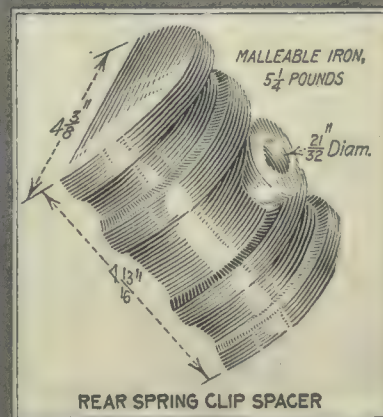
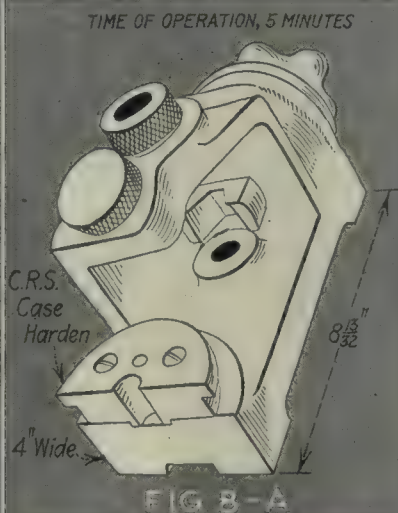
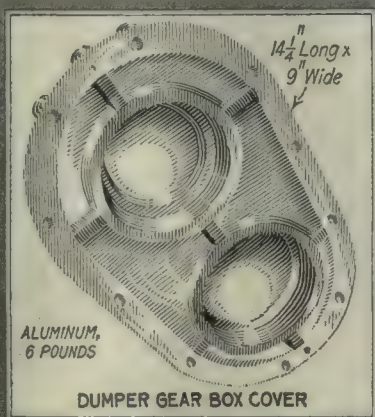
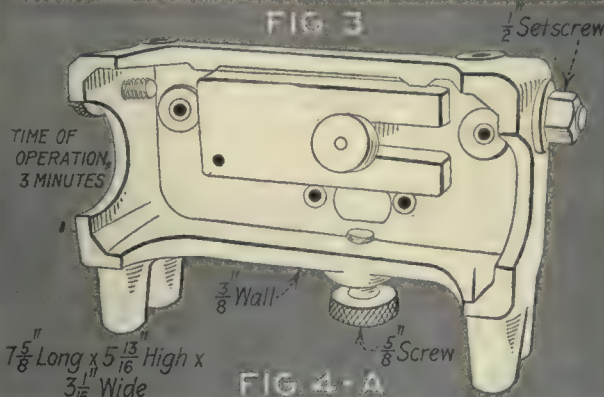
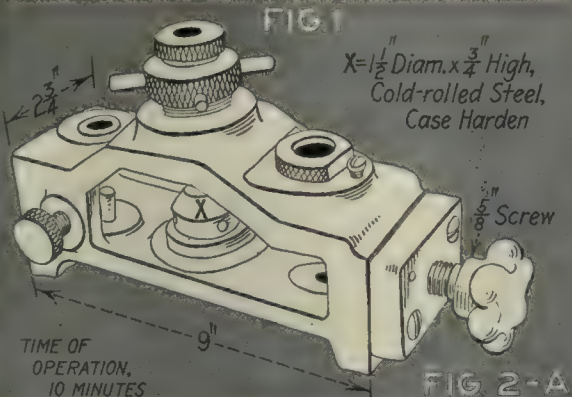
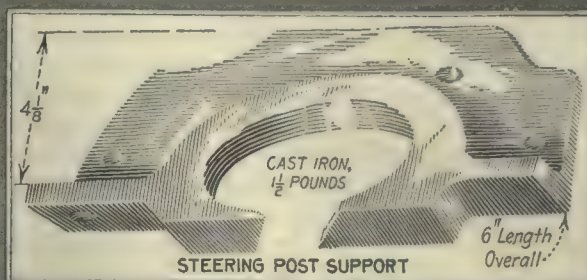
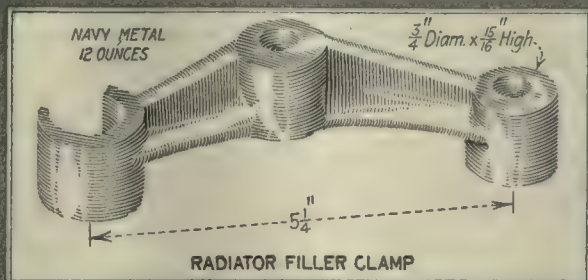
Operation—Drilling and reaming dumper clutch fork, Fig. 7. The forging is located against a steel semicircular block, being forced against it by a V-fitting around the boss operated by a knob-headed screw. A knurled headed screw is then tightened against the piece to hold it in position.

Hole Machined—One $\frac{47}{64}$ -in. drilled, after which it is reamed to $\frac{3}{4}$ in.

FIGS. 10 AND 10-A

Operation—Drilling rear spring clip spacer, Fig. 9. The casting is located against two button-head screws, the piece being forced against them by a pin-headed screw.

Hole Machined—One $\frac{3}{8}$ -in. drilled.



ALL BUSHINGS USED FOR GUIDING TOOLS ARE BLACKENED. ALL JIG AND FIXTURE BODIES ARE CAST IRON. STRAPS AND FASTENINGS, MACHINERY STEEL; GUIDE BUSHINGS ARE TOOL STEEL, HARDENED AND GROUND

Adjustable Blade Die

By WILLIAM SCHNEIDER

The adjustable threading die illustrated and described herewith was designed for severe usage, as will be seen from its construction. It is built along such rigid lines that it possesses practically the same strength as a solid piece of steel.

The general design of the mechanism is simple, as may be seen by referring to Fig. 1. The die is designed for threading brass rings that are cast into cast-iron disks. I tried all kinds of dies on this job with varying success, until the one shown exactly filled the bill.

The time- and money-saving feature is the small cost of making the chasers as well as keeping them in good working order, which results were secured as follows: A hob to be used on the miller was made for each dif-

ferent pitch of thread it was desired to cut. These hobs were made somewhat different from the ordinary chaser hobs, for instead of having a lead, which is required for die hobbing, the pitch only was needed. The hob was made about $\frac{1}{4}$ in. longer than the chaser and of sufficient diameter to insure easy and fast cutting.

The method of threading, or hobbing, the chaser was to place one set of six in an ordinary miller vise, at one side of which was fastened a step block, each step corresponding to the lead. This arrangement makes certain that the chaser is of proper length and even at the cutting point, when placed in position. The chasers were made in sets and kept in stock in the tool crib, so that when one set was dull, it was not necessary for the man on the job to wait until it could be ground and put into shape. It was only necessary for him to loosen the screws *I*, Fig. 1, to remove the dull ones and insert sharp ones in their places, without disturbing the set-up of the machine or die.

The construction of this die is clearly shown in Fig. 1. At *A* is the main body, which should be made of machinery steel or a material equally as strong. At *B* is

the body ring, which is a light driving fit over the body *A* and is held onto the body by the screw *L*. Two pins *E*, Fig. 1, which are a driving fit in the body *A* and a sliding fit in the turret head, act as a key to keep the die head rigid and also to prevent unnecessary strain on the shank *F*.

The hardened tool-steel sizing plug *J* is made of the same size as the piece to be threaded. The sizing plug pin *D* is made so that when screwed into and tightened against the body *A* by the use of a spanner wrench at *G* the sizing plug *J* will be free to revolve without any end play.

The high-speed steel chasers *C* are held in place by the setscrew *I*. At *K* is a hardened screw to keep the sizing plug from revolving when inserting the chasers and also to prevent it from revolving when the die is in use.

To set the chasers for varying lengths of thread, loosen the setscrews *I* and insert the spanner wrench in the sizing plug *J* at *H*. As this plug is threaded for the lead and pitch of the thread to be cut, it will be readily seen that, when turned to the right or left, it will lengthen or shorten the distance from the end of the chaser and the head. As the chasers become dull, they are ground off on the face *M*. This can be done until they are so short that they are held with only a single screw *I*. If, as so often happens, one or two threads break off

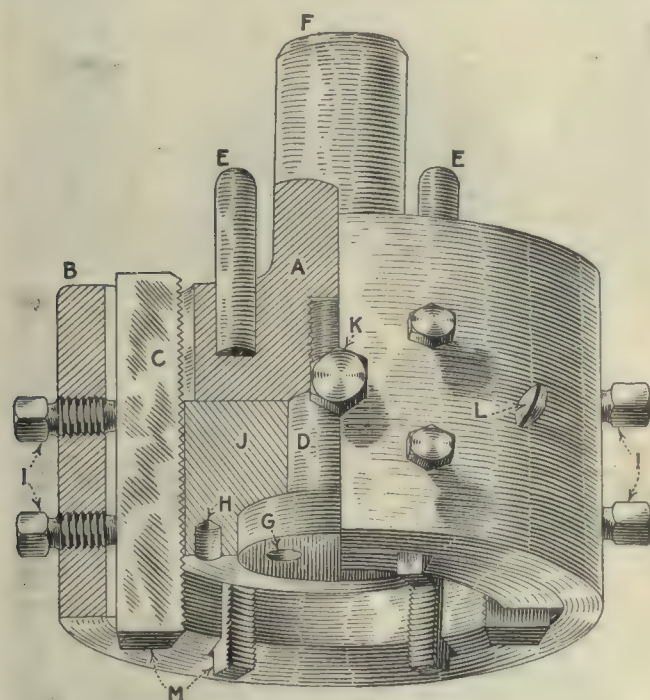


FIG. 1. ADJUSTABLE THREADING DIE

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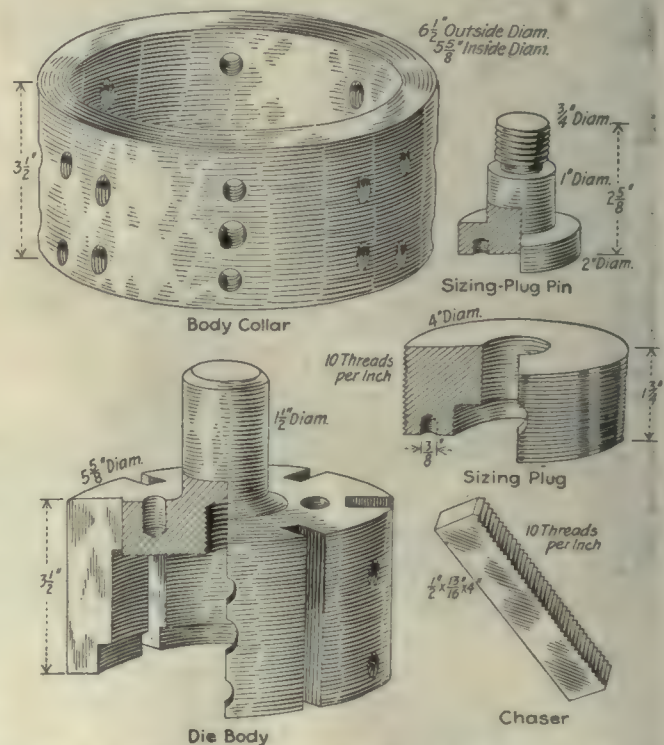


FIG. 2. DETAILS OF ADJUSTABLE THREADING DIE

from one chaser, it is not necessary to condemn the complete set. Grinding off the broken end and resetting the cutting edge in line with the rest are sufficient. If a hard spot is struck in the work or if for any other reason one or more chasers become too short to be firmly held in place, any one of the steel chasers can be inserted in its place after grinding the lead to correspond with the balance.

The details shown in Fig. 2 are for a 4-in. 10-pitch die head. The same construction can be carried out on larger or smaller die heads.

Double-Helical Gear Cutter

SYNOPSIS—Details of a machine in which double-helical gears are produced by a shaping process. The teeth are generated by cutters of the pinion type. The machine described is the first of its type and for repetition work is calculated to be an extremely rapid producer.

The Power Plant Co., Ltd., West Drayton, Middlesex, England, which has for long specialized on the production of machine-cut double-helical gears, has recently undertaken the manufacture of a new machine for this purpose, designed by W. E. Sykes. It produces double-

of the cutting edge being in the same plane, approximately at right angles to the cutter axis.

For the production of double-helical gears two of these cutters are necessary, one working from the right-hand, the other from the left-hand side of the blank. Each cutter reciprocates over half the face of the blank, and they work alternately; that is, while one is on the cutting stroke the other is on the return stroke. The burr of metal left by one is removed by the other, the resultant tooth being clean cut with a sharp angle or apex, inner and outer.

A special machine has been built to grind cutters of any desired pressure angle or spiral angle, but this is

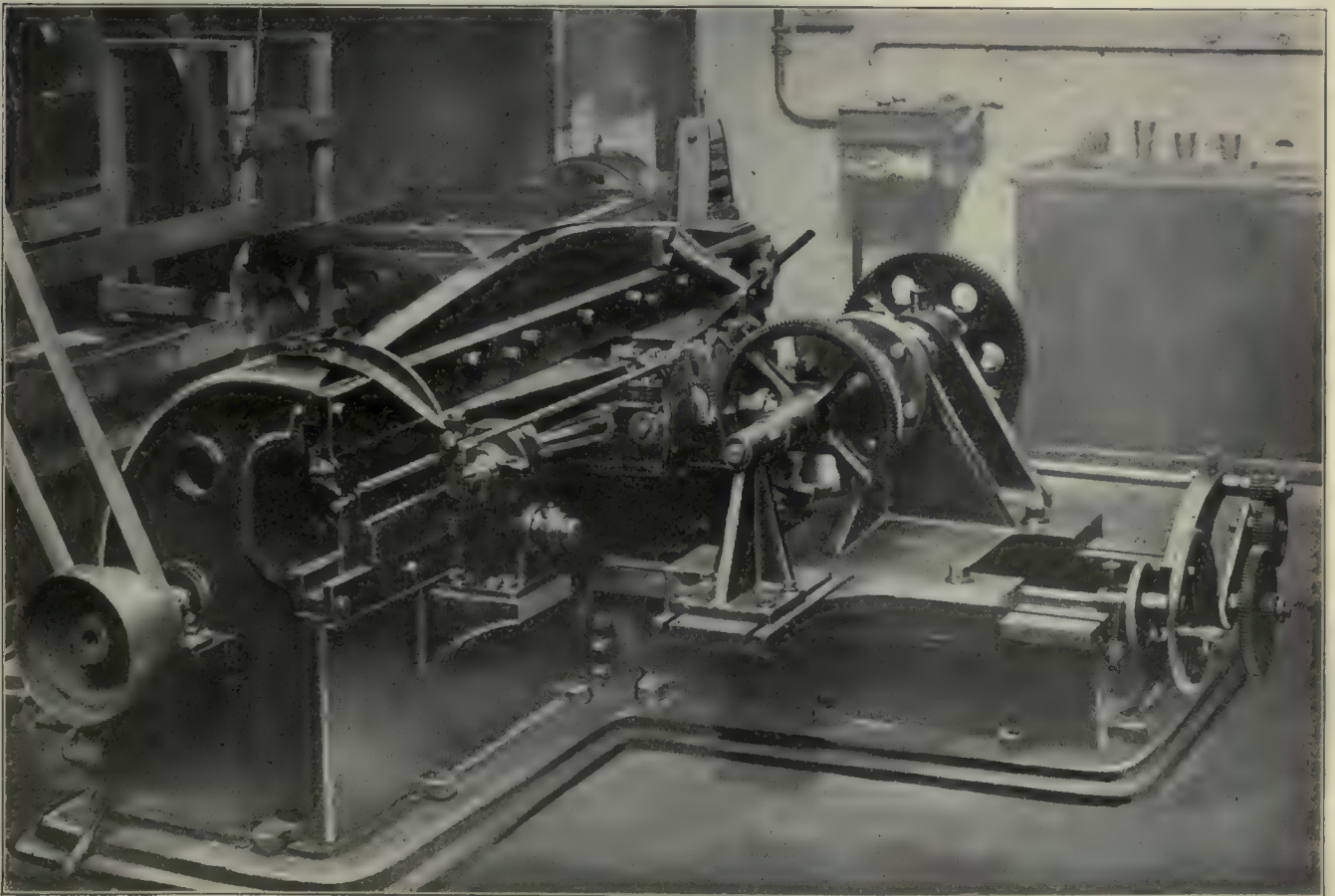


FIG. 1. SYKES DOUBLE-HELICAL GEAR CUTTER

helical gears by a shaping process. In the past the firm has cut these gears by the hobbing and end-milling processes.

In the new Sykes machine the teeth are generated by cutters of the pinion type. The tooth curves are true involutes without compromise, the cutters being in the form of single-helical pinions, modified only so as to produce the necessary cutting edges. These cutters are first milled by a generating process, then hardened and afterward ground to correct profile also by a generating process.

The cutting ends or faces of the cutter teeth are ground concave, and one of the side cutting edges on each tooth is arranged to remove all the metal in the blank up to the inner meeting points of the teeth being cut, the entire profile

not yet on the market. The machine built will take blanks up to 27-in. diameter by 12-in. face width. It was in fact designed for wheels not exceeding 15-in. diameter by 4 diametral pitch, the dividing wheel being 20 in. in diameter. As to minimum diameter, this depends on the size of the cutter; with a 5-in. cutter the smallest diameter of blank is $1\frac{1}{2}$ in.

The standard pressure angle adopted for the cutters is 20 deg., but cutters of $22\frac{1}{2}$ -deg. pressure angle are also provided. The cutter-grinding machine, however, can produce cutters of any desired pressure angle.

Front and back views of the machine are given in Figs. 1 and 2. The mechanism divides itself into two parts—cutter operating and work operating. The machine is in fact made with two separate beds bolted together after

completion, and the only operating connection is the feed-shaft. The wheel blank is secured, as shown, on an arbor mounted in the hollow spindle of the headstock which carries the main index wheel and worm. The wormshaft is splined and connected through change gears to the feedshaft, which forms the connection to the cutter mechanism.

The cutters are reciprocated across the face of the blank by cranks, which will be seen in Fig. 2, the crank disks being driven through worm gearing inclosed in a case. During reciprocation the cutters have a screw motion imparted by the spirally fluted bars, which reciprocate in the nuts formed in the cutter index wheels. The cutters therefore represent single-helical pinions of narrow face reciprocating in a helical wheel. In addition, the cutters slowly revolve in unison with the wheel blank, this being equivalent to that of a spur wheel and pinion. This motion, besides generating the tooth profiles, serves as an automatic feed. It consists of a simple interconnection between the cutters and the wheel blank and is operated by the ratchet feed, shown in Fig. 2, driven by a small crank disk on the end of one of the main crankshafts. A tilting motion operated by friction rods lifts the cutters from the work on the

its operation, as the change gears are in the same ratio as the number of teeth in the cutters and the number of teeth to be cut; the number of teeth in the driver equals the number of teeth in the cutters, and the number of teeth in the driven equals the number of teeth to be cut.

In the machine described, cutters with 5-in. pitch diameter are generally used. As the spirally fluted bars have a lead of 74 in. and as the connecting gear wheels have a ratio of 2 to 1, the lead of the cutters equals 37 in.

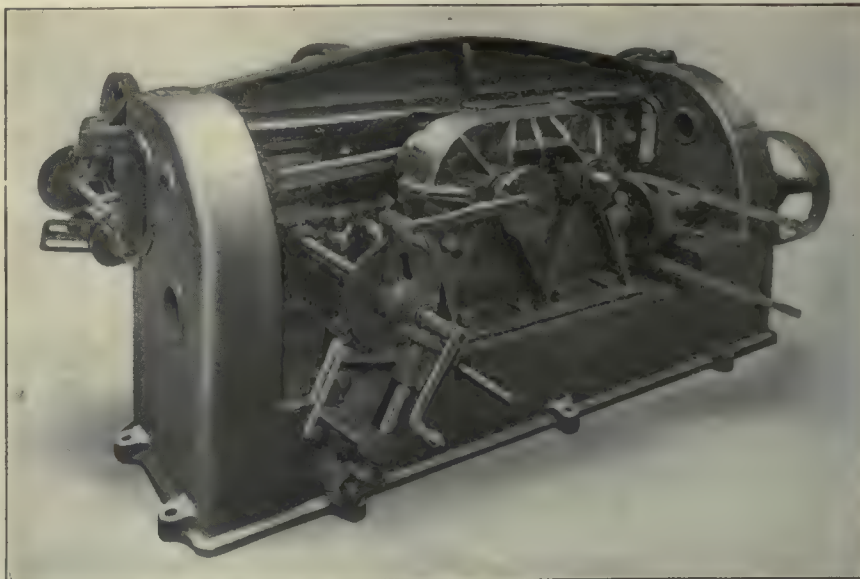


FIG. 2. REAR VIEW OF SYKES GEAR CUTTER

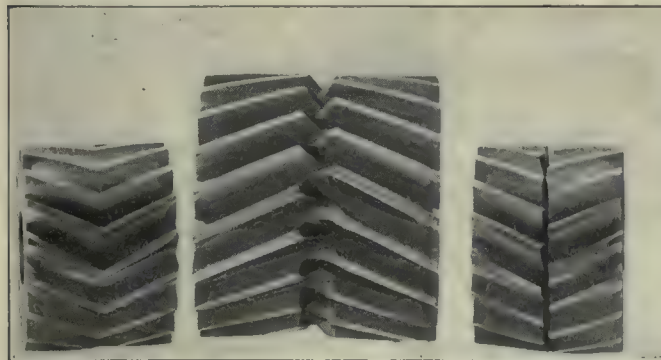


FIG. 3. THREE TYPES OF DOUBLE-HELICAL GEARS

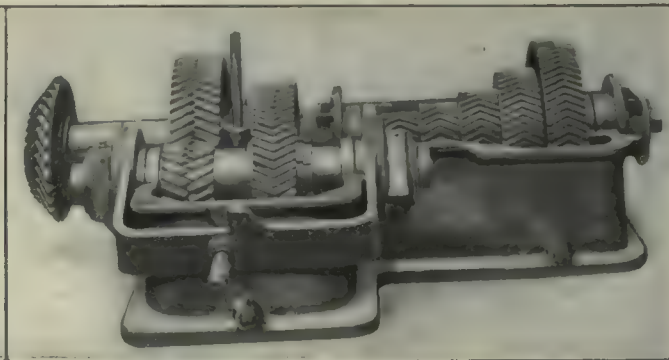


FIG. 4. A 10-SPEED GEAR BOX WITH SYKES GEARS

return stroke. This tilting motion is obtained by fresh adaptation of the ordinary clapper box used on shapers and planers.

The housings carrying the cutter spindles are hinged, the axis of the trunnions being in line with the pitch line of the gear wheels connecting the cutter spindles and the spirally fluted bars; the point of intersection is at one end of the teeth, so that on the return stroke the teeth are in mesh at only one end. This however, has no bad effect on the teeth, because the pressure on the return stroke is very slight. Suitable seatings and abutments are provided, which insure rigidity on the cutting stroke. The blank is advanced toward the cutters by the hand-wheel, Fig. 1, until the desired depth is reached. This can be done while the generating mechanism is in operation. An automatic depth-feed mechanism has been designed, but has not yet been applied.

It will be gathered that the arrangement of the machine is very simple. No calculations are necessary for

With cutters 5 in. in diameter the spiral angle is 23 deg. If cutters of 6-in. diameter are used, a spiral angle of 27 deg. is obtained. Therefore, to alter the spiral angle it is only necessary to use cutters of a suitable diameter. Alternatively, the spiral bars can be changed, or otherwise the ratio of the driving wheels can be altered. It is found, however, that all ordinary requirements are met by choosing cutters of suitable diameter.

The machine has up to the present cut about 2,000 gear wheels, and it is claimed that it cuts about twice as fast as the hobbing machine designed for double-helical gears. There is no doubt that it produces double-helical gears with continuous teeth very much quicker than a machine using end mills. The cutters are ground with profiles of true involute form, and some have cut as many as 50 steel wheels without any need of resharpening. This is explained by the fact that the cutters, being strong, can be made harder than the teeth of hobs. The cutting times of 4-point steel and cast iron about match.

A 27-in. diameter cast-iron wheel, 3-in. face, 4 diametral pitch, was cut in 72 min. The machine was making 90 strokes a minute, and the feedshaft made one revolution in 12 sec. Now 120 revolutions of the feedshaft equals one revolution of the blank; therefore, the blank revolved once in 24 min. Three cuts were taken with this wheel, making the total time 72 min. The times required for production are approximately as follows:

Gears Up to 6 Diametral Pitch and 5-In. Face			
Diameter, In.	Cutting Time, Min.	Setting Time, Min.	Total Time, Min.
2½	9	5	14
5	17½	5	22½
10	35	5	40
20	70	8	78
25	85	10	95
Gears Up to 5 Diametral Pitch and 4-In. Face			
5	23	5	28
10	40	5	45
20	80	8	88
25	100	10	110

The setting time of course refers to gears of same pitch, diameter and face, and does not allow for change of ma-

chine for cutting gears that are of different diameters. Fig. 3 shows three different types of double-helical gears that have been produced on the Sykes machine. The first is the type with continuous teeth; the second is an example of staggered teeth, while the third has a narrow groove in the center, the teeth being staggered one-half the pitch.

Fig. 4 shows a 10-speed gear box with cover removed. It will be noticed that the tumbler gears are of the continuous-tooth type cut on the Sykes machine, while one of the back gears is of the staggered type; the bevel gear at the end is cut by the end-milling process. By a simple modification this gear shaper can be arranged to cut straight-tooth gears, using both cutters. For repetition work the machine should be an extremely rapid producer.

The double-helical machine described is the first of this particular type and has been thoroughly tested.

Chucking 8-In. Shells

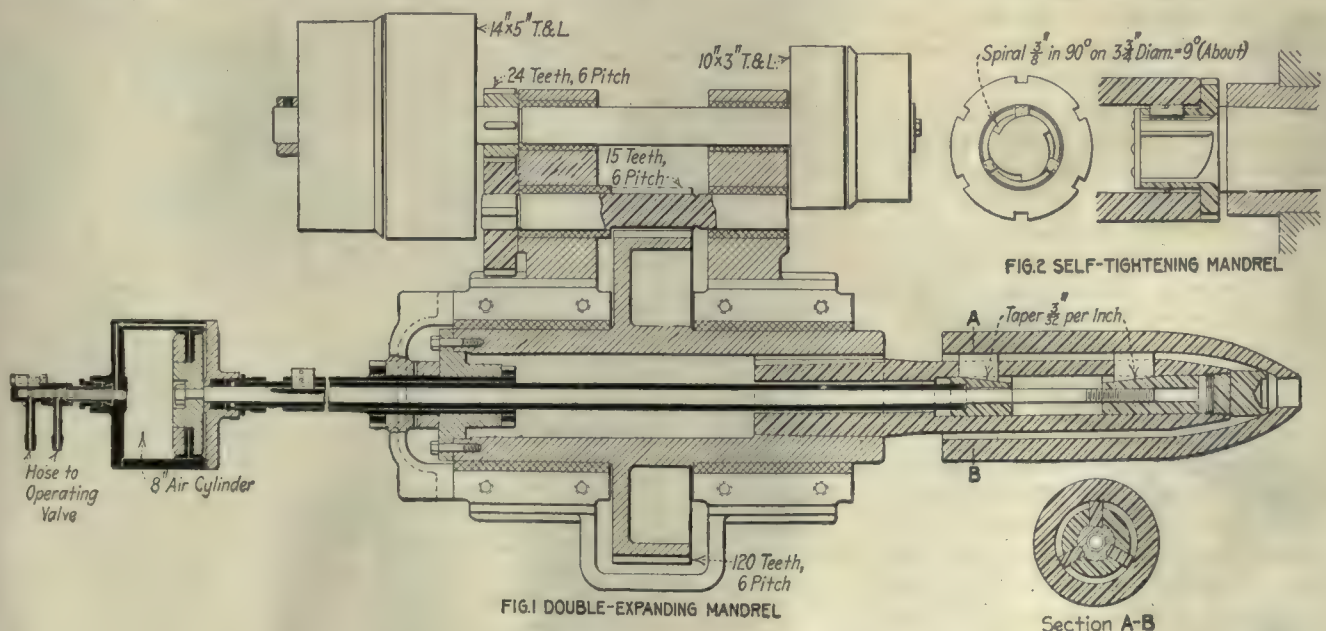
By H. V. HAIGHT*

SYNOPSIS—Methods in successful use for rapidly and securely chucking 8-in. shells for the various machining operations. These methods include self-tightening collet chucks, self-tightening expanding mandrels and air-operated expanding mandrels.

The methods of chucking described below have been developed in a plant making the British 8-in. howitzer shell. There is a large amount of stock to remove from

for this work. The principal difficulty with the ordinary jaw chuck is that it has no "follow up." Consequently, if the work slips the least bit in the jaws, it wears and loosens the jaws slightly and goes on slipping more and more. Finally, it becomes necessary to stop and tighten the chuck. The next time the operator tightens the chuck very hard. The result is that there are some new chucks wrenches to make and jaws and screws or scrolls to be replaced.

In presenting a chucking device so that it can be successfully copied in another shop it is essential to give



FIGS. 1 AND 2. TWO FORMS OF SHELL MANDRELS

the forgings, and the feeds are heavy, so that it was essential to have the shells held very securely. An extensive experience in making smaller sizes of shells had shown that the ordinary jaw chuck was not suitable

two items of information: The general idea, which can be shown by sectional drawings; and the proportions on which the successful holding of the work depends—that is to say, the size of air cylinders, angles of jaws, pitch of threads, etc. Such details are usually lacking, and I take this opportunity to mention this omission.

*Chief engineer, Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, Quebec.

ribs for the copper bands. With either Fig. 2 or Fig. 5 self-tightening mandrels, the very self-tightening feature implies that the work may turn slightly under the pressure of the cut and thus tighten up; but if the work turned slightly when cutting the waved ribs, it would throw them out of register and cut them entirely off. For this reason the single expanding mandrel operated by air is better for this work. An 8-in. cylinder was found too small to hold the work securely, but a 10¼-in. air cylinder gives satisfactory results.

In Fig. 7 is illustrated the self-tightening chuck for holding the shells for all operations on the inside and on the base. The shell is shown in position in the headstock of the thread miller, but it is held in the same way for boring, reaming, counterboring and facing the base after the base plug is screwed in. In Fig. 8 are shown the details of the collet ring. It will be noticed that the ring is cut in six pieces, which are held apart

way, as the pressure of the cut has a tendency to pull the work out of the chuck.

In Fig. 11 is shown a simple cone chuck or cup center for driving the shell when turning the copper band. This is not altogether satisfactory for two reasons: It takes a little time to enter the driving pin in the hole in the adapter; as band turning is a comparatively short operation, this makes a proportionately large waste of

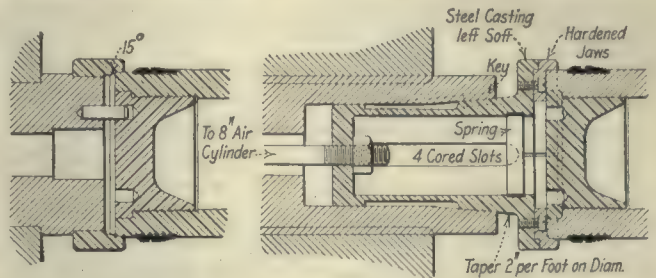


FIG. 11 CONE CHUCK

FIG. 12 DRAW-IN COLLET CHUCK

FIGS. 11 AND 12. TWO FORMS OF CHUCK

time. The other difficulty is that the shell is centered by the rounded corner; if this corner is not turned concentric with the body, the band will not be turned concentric with the body. An air-operated collet chuck, Fig. 12, is being made up to take the place of this cone chuck. On account of the space taken up by the block that holds the band-turning tools, the collet chuck could not be made any larger in diameter than the cone chuck, and this fact accounts for the rather close design of the collet chuck. This design has not yet been tried, but all the others are in successful use.

Visiting--A Visitor's View

By W. OSBORNE

In a busy world each man cannot investigate everything with which he comes in contact. If he tried to, he would not have time for anything else. This leads to styles—yes, in thought, as well as in practice—and it is only when something gives us a jar that we stop and, if not in too big a hurry, do a little analyzing.

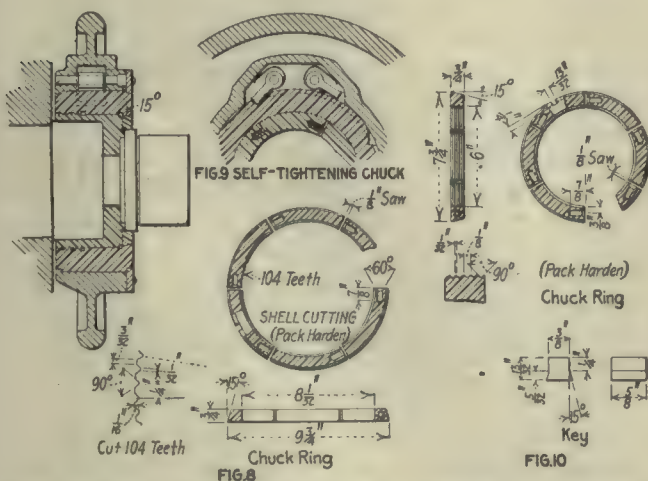
I got a little jar lately. It was this: Finding it necessary to be in a large manufacturing city in the Middle West for some length of time on business not in any way connected with the buying of equipment or supplies, but having a bit of spare time now and then, I thought that, as I had opportunity, I would visit some of the manufacturing plants that were somewhat in my own line. That would take in the foundries and the machine shops.

Everybody knows that the *style* at present in such business is "Visitors Welcome." For a time things progressed smoothly enough. Then came the jar that has set me thinking.

To save time, which in my case was available in limited quantities at intervals only, I got a letter from a friend to a manager of a plant that I wished to visit. This plant was a foundry and was not at all likely to be getting any business, at least directly, from our part of the country, which is several hundred miles away.

THE EXPERIENCE THAT SET ME THINKING

The city is a large one, and the plant is in the suburbs. If there is a sign on the outside of the buildings or in the office that gives the name of the company



FIGS. 8 TO 10. SELF-TIGHTENING CHUCK AND DETAILS

by small spiral springs. The ring has a keyway that engages a key in the nut of the chuck, and this makes it self-tightening. The chuck is tightened or loosened by a momentum wheel that revolves loosely on the chuck nut and has two pawls that engage in notches in the chuck nut. By backing the wheel up and then bringing it forward with a bang, it strikes a blow on the nut that tightens or loosens it very effectively.

In reference to the headstock, a point that requires explanation is the feed for the thread milling. This machine is a double-spindle thread miller, one spindle carrying standard milling cutters for truing up the counterbore and cutting the clearance at the end of the thread, the other spindle carrying a thread-milling hob. The spindle extension is threaded the same pitch as the thread to be cut and is always in engagement with its nut. The nut also carries an arm with two pawls. When one of these pawls is engaged, the nut revolves with its screw and the counterbore can be milled. When the other pawl is engaged, the nut is prevented from revolving; the screw then feeds through the nut, and the thread can be cut. Before the spindle has been fed far enough to come to the end of its travel and break anything, it strikes a bell that calls the operator's attention.

In Fig. 9 is illustrated a self-tightening chuck similar in principle to the one in Fig. 7, but designed for holding the base plug. Details of the chuck ring are shown in Fig. 10. The teeth of this ring are cut the other

or tells the nature of its business, I did not see it. The space to which a caller is limited is small, but gives a view of the office and of another office across the room.

After looking me over carefully, a man opened a window and asked me the nature of my business. I asked if the manager was in. Being informed that he was, I told this man that I had a letter to the manager, which would explain what I wanted. At the same time I produced the letter. He did not take the letter, but walked across the room and came back and asked me to be seated, saying that the manager was busy at that moment, but would see me soon. This manager was sitting in his office in plain view, smoking a large pipe and talking to someone and facing toward me. While I was there, several men passed in and out to him; and he came out twice and walked leisurely around near his office door, still smoking. I sat on that bench for an hour, and from all appearances might have been allowed to sit there another hour; but my time was running out, so I informed the man at the window that evidently people who called except by special invitation were intruders and that I would not trespass any further. I came away.

I could not think that there was anything personal in my treatment. I was a stranger. I had my Sunday clothes on. I acted courteously to the man at the window, and he acted courteously to me. Evidently, here was a system that I was not in line with and a place that did not desire to encourage callers.

HAS SHOP VISITING A REASONABLE FOUNDATION?

That was the jar. I have thought the matter over and have wondered if our ideas on visitors and visiting have been following the style and have not been founded on a reasonable foundation.

A machine shop and a foundry being part of the corn-sheller business, I am interested in them. Each one has some individuality of its own. By visiting, I may see the difference in practice and hear the difference in theory on which they are run and so improve my own practice. Incidentally I may meet some men in the same business whom it is a pleasure to know. I may be able to see in operation systems or methods or machinery or devices that have been written about. Seeing them, I am able to judge whether or not they would fit in my place along with my present practice; or if not, how much change would be necessary to make them fit. I may be better able to judge whether my own practice is above or below the average. There are numbers of other good reasons why I should like to visit other shops.

You will please observe that all these reasons show that in some way I might be benefited by my visiting. As an admission fee is not charged to visitors, the places visited should have some way of getting a return. If I, being owner, superintendent, foreman or machinist of a corn-sheller works, should go to a machine-tool builder and ask to see his shops, I can see why he should be willing to spend some time with me. It is advertising expense. Even if I am a farmer or someone else not at all directly interested in the use of his machinery, it is still a good bet that, being interested enough to visit, I will be interested enough to talk about it and so help his publicity campaign. Valuable suggestions or criticisms may come from some of the visitors. Present or future orders may be lurking about the person of some of these visitors and not be revealed until after the visit.

There are numbers of shops that can, at a profit to themselves, encourage visitors. Has it been the views of such shops that have set the style of thinking, as a general proposition, that visitors should be welcomed? Why should the foundry referred to allow me to visit it? What benefit could its owners reasonably expect to receive that would pay them for the cost of my visit?

I do not know that the efficiency engineers have as yet isolated, tabulated and laid out curves showing the cost of visitors in any plant under their charge; but that there is a cost, there can be no doubt. I cannot think of anything to set off against the cost to that foundry. Even if its work should come to me, it has lost its identity before I get it. As yet the machine-tool builder does not state that his machines are better because made in a certain foundry. Two lathes received from him at the same time may have been made in different foundries, for all I know. The foundry I tried to visit cannot sell castings as castings in my part of the country. Freight rates prevent it. If on going to such a place I should be confronted with a sign something like this, "Visitors not received except by special arrangements made beforehand through the office," I could see a good reason for it from their standpoint.

In engineering we have made progress to the point of doing things for good engineering reasons more than for mechanical style. Why should we not do the same thing in such matters as these—not try to do it by indirection? If we believe that visitors are unprofitable, let it be so known. It will not leave as bad a taste as it does to make it so tedious that attempted visitors are discouraged and give up the attempt. I would say that I am not alone in my opinions on this subject.

VISITORS, IF ALLOWED, SHOULD RECEIVE ATTENTION

There is one other point. If visitors are allowed, they should receive attention enough to make it a visit. Many men of some mechanical importance—but without orders in their pockets at the time—have been walked through plants in charge of a guide who was mechanically entirely ignorant of the plant and its work. His only qualification was that he was possessed of a pair of good legs and a bored look. Such treatment seems a trifle like a very strong hint not to intrude again.

If we are to have a change of style in such matters, somebody must start the ball. My idea is that visitors have no right to expect a welcome from any plant unless, from some angle, that visitor has a chance of being profitable to the visited. My claim is that visitors generally do not look at it that way, nor do the visited.

■

Overtime Fatigue

As the result of some interesting investigations carried on under the direction of the Home Office, London, England, a report published in the form of a Home Office Blue Book draws the conclusion, based on a long study of industrial fatigue, that as a permanent factor in assisting output, excessively long hours absolutely defeat the end in view. The instance of a man working a 16½ per cent. shorter day and producing 5 per cent. greater output is given to demonstrate that overtime is a double evil, for not only during the hours of overtime is the worker's output less than normal, but this reacting upon his general health has been proved to affect detrimentally also his daily output during normal hours.

United States Munitions*

The Springfield Model 1903 Service Rifle

Operations on the Receiver--IV

SYNOPSIS—This is the concluding article describing the manufacturing operations on the receiver—the most complicated part of the rifle, from the standpoint of number and complexity of operations performed. Milling, shaving, burring and profiling operations are in the majority, and many useful ideas regarding jigs, fixtures and equipment may be had by studying the devices used at Springfield.

On an article which is as complicated as the Springfield rifle receiver, speaking relatively to the number and sequence of operations, there must always be a large number of minor cleaning up, burring, filing, and polishing

difficult machining operations which have preceded them. And it is a fact that while these minor operations appear in themselves to be unimportant in the average shop they are often the ones that are found to delay most everything else. It is a case of little difficulties becoming big obstacles.

The progressive shop manager, especially in such plants as are concentrating their energies on mass production of one article, has an opportunity to make extensive savings in cost by eliminating the delays which necessarily arise with a succession of these minor operations. One of the most potent ways to save money on a sequence of such operations is to as far as possible eliminate the handwork.

No matter how highly skilled hand labor becomes, it can never approach the efficiency of a mechanical device

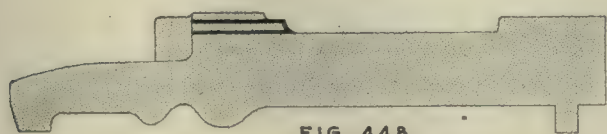


FIG. 448

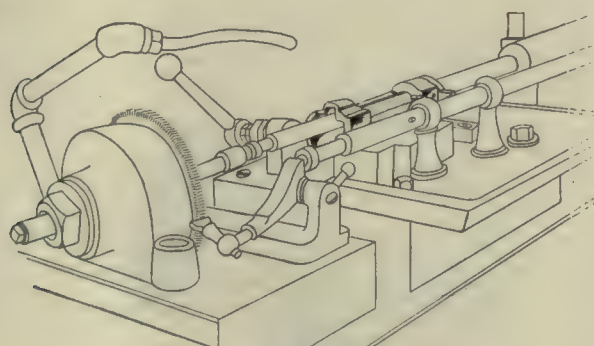
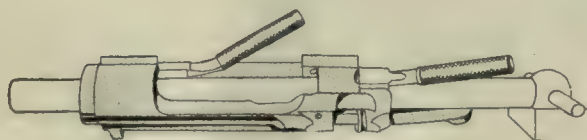


FIG. 449



Operation 52

OPERATION 52. SHAVING SAFETY-LUG SLOT

Transformation—Fig. 448. Machine Used—Machine made at Hill shops, Fig. 449. Number of Operators per Machine—One. Work-Holding Devices—Held in vise jaws. Tool-Holding Devices—In barrel. Cutting Tools—Radius cutters. Cut Data—30 strokes per min.; 0.005-in. feed. Coolant—Cutting oil, 1/2-in. stream. Average Life of Tool Between Grindings—150 pieces. Gages—Fig. 450: A, width; B, depth, curved to fit between plug and bridge over safety-lug slot. Production—50 pieces per hr. Note—Located by bottom and side.

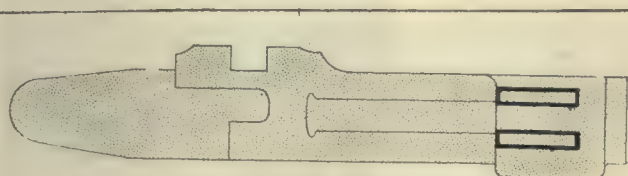


FIG. 451

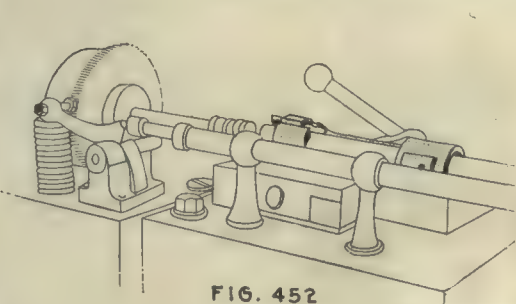


FIG. 452

Operation 53

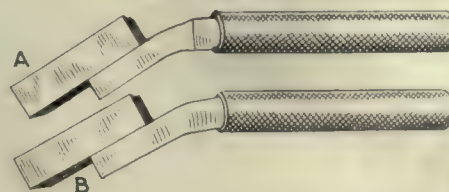


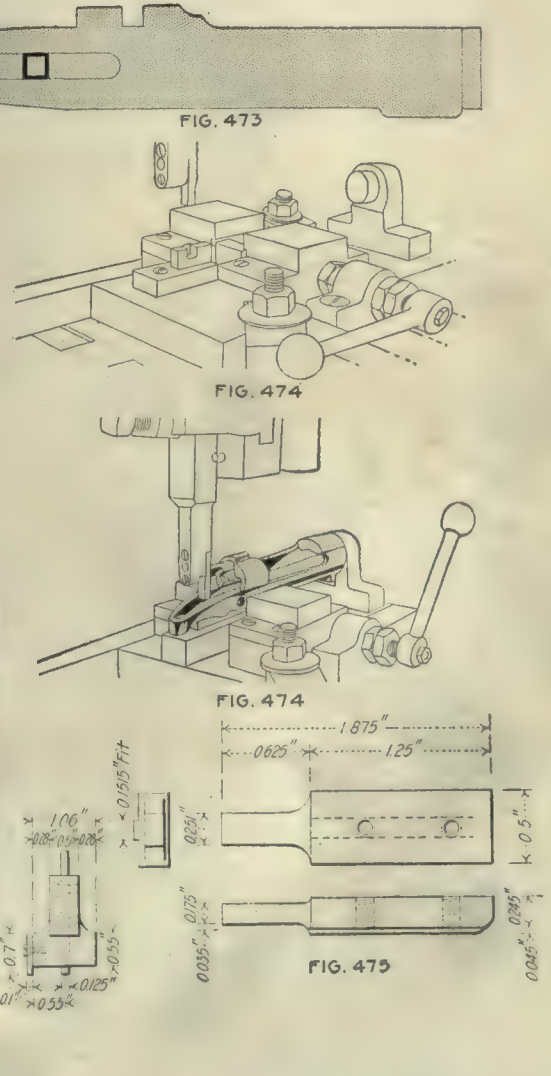
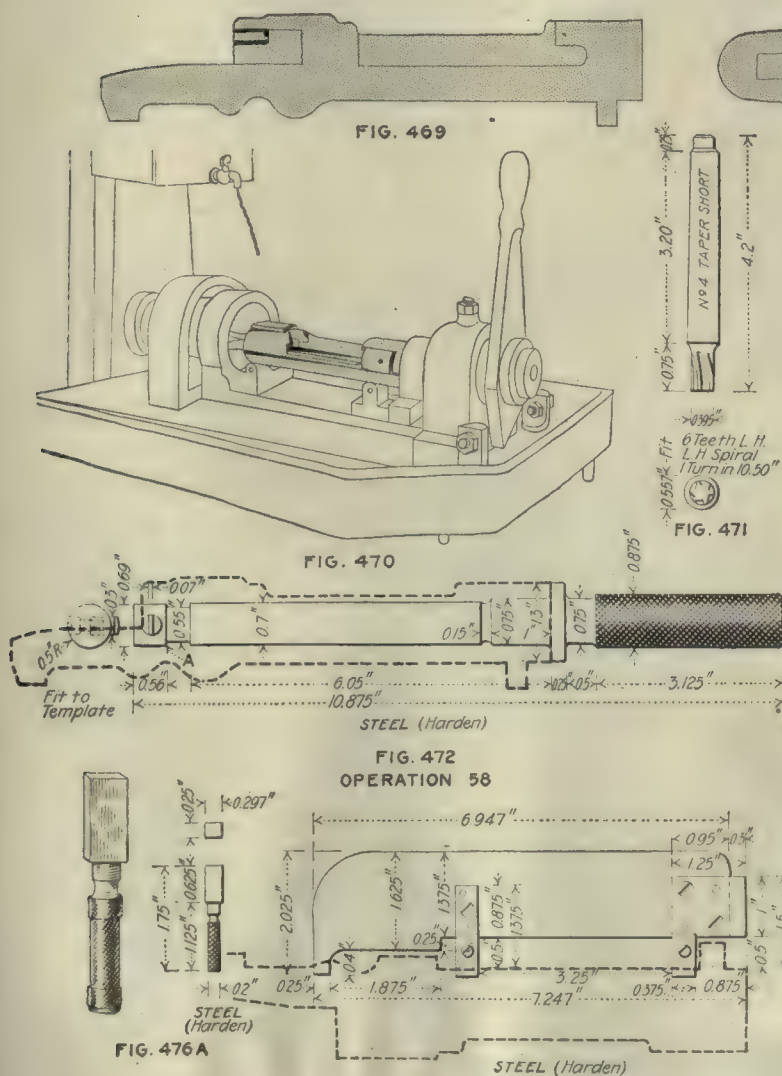
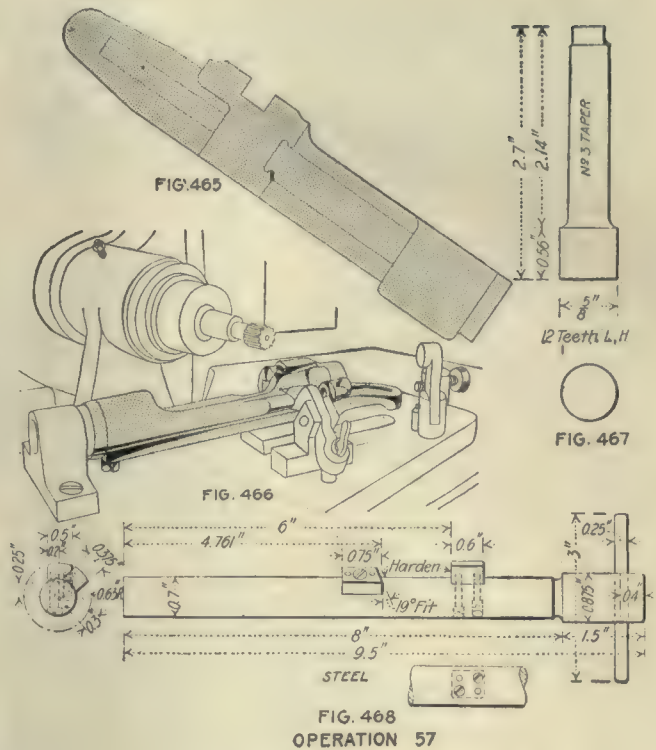
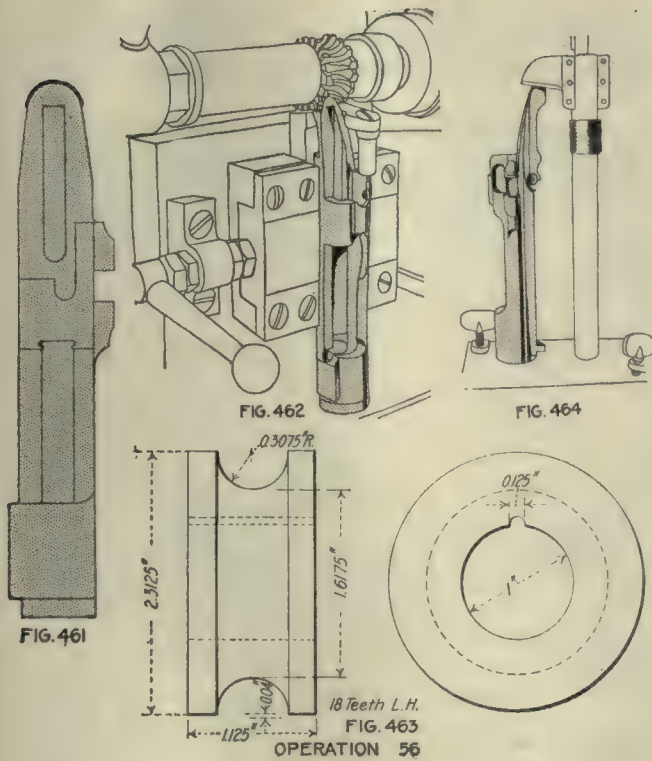
FIG. 453

OPERATION 53. SHAVING FRONT LOCKING-LUG SLOT

Transformation—Fig. 451. Machine Used—Machine made at Hill shops. Number of Operators per Machine—One. Work-Holding Devices—Held in vise jaws, Fig. 452. Tool-Holding Devices—Same as Fig. 371. Cutting Tools—Similar to Fig. 371. Cut Data—50 strokes per min.; hand feed. Coolant—Cutting oil, 1/2-in. stream. Average Life of Tool Between Grindings—150 pieces. Gages—Fig. 453, depth of slot, goes between plug and wall. Production—50 pieces per hr. Note—Locating points, bottom and side.

operations which are really as essential to the correct finishing of the piece as are the more pretentious and

properly designed to perform the same work. This is almost a self-evident statement, and it is borne out by a multitude of cases common to the experience of any shop



man. Possibly one of the reasons for the existence of this fact is due to the slight but inevitable period of time which must elapse between the conception of an idea and

its manual execution. It may almost be said that for very simple repetitive operations which do not require a high degree of intelligence, that the presence of intelli-



FIG. 477



FIG. 481

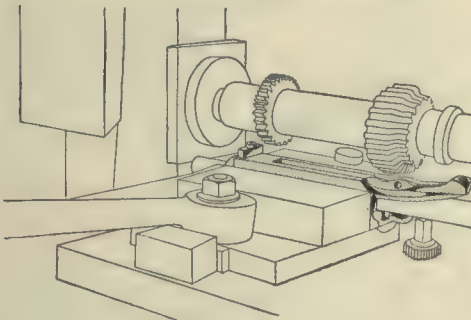


FIG. 478

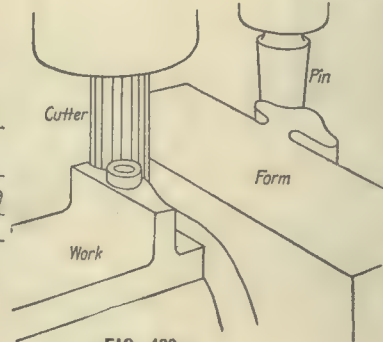


FIG. 482

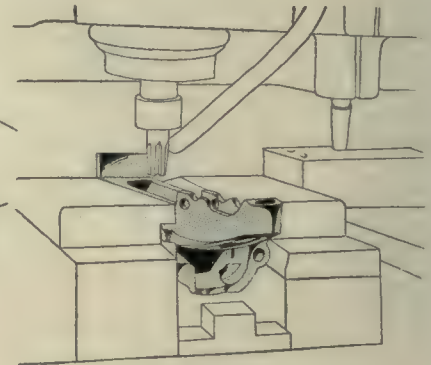


FIG. 483

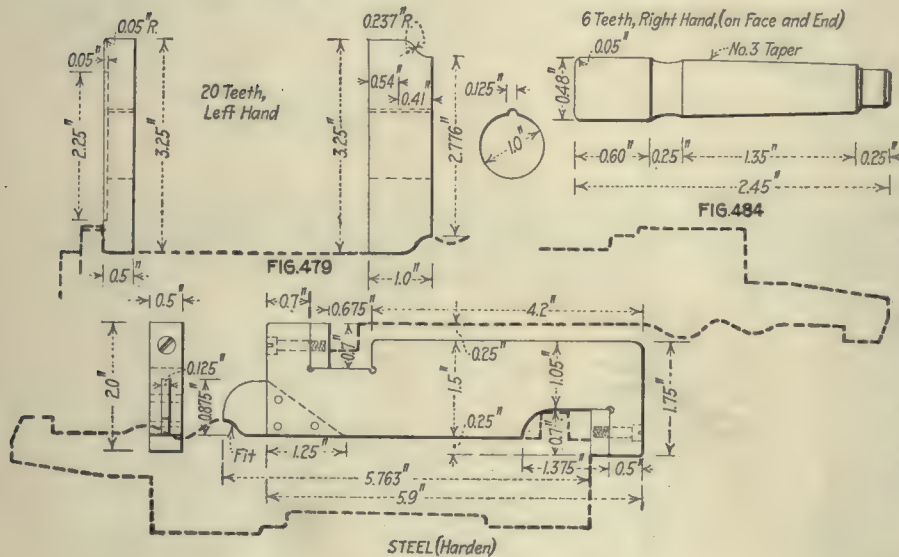


FIG. 479

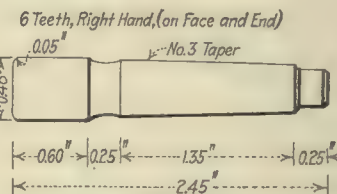


FIG. 484

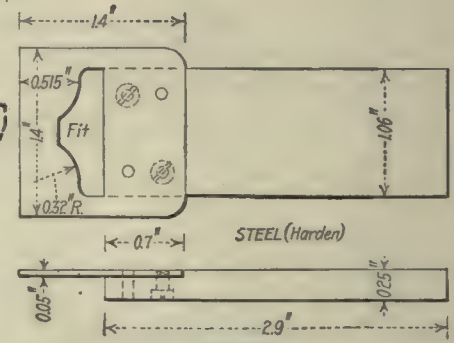


FIG. 485

FIG. 480

OPERATION 71

OPERATION 58. HAND MILLING EXTRACTOR CAM

Transformation—Fig. 469. Machine Used—Standard No. 4½ hand milling machine. Number of Operators per Machine—One. Work-Holding Devices—Held in rotating fixture, Fig. 470. Tool-Holding Devices—Taper shank. Cutting Tools—End mill, Fig. 471. Number of Cuts—One. Cut Data—Speed, 800 r.p.m.; hand feed. Coolant—Cutting oil, ½-in. stream. Average Life of Tool Between Grindings—4,000 pieces. Gages—Fig. 472, radius of recess behind cam and distance of cam from front of receiver; edge A shows through cutoff opening when distance is correct. Production—175 pieces per hr. Note—Locating points are hole and bottom.

OPERATION KK. REMOVING BURRS LEFT BY OPERATIONS 48, 49 AND 56

Number of Operators—One. Description of Operation—Removing burrs thrown up by operations 48, 49 and 56. Apparatus and Equipment Used—File and reamer. Production—150 pieces per hr.

OPERATION 59. SHAVING SEAR-NOSE SLOT

Transformation—Fig. 473. Machine Used—Bement Miles Co. slotting machine. Number of Operators per Machine—One. Work-Holding Devices—Held on a stud in vise jaws, Fig. 474. Tool-Holding Devices—Cutter screwed to holder, similar to Fig. 369. Cutting Tools—Slotting cutter, Fig. 475. Cut Data—60 strokes per minute; hand feed. Coolant—Cutting oil put on with brush. Average Life of Tool Between Grindings—300 pieces. Gages—Fig. 476: A, size of slot; B, position from front end of receiver. Production—75 pieces per hr. Note—Locating points, hole and bottom.

OPERATION 71. MILLING REAR END OF MAGAZINE TO LENGTH AND REAR OF RECOIL LUG

Transformation—Fig. 477. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Machines per Operator—Two. Work-Holding Devices—Held on mandrel and vise jaws, Fig. 478. Tool-Holding Devices—Cutter arbor. Cutting Tools—Facing mill and form cutter, Fig. 479. Number of Cuts—One. Cut Data—Speed, 80 r.p.m.; ⅝-in. feed. Coolant—Compound, two ¼-in. streams. Average Life of Tool Between

Grindings—2,000 pieces. Gages—Fig. 480, contour and distance of lug from front end. Production—50 pieces per hr. Note—Locating points, hole and sides.

OPERATION 69. PROFILING FRONT END OF RECOIL LUG

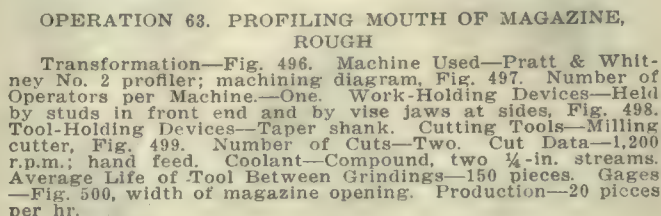
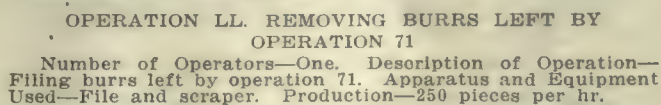
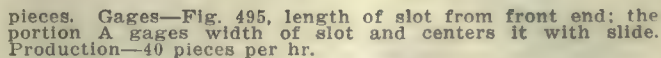
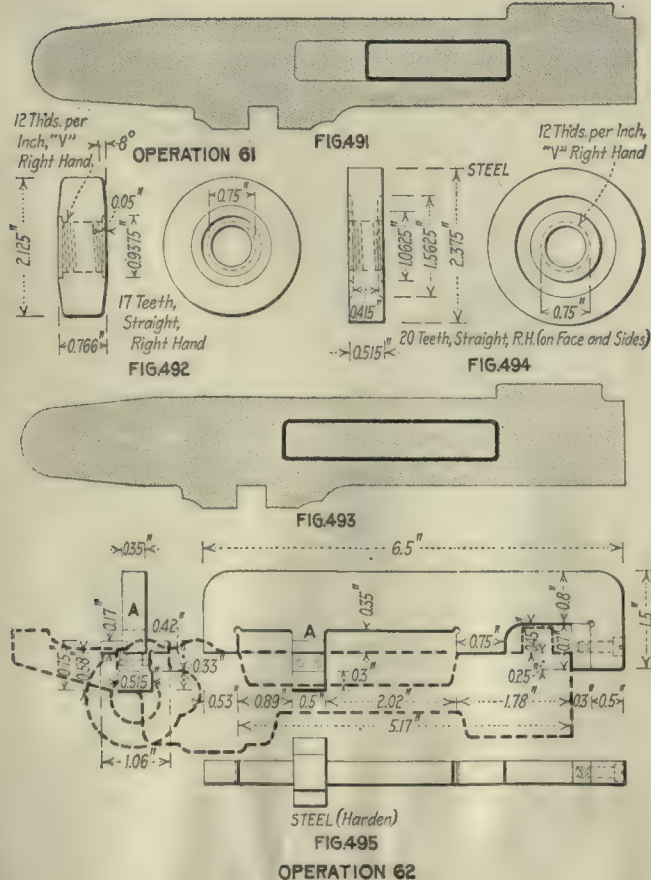
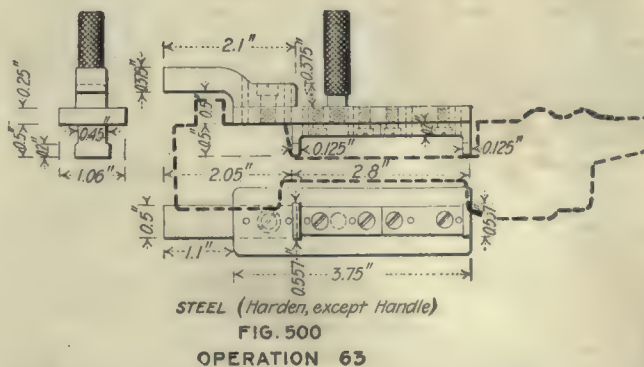
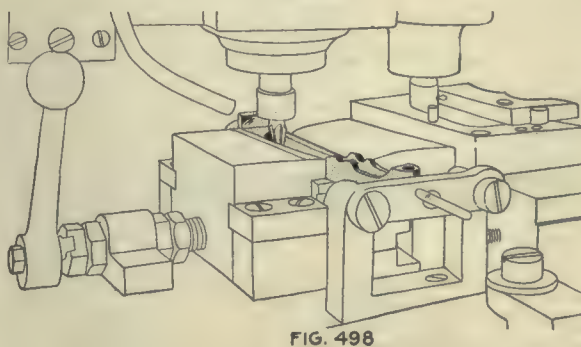
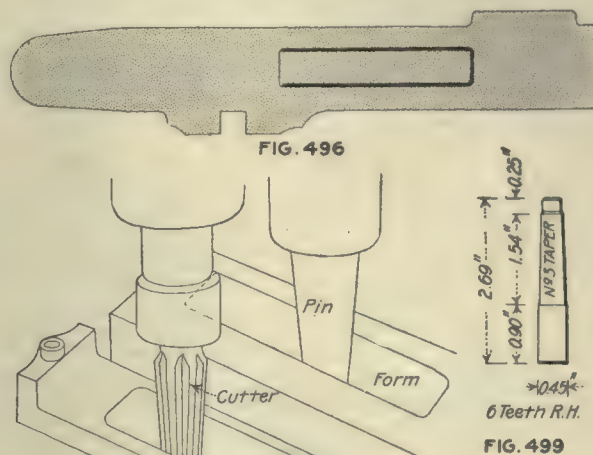
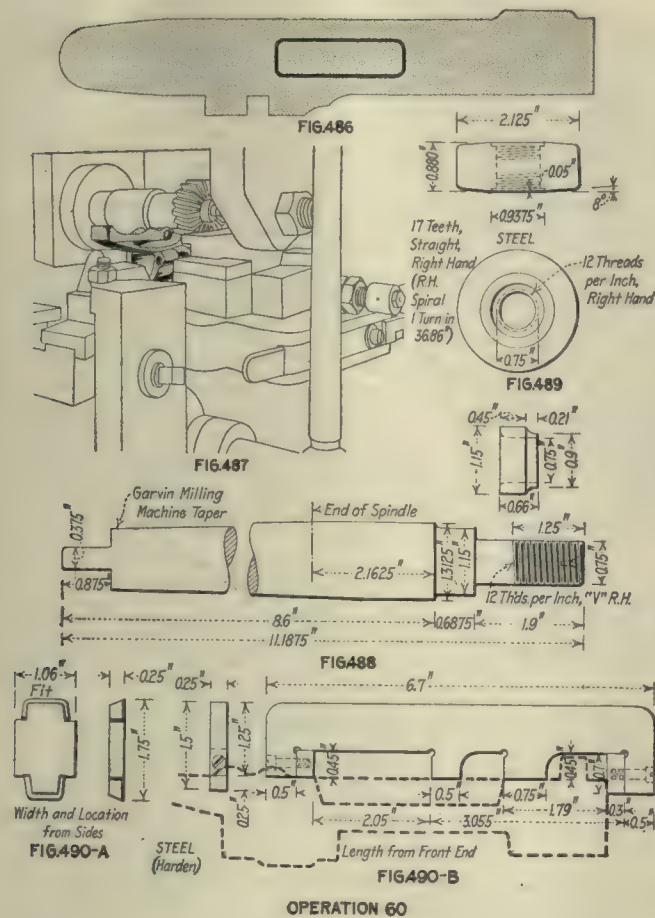
Transformation—Fig. 481. Machine Used—Pratt & Whitney No. 2 profiler; machining diagram, Fig. 482. Number of Operators per Machine—One. Work-Holding Devices—Held on stud and vise jaws, Fig. 483. Tool-Holding Devices—Taper shank. Cutting Tools—End mill, Fig. 484. Number of Cuts—Two. Cut Data—1,200 r.p.m.; hand feed. Coolant—Compound, two ¼-in. streams. Average Life of Tool Between Grindings—400 pieces. Gages—Fig. 485, form gage that fits over lug. Production—80 pieces per hr. Note—Locating points, hole and side.

OPERATION 60. MILLING THROUGH MAGAZINE REAR END (BREAKING THROUGH)

Transformation—Fig. 486. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Machines per Operator—Two. Work-Holding Devices—Held on stud and vise jaws, Fig. 487, on a rising and falling fixture to sink cutter into work. Tool-Holding Devices—Cutter arbor, Fig. 488. Cutting Tools—Side-milling cutter, Fig. 489. Number of Cuts—One. Cut Data—Speed, 130 r.p.m.; ⅝-in. feed. Coolant—Compound, ¼-in. stream. Average Life of Tool Between Grindings—2,000 pieces. Gages—Fig. 490: A, width; B, location from sides. Production—210 pieces per hr. Note—Locating points, hole and sides.

OPERATION 61. MILLING THROUGH MAGAZINE FRONT END

Transformation—Fig. 491. Machine Used—Garvin No. 2 Lincoln miller. Number of Machines per Operator—Two. Work-Holding Devices—Same as Fig. 487. Tool-Holding Devices—Same as Fig. 488, except to fit Garvin miller. Cutting Tools—Form cutters, Fig. 492. Number of Cuts—One. Cut Data—Speed, 120 r.p.m.; ⅝-in. feed. Coolant—Compound, ¼-in. stream. Average Life of Tool Between Grindings—2,000 pieces. Gages—See Fig. 490. Production—40 pieces per hr.



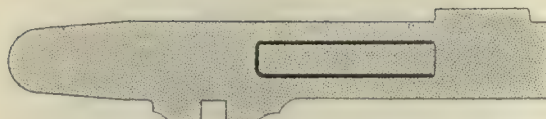


FIG. 501

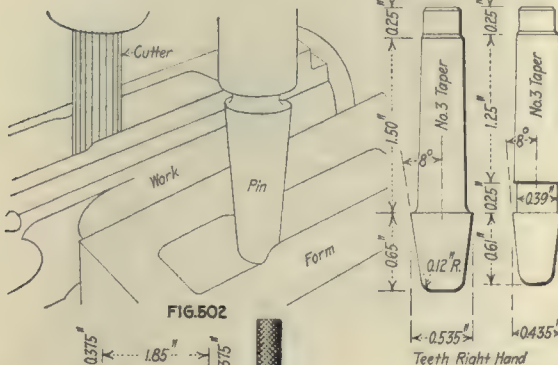


FIG. 502



FIG. 503

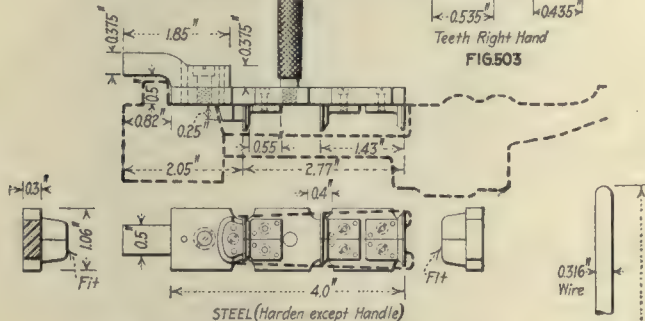


FIG. 504

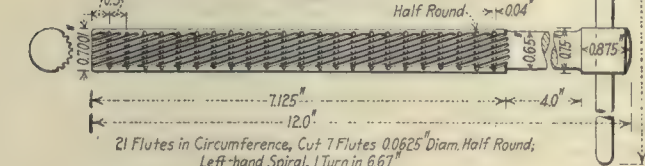


FIG. 505

OPERATION 64

OPERATION 64. PROFILING MAGAZINE TO FINISH

Transformation—Fig. 501. Machine Used—Pratt & Whitney No. 2 profiler; machining diagram, Fig. 502. Number of Operators per Machine—One. Work-Holding Devices—Same as Fig. 498. Tool-Holding Devices—Taper shank. Cutting Tools—Milling cutters, Fig. 503. Number of Cuts—Two. Cut Data—1,200 r.p.m.; hand feed. Coolant—Compound, two ¼-in. streams. Average Life of Tool Between Grindings—150 pieces. Gages—Fig. 504, size, position and shape. Production—20 pieces per hr.

OPERATION MM. REMOVING BURRS LEFT BY OPERATION 63 (REAMER)

Number of Operators—One. Description of Operation—Removing burrs thrown up by operation 64. Apparatus and Equipment Used—File and reamer, Fig. 505. Gages—None. Production—250 pieces per hr.

OPERATIONS 64½ AND 65. PROFILING BEVEL FRONT-END WALL OF MAGAZINE; PROFILING REAR CORNERS OF MAGAZINE

Transformation—Fig. 506. Machine Used—Pratt & Whitney No. 2 profiler; machining diagram, Fig. 507. Number of Operators per Machine—One. Work-Holding Devices—Held by front-end stud and vise jaws, Fig. 508. Tool-Holding Devices—Taper shank. Cutting Tools—Bevel cutter and end mill, Fig. 509; A, bevel for front walls; B, for round corners in rear. Number of Cuts—Two. Cut Data—1,200 r.p.m.; hand feed. Coolant—Compound, two ¼-in. streams. Average Life of Tool Between Grindings—200 pieces. Gages—Fig. 510; A, angle of front end; B, shape of rear; C, rear corners. Production—45 pieces per hr.

OPERATION 66. PROFILING LOWER RAMP

Transformation—Fig. 511. Machine Used—Pratt & Whitney No. 2 profiler. Number of Operators per Machine—One. Work-Holding Devices—Held on stud and finger clamp, Fig. 512, operated by lever; tang is supported by clamp and thumb-screw. Tool-Holding Devices—Taper shank. Cutting Tools—End mill, Fig. 513. Number of Cuts—Two. Cut Data—Speed, 1,200 r.p.m.; hand feed. Coolant—Compound, two ¼-in.

gence in the operator is a handicap. A machine does not think, neither does it lose time by stopping to think.

Advantage has been taken of these simple but important facts in the arrangement of minor operations at

in. streams. Average Life of Tool Between Grindings—200 pieces. Gages—Fig. 514, rests on bottom with tongue through front end; locates position of slot by straight-edge across front end. Production—45 pieces per hr.

OPERATION NN. REMOVING BURRS LEFT BY OPERATIONS 64½ AND 65

Number of Operators—One. Description of Operation—Removing burrs thrown up by operations 64½ and 65. Apparatus and Equipment Used—File and reamer, same as Fig. 505. Gages—None. Production—250 pieces per hr.

OPERATION 68. COUNTERBORING FOR EJECTOR PIN AND REAR GUARD SCREW AND MILLING FOR FRONT END OF GUARD

Transformation—Fig. 515. Machine Used—Pratt & Whitney 14-in. vertical four-spindle drilling machine. Number of Operators per Machine—One. Work-Holding Devices—Drill jig, Fig. 516; held on mandrel and clamped down by finger clamp; located by hole and right side. Tool-Holding Devices—Drill chucks. Cutting Tools—Reamer a, two counterbores b and c and one hollow mill d with pilot, Fig. 517; a, reamer for ejector pin; b, counterbore for pin; c, counterbore for rear guard screw; d, hollow mill with pilot for front guard screw on recoil lug. Number of Cuts—One each. Cut Data—600 r.p.m.; hand feed. Coolant—Cutting oil, ½-in. stream. Average Life of Tool Between Grindings—200 pieces. Gages—Fig. 518; a, depth of ejector-pin counterbore; b, diameter of both ejector-pin holes; c, height of recoil lug from bottom of receiver; d (back end of same gage), diameter of boss; e, gages height of counterbore in tang with bottom of receiver. Production—40 pieces per hr.

OPERATION 67. PROFILING UPPER RAMP

Transformation—Fig. 519. Machine Used—Ames Manufacturing Co. single-spindle profiler. Number of Operators per Machine—One. Work-Holding Devices—Held against bottom by finger clamp, Fig. 520, operated by cam A; located by upper stop B; supported by a screw. Tool-Holding Devices—Taper

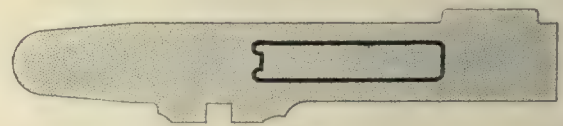


FIG. 506

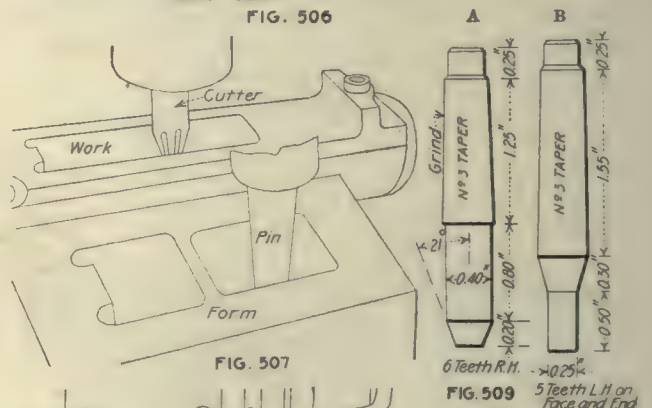


FIG. 507

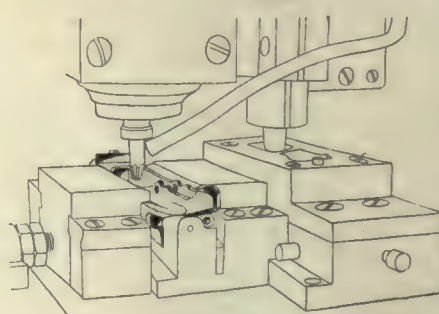


FIG. 508

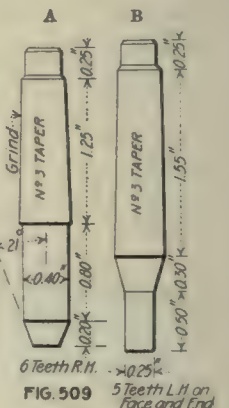


FIG. 509

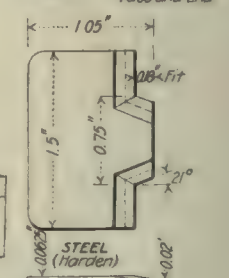


FIG. 510A

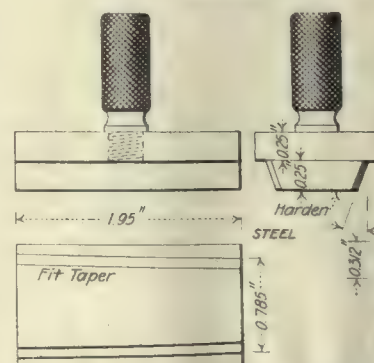


FIG. 510B

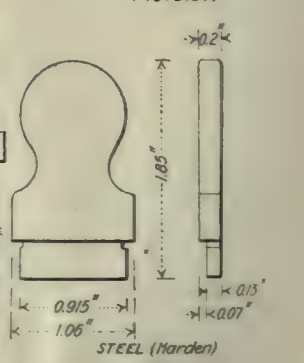
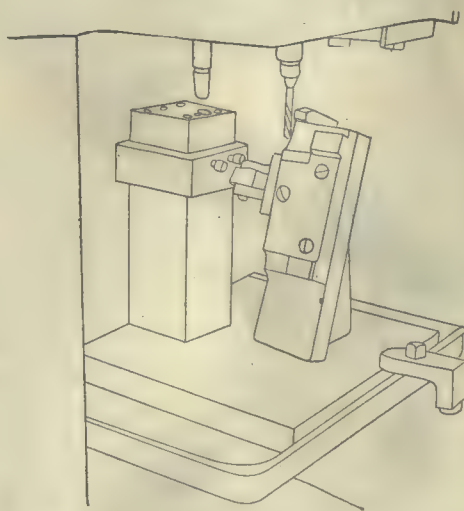
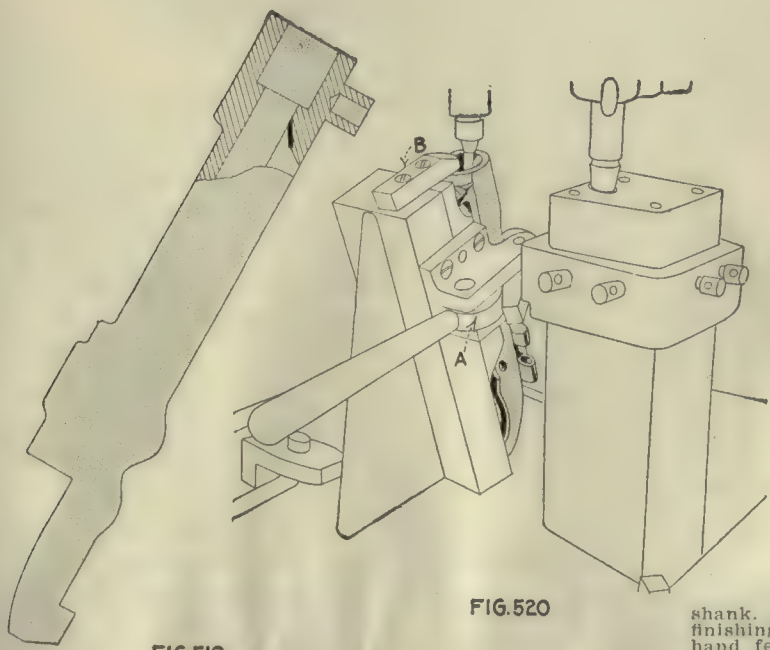
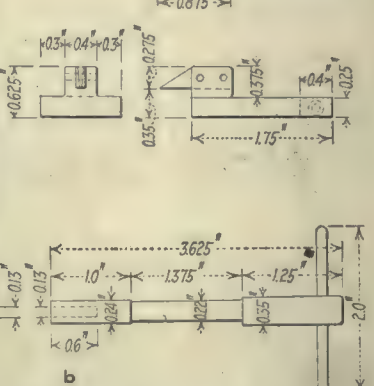
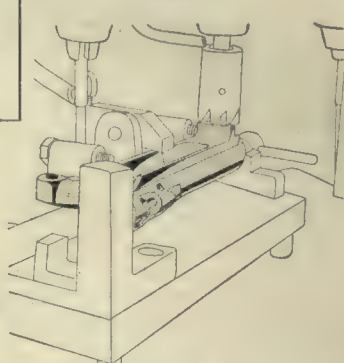
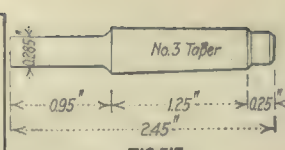
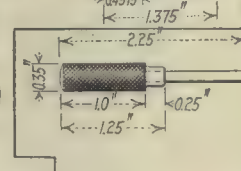
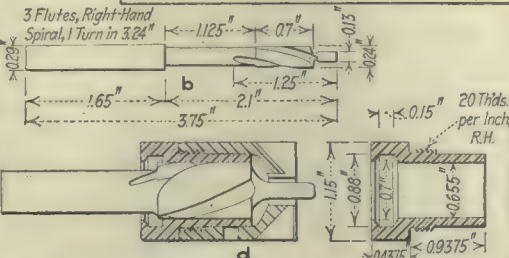
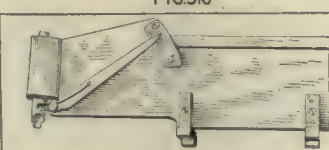
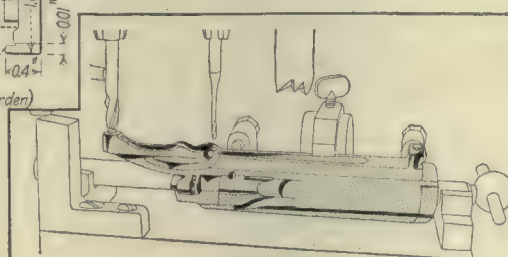
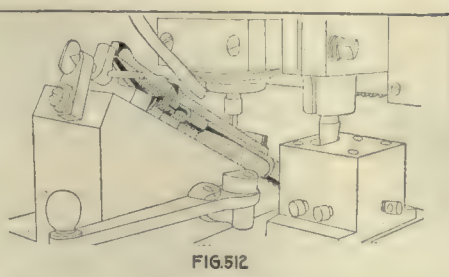
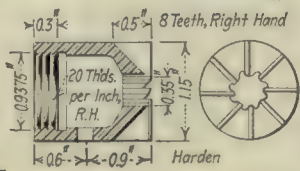
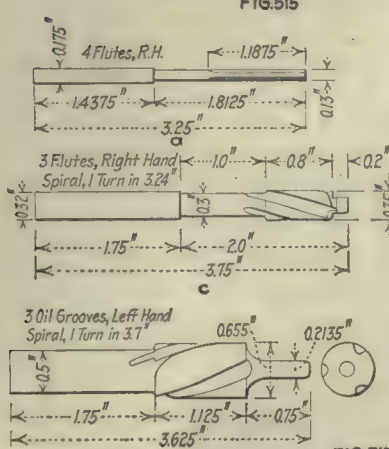
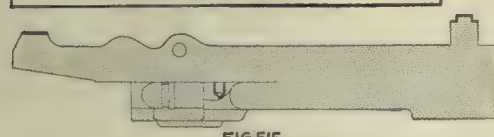
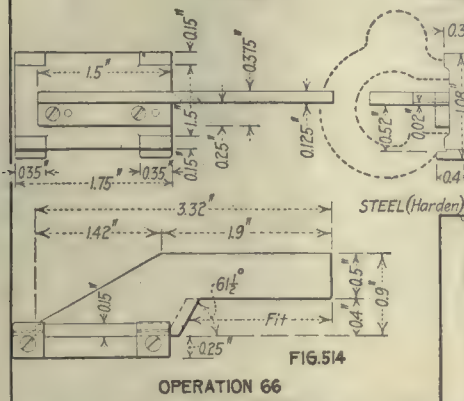


FIG. 510C

OPERATION 64½ & 65



shank. Cutting Tools—End mill, Fig. 521; A, roughing; B, finishing. Number of Cuts—Two. Cut Data—1,300 r.p.m.; hand feed. Coolant—Triumph cutting oil. Average Life of Tool Between Grindings—300 pieces. Gages—Fig. 522, used same as gage in Fig. 514. Production—80 pieces per hr.

the Springfield armory. It is evidenced for instance in this article in the large number of shaving operations for which special machinery has been designed. As a rule an operation of this kind replaces what would ordinarily be handwork and does it efficiently as to cost.

OPERATION 70. SHAVING REAR END OF MAGAZINE

Transformation—Fig. 523. Machine Used—Bement Miles slotting machine, 28-in. table. Number of Operators per Machine—One. Work-Holding Devices—Held on 3 sides at each end and by cam-operated vise jaws, Fig. 524; forced against fixed stud A by thumb-screw B; clamped by cam C. Tool-Holding Devices—Cutter screwed to holder, same as operation 38. Cutting Tools—Slotting cutter, Fig. 525. Cut Data—Speed, 60 strokes; hand feed. Coolant—Cutting oil put on with brush. Average Life of Tool Between Grindings—250 pieces. Gages—Fig. 526; goes on bottom and is measured from front end by straight-edge. Production—80 pieces per hr.

OPERATION OO. REMOVING BURRS LEFT BY OPERATION
70 (REAMER)

Number of Operators—One. Description of Operation—Removing burrs thrown up by operation 70. Apparatus and Equipment Used—Reamer, same as Fig. 505. Production—250 pieces per hr.

OPERATION 73. MILLING RIGHT SIDE OF REAR LOCKING-LUG SEAT TO FINISH

Transformation—Fig. 527. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Operators per Machine—One. Work-Holding Devices—Held in double vice, same as cutting, Fig. 530. Tool-Holding Devices—Standard arbor. Cutting Tools—Timing cutters, Fig. 528. Number of Cuts—One. Cut Data—Speed, 60 r.p.m.; feed, $\frac{1}{16}$ in. per min. Coolant—Compound, two $\frac{1}{2}$ -in. streams. Average Life of Tool Between Grindings—2,500 pieces. Gages—Similar to Fig. 532. Production—30 pieces per hr. Note—Using bottom and hole as working points.

OPERATION 74. MILLING RIGHT SIDE OF FRONT
LOCKING LUG TO FINISH

Transformation—Fig. 529. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Operators per Machine—One. Work-Holding Devices—Held in double vise on mandrel, Fig. 530. Tool-Holding Devices—Standard arbor. Cutting Tools—Forming cutters, Fig. 531. Number of Cuts—One. Cut Data—Speed, 60 r.p.m.; %-in. feed. Coolant—Compound, two $\frac{1}{2}$ -in. streams. Average Life of Tool Between Grindings—3,000 pieces. Gages—Fig. 532. Production—30 pieces per hr. Note—Locating points, bottom and hole.

OPERATIONS 75 AND 76. PROFILING BOLT-STOP CAVITY
(FIRST AND SECOND CUT)

Transformation—Fig. 533. Machine Used—Pratt & Whitney No. 2 profiler; machining diagram, Fig. 534. Number of Operators per Machine—One. Work Holding Devices—Held in sand and vice jaws. Fig. 535. Tool Holding Devices—Tape shank. Cutting Tools—Slotting cutters, Fig. 536; A, first cut; B, second cut. Number of Cuts—Two. Cut Data—1,200 r.p.m.; hand feed. Coolant—Compound, $\frac{1}{4}$ -in. stream. Average Life of Tool Between Grindings—450 pieces. Gages—Fig. 537: A, thickness of wide slot; B, thickness of narrow slot; C, depth from bottom and front end; D, location from bottom; E, location from front end and side. Production—60 pieces per hr.



FIG. 523

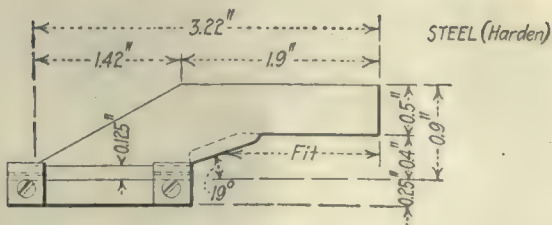
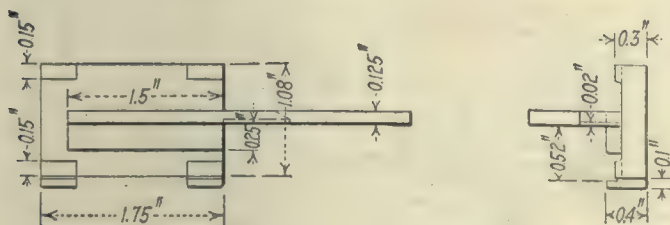


FIG. 522

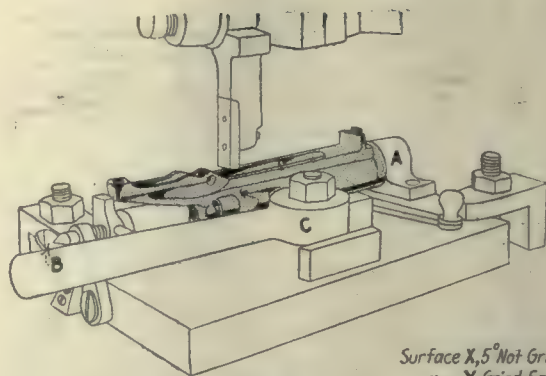


FIG. 524

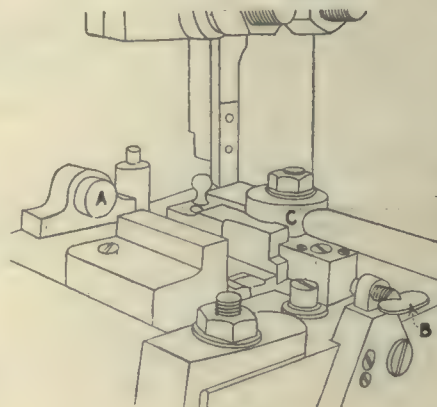


FIG. 524

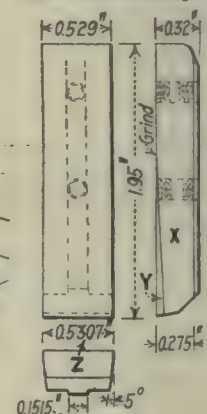
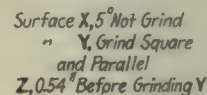


FIG.525

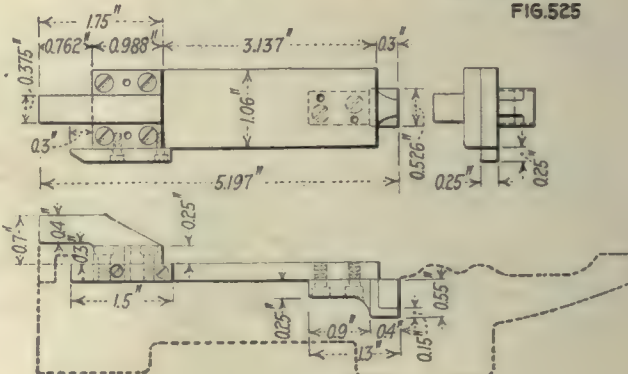


FIG.526

OPERATION 70

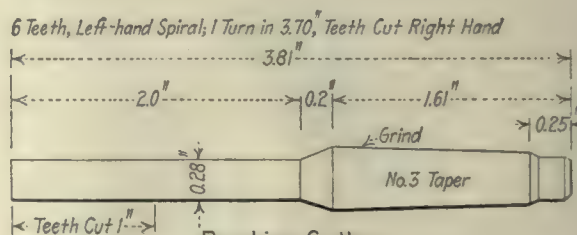
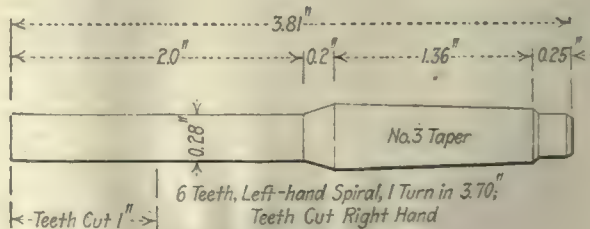


FIG.521-A



Finishing Cutter

FIG. 521-B

OPERATION 67

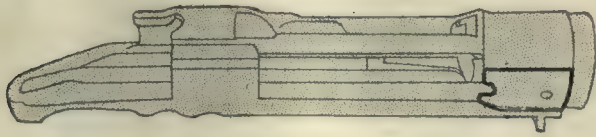


FIG 527

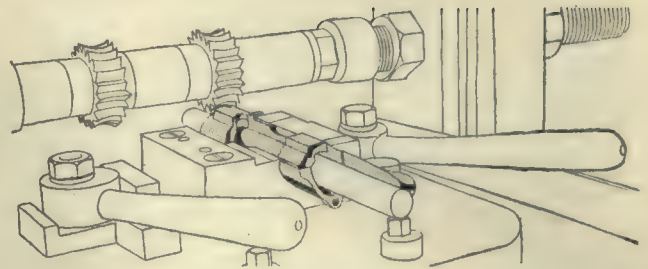


FIG. 530

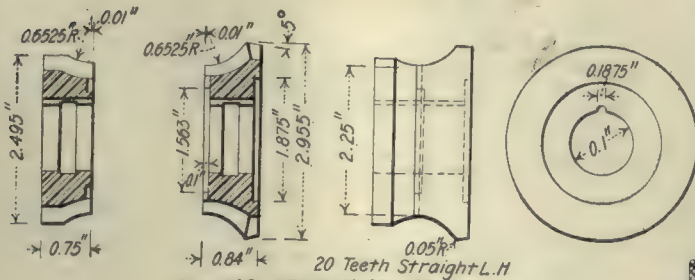


FIG. 528. OPERATION 73

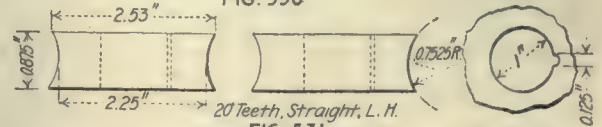


FIG. 531

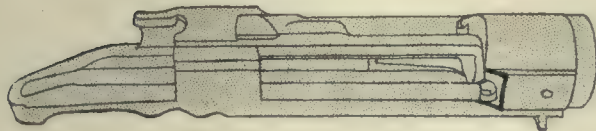


FIG 529

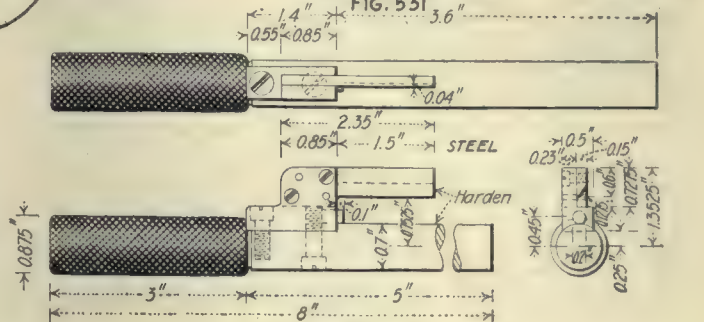


FIG. 532

OPERATION 74



FIG. 533

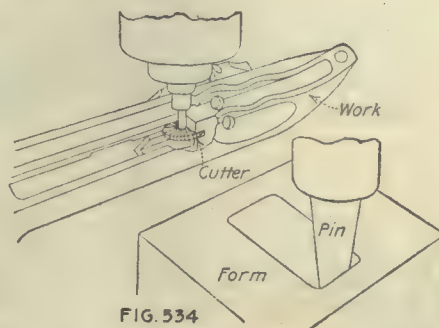


FIG. 534

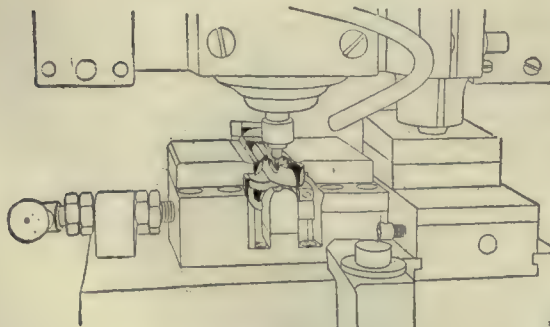


FIG. 535

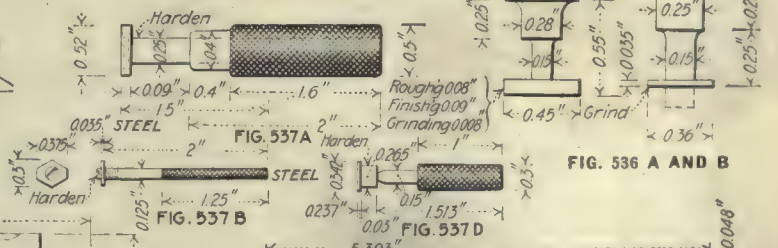


FIG. 536 A AND B

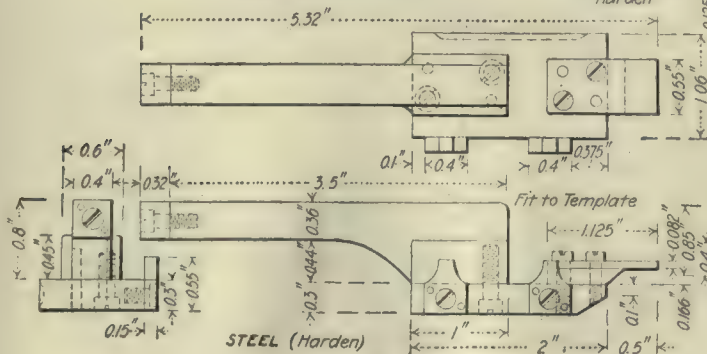


FIG. 537 C

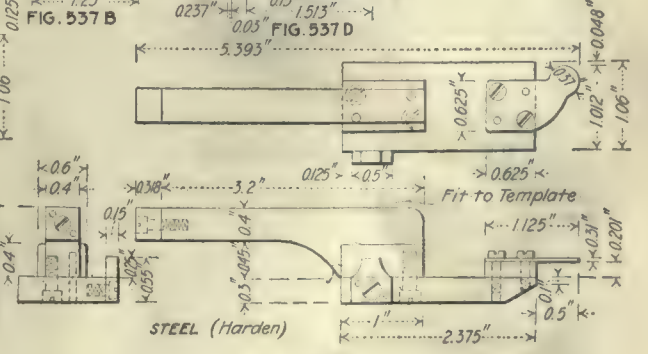


FIG. 537 E

OPERATION 75 & 76

The ideal manufacturing process is one in which hand-work does not enter. Whether this is a possibility in as far as the manufacture of a certain piece is concerned, must be determined from the standpoint of financial desirability. Owing to the flexibility of the human anatomy,

the replacement of some simple hand operations may involve complicated and expensive machines. However, it must be said that in so far as it has been advisable to do so, this principle has been carried out at the Springfield armory, and at a comparatively low cost.

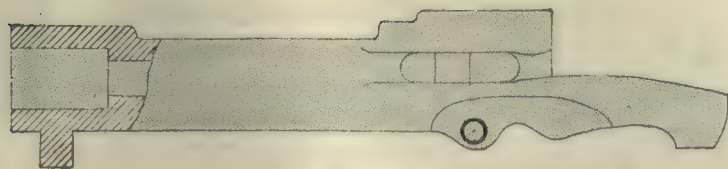


FIG. 546

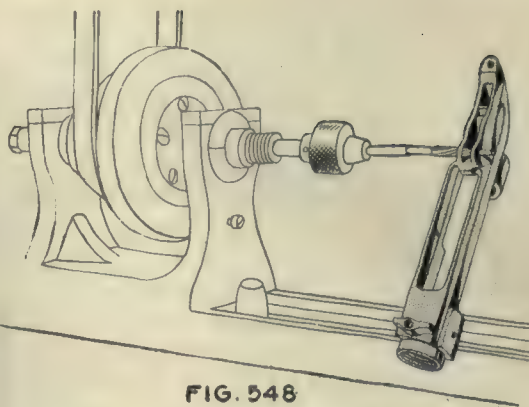


FIG. 548

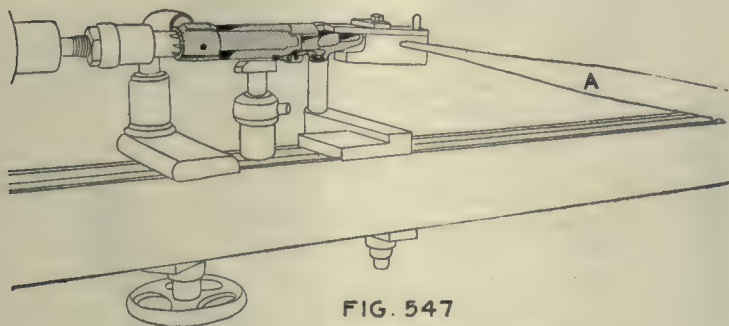


FIG. 547

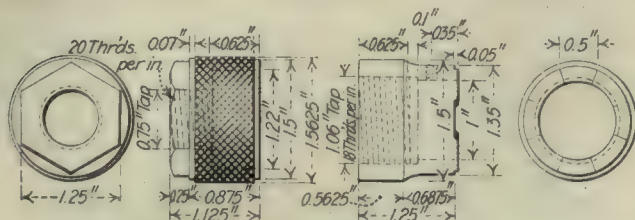
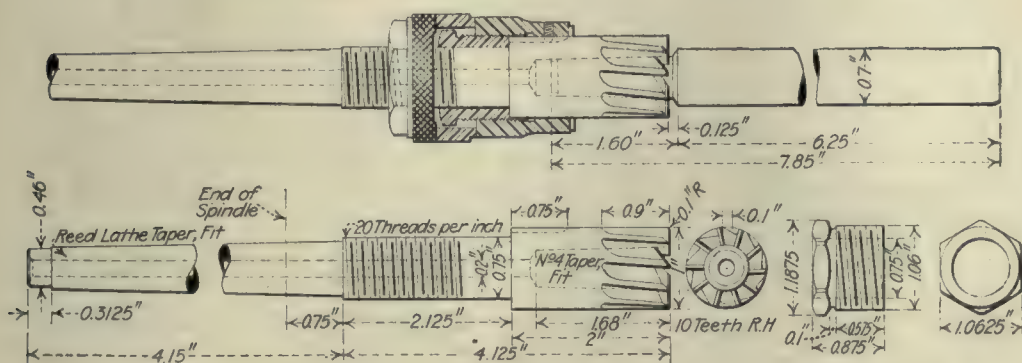


FIG. 549 A OPERATION 82

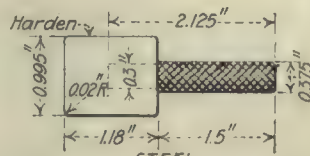
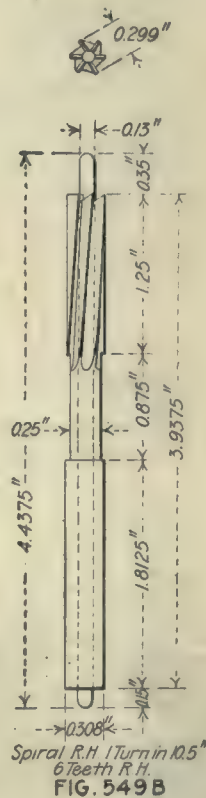


FIG. 550



Spiral R.H. 1 Turn in 10.5"
6 Teeth R.H.
FIG. 549B



FIG. 551, OPERATION 95

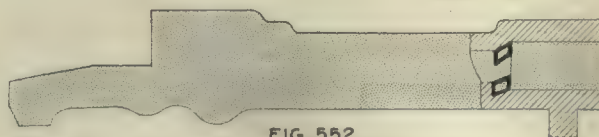


FIG. 552

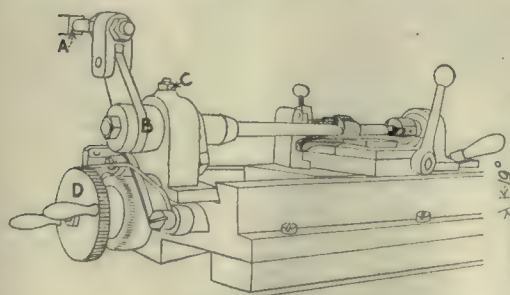


FIG. 553

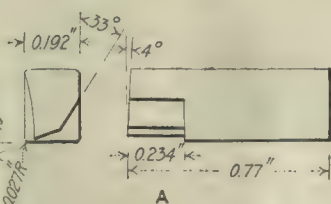


FIG 554

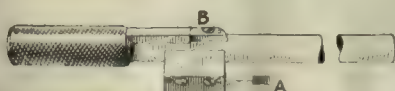
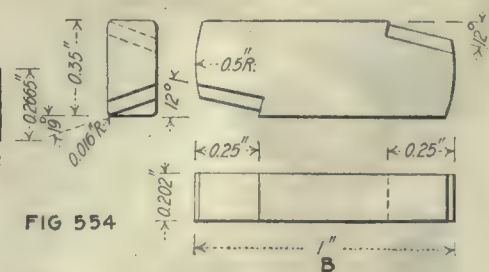


FIG. 555 A



FIG 555B

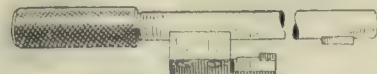
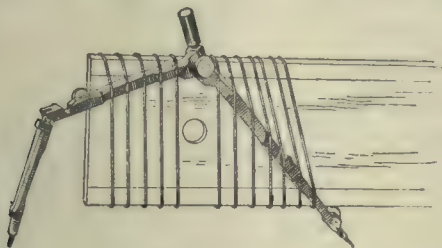


FIG. 555C.

Letters from Practical Men

Drafting-Room Kink

The illustration shows how a compass and T-square blade may be made to take the place of a beam compass. The compass is spread as shown. The screw heads and



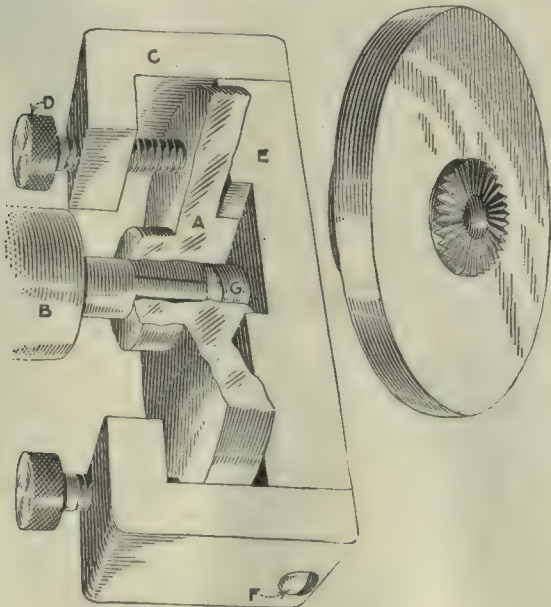
DRAFTING-ROOM KINK

the joint clamp catch against the edges of the blade and are "rapped" into place. This arrangement is of advantage when a proper instrument is not at hand.

Chicago, Ill. JOHN E. TITUS.

A Locating Jig

The drawing illustrates a little device that helped me a great deal. The casting A had to have teeth cut on the front, as shown. This casting was finished on the front and in the hole only, and could be held only on the dividing head on the expansion arbor B. The diffi-



THE LOCATING JIG

culty in this case was that there was no way of setting the job so that the teeth would come out uniformly deep with relation to the finished front face. To assure this I made up the jig shown. The clamping blocks C which carry the screws D are held to the main bar E by the fillister head screws F. A small projection G on E fits into the hole in the casting. This jig is secured to

the casting by means of the screws D. The casting is put on the expansion arbor B, and the projection G acts as a stop against the end of the chuck. The chuck is now expanded, the screws D loosened and the jig taken off. In this manner all the castings were put on the chuck in the same position with relation to the finished face, and the teeth were then cut uniformly deep.

Brooklyn, N. Y. EDWARD HELLER.

Crane Inspection and Operation

Perhaps other shopmen may be interested in the accompanying instructions to crane operators. These instructions cover the transmission of orders from the crane hitcher to the crane operator, by the use of manual and audible signals. It is common shop practice to permit the crane hitcher and the crane operator to formulate their own methods; or where better supervision of hoisting machinery is enforced, manual- and audible-signal instructions are formulated for the employees, who, however, are seldom sufficiently drilled in this matter. The result is misinterpretation and confusion of signals,

CRANE-INSPECTION REPORT

Make and capacity of crane.....Mach. No.....Date.....

Instructions to Inspector: Any dangerous condition shall be indicated by underscoring the report in red, and inspector will definitely state whether he considers it necessary to shut down crane immediately or whether it be permitted to operate. He shall follow all repairs vigorously until the machine is right.

Electrical Equipment:	Commutator or Collector Rings	Air Gap	Brushes	Grounds
Main hoisting motor.....	.....	.....	.....	.....
Auxiliary hoisting motor.....	.....	.....	.....	.....
Trolley travel motor.....	.....	.....	.....	.....
Bridge travel motor.....	.....	.....	.....	.....
	Resistance Grids	Contacts	Lost Motion	
Main hoisting controller.....	.....	.....	.....	.....
Auxiliary hoisting controller.....	.....	.....	.....	.....
Trolley travel controller.....	.....	.....	.....	.....
Bridge travel controller.....	.....	.....	.....	.....
Lubrication and Mechanical Condition:				
Motor bearings, Main.....	Auxiliary.....	Trolley.....	Bridge.....	
Drum bearings, Main.....	.....	Auxiliary.....	.....	
Gearing.....	.....	Hooks.....	.....	
Hoisting cable or chain, Main.....	.....	Auxiliary.....	.....	
Safety Appliances:				
Automatic stop, Main.....	Auxiliary.....	.....	.....	
Drum brake, Main.....	Auxiliary.....	.....	.....	
Solenoid brake, Main.....	Auxiliary.....	.....	.....	
Trolley travel brake.....	.....	Bridge travel brake.....	.....	
Runway stops.....	.....	.....	.....	
Suggestions.....	.....	.....	.....	
(Signed).....	.....	Inspector	.....	

with consequent impairment of crane service and many avoidable accidents, both of which reduce shop efficiency to a frequently unsuspected extent.

A 10-min. signal drill each week will greatly improve the mutual understanding of crane operators and hitchers and avoid much friction. The illustrated instructions shown have been developed to assist the cranemen to memorize the signals. Each crane hitcher and operator is provided with a copy, and additional copies are posted in the crane cage or cab and at appropriate places about the works. It will be noticed that all manual signals are made with the right hand, permitting full use of the left hand for balancing or landing the load. It will also be observed that the signals apply with equal facility

to jib, bracket or traveling and locomotive cranes. In practice it is frequently possible and always desirable to use both manual and audible signals, as sometimes the

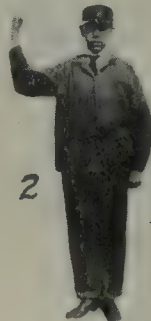
will help reduce accidents to men and machinery to a minimum and promote more nearly continuous crane service. The crane inspection should be made by a com-

June 3, 1916.

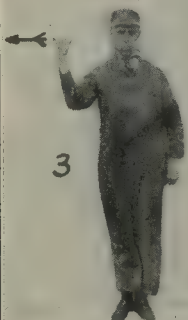
INSTRUCTIONS TO CRANE OPERATORS



1 FORWARD.
A movement of the right hand with thumb pointing in the direction of travel, or
2 short and 1 long blasts of whistle.



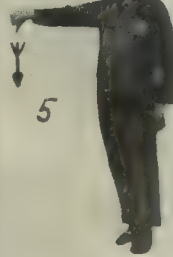
2 BACKWARD.
A movement of the right hand with thumb pointing in the direction of travel, or
2 long and 1 short blasts of whistle.



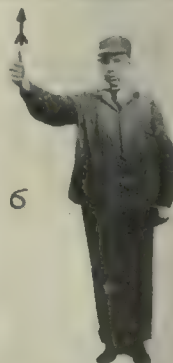
3 TO RAISE LOCOMOTIVE CRANE TO RIGHT OR TO MOVE TROLLEY TO RIGHT.
A movement of the right hand with thumb pointing in the direction of travel, or
1 short and 1 long blast of whistle.



4 TO SLAVE LOCOMOTIVE CRANE TO LEFT OR TO MOVE TROLLEY TO LEFT.
A movement of the right hand with thumb pointing in the direction of travel, or
1 long and 1 short blast of whistle.



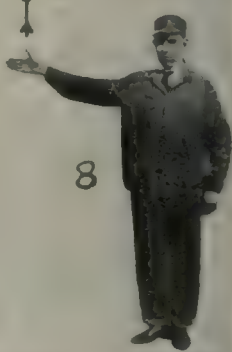
5 TO LOWER THE LOAD ON THE LOCOMOTIVE CRANE OR TO LOWER WITH THE SMALL HOIST OF THE TRAVELING CRANE.
A movement of the right hand with thumb pointing downward and with hand closed, or
1 long blast of whistle.



6 TO RAISE THE LOAD ON THE LOCOMOTIVE CRANE OR TO RAISE WITH THE SMALL HOIST OF THE TRAVELING CRANE.
A movement of the right hand with thumb pointing upward and with hand closed, or
1 short blast of whistle.



7 TO LOWER BOOM OF THE LOCOMOTIVE CRANE OR THE LARGE HOIST OF THE TRAVELING CRANE.
A movement of the right hand with thumb pointing downward and hand open, or
2 long blasts of whistle.



8 TO RAISE BOOM OF THE LOCOMOTIVE CRANE OR THE LARGE HOIST OF THE TRAVELING CRANE.
A movement of the right hand with thumb pointing upward and hand open, or
2 short blasts of whistle.



9 TO GO SLOW.
Raise arm and move vertically in a circle, or
1 very long blast of whistle.



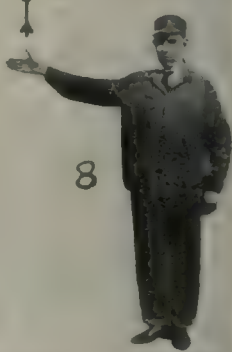
10 TO SIGNAL "ALL RIGHT"
Wave arm horizontally, or
3 short blasts of whistle.



10



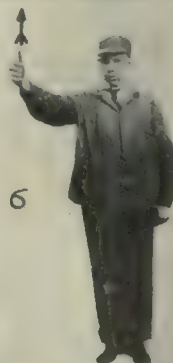
9



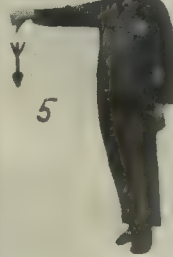
8



7



6



5



4

ILLUSTRATED INSTRUCTIONS TO CRANE OPERATORS

sense of sight responds more quickly than the sense of hearing and vice versa.

As a further precaution stress is laid upon the proper inspection and maintenance of cranes and other hoisting machinery. An analysis of accidents discloses comparatively few accidents due to defective equipment. However, the weekly crane-inspection report, page 957, has merit and

petent maintenance man or jointly by the shop electrician and the master mechanic. A signed crane report brings a man to a realization of his moral obligation to exercise care and diligence to maintain the cranes in a safe and satisfactory condition at all times during their service.

Holyoke, Mass.

ROBERT E. NEWCOMB.

Discussion of Previous Question

How Would You Produce This Casting?

It seems strange that so simple a pattern as that shown on page 318 should puzzle a pattern maker, but the simple ones sometimes give us more worry in the foundry than would one for a four- or a six-cylinder motor.

In using the ram-up core shown in Fig. 1 one takes chances of not getting the bosses right. The core would

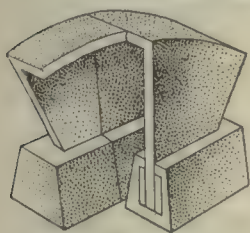


Fig. 1

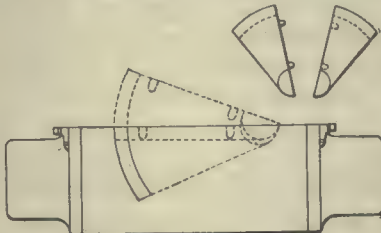


Fig. 2

TWO METHODS OF MAKING THE CASTING

also leave a fin or mark on the casting as far as the core strikes. This fin would have to be ground off each casting, for even if the fit is almost perfect there will be a mark. This method does not require a highly skilled molder.

The other way to make the castings is as shown in Fig. 2. Simply have a split pattern, ram up the drag half of the pattern first, then place the other half of the pattern on top of the one in the drag and ram the cope. When the ramming is done, remove the cope, in which half of the pattern will remain, and set it aside. Touch up the mold of the bottom half, then draw the pattern as shown, the boss forming a pivot for the pattern to swing on.

After removing the half-pattern from the cope and drag, close up the mold, and it will be ready for pouring. To get a perfect casting I should prefer the method illustrated in Fig. 2, for it will be as clean as the mold and must come right if the pattern is made right and a skilled molder is employed.

EDWARD J. HANSEN.

Kenosha, Wis.

Fatigue as an Important Cause of Occupational Disease

I read with deep interest the editorial on page 609, on fatigue as a cause of occupational disease. I do not believe that an occupation ever existed that did not entail more or less fatigue, and have studied several individual cases only to find it invariably comes from monotony. It is practically impossible for the manufacturer to make the work less monotonous, or enough so to suit the individual.

Shop conditions are not exclusively to be blamed for fatigue among the employees. From my own experience I gather there is something else that plays an important part.

A few years ago I had the whole corner of a shop to myself, with a large window that commanded a fine

view down a river. Plenty of people passed over a bridge right in front of my window, and there were no rules against speaking to some of them occasionally, if I chose. There was a large door just behind me, and all the daylight Nature could furnish. What more could the employer give? I had to get out the work as the circumstances demanded. But with air, light and heat of the best, the monotony was there; and in spite of all I could do I was tired out by the noon hour.

I put my case before a physical director and was "put next" to the trouble. The first thing he did was to explain to me that there were several of my muscles that were never brought into action. My occupation made no demand on them. Following his instructions, after I got home in the evening, regardless of how tired I was, I busied myself with the indian clubs and dumbbells and in that way soon rebuilt the degenerated muscles. The results were almost unbelievable. The practice of getting up in the morning, eating a light breakfast, grabbing a dinner pail, hustling to work, coming home at night, eating an evening dinner and sitting around a short time before retiring, repeated day in and day out, year in and year out, plays a most important part in causing fatigue.

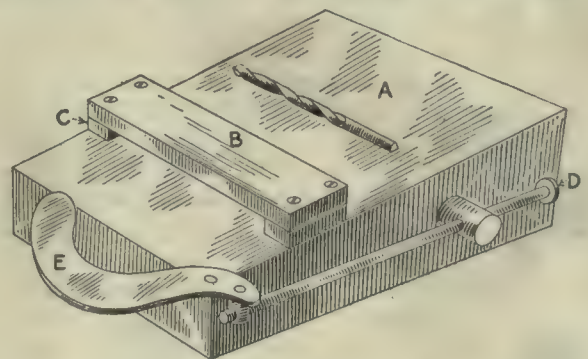
The only thing left to do for each individual is to dismiss the shop entirely from his mind as soon as he leaves it at night. Take up work around the house that will bring unused muscles into play. Let each one treat his own case as he sees fit—he will soon get satisfactory results.

J. A. RAUGHT.

Janesville, Wis.

Adjustable Limit Gage for Munitions Parts

On page 339 of the *American Machinist* I noticed a description of a so-called "bridge-gage" that brought to



ANOTHER BRIDGE-GAGE

mind the gage shown in the accompanying illustration, which might be classed as a bridge-gage.

This gage is used for testing the straightness of small-size twist drills. The base A is a cast-iron block with the top planed at a slight angle. The piece B is tool steel, hardened and ground. Two spacing blocks C vary

in thickness with the different sizes of drills to be tested. In use a drill is tested by rolling it down the incline. If within the limits of straightness, it will roll under the bridge piece *B*; but if too crooked, it will not roll under and will stick. By pressing on the plunger *D*, the arm *E* swings around and pushes the crooked drill out from under the bridge, so the operator may straighten and again test it.

H. M. DARLING.

Greenfield, Mass.

✱

Drawbacks of a Compulsory Metric System

I have read with interest the article by W. Osborne on page 560, but can see no vital point in what he has written. Why should we make the meter of such length that we could easily figure a more even ratio between an inch and a meter?

The only way out of our chaotic English system would be to disregard it utterly and use the ratio between millimeters and thousandths of an inch to simplify the transposition between metric and English standards. Suppose the meter were 40 in. long, what relation would $\frac{1}{32}$ in. bear to it? How would this assist us in comparing the foot, the yard, the rod, the mile, etc.?

Why not begin now to make the change, and while undergoing the change use a computed table so that the workmen using English scales can refer to it, while those desiring to simplify their work could purchase metric devices? If all scales, micrometers, etc., sold in the past 10 years had been metric, how many of our workmen today would be using the old, awkward English system? Perhaps Mr. Osborne has not thought of the question in this light.

The present time is the time to do things; therefore, why delay?

H. G. FISCHER.

Chicago, Ill.

✱

A Metric Question

As there has been considerable discussion in the *American Machinist* lately on the merits of the metric system, will one of the readers who favor the metric system please answer the following question. It is not a catch question, but one in which I am interested. In graduating a circle is it divided into 360 degrees or a multiple of 100?

We propose to make the lead screw of the lathe 6 mm. lead. The following are metric leads given in a well-known reference book: 0.5, 0.75, 1, 1.25, 1.5, 1.75, 2, 2.5, 3, 3.5, 4, 4.5, 5, 5.5, 6, 6.5, 7, 7.5, 8, 9, 10, 11, 12. What form of dial can be used to pick up all these leads without a backing belt? If they cannot all be picked up which leads mentioned are not used in actual practice?

In dividing a crossfeed screw, into what part of a millimeter is it usual to divide the graduated collar?

Galt, Canada.

CECIL H. SMITH.

✱

A Query on Cross Knurling

Walter Gribben on page 693 asks why, in ordinary cross knurling, one knurl will sometimes cut more nicks in the work than the other.

In my opinion, this action is due to two causes: First, a difference in the pressure exerted upon the two knurls,

and second, to the fact that the lower knurl must track over the work already marked by the upper one.

Considering the knurl and the work as a pair of gears, the number of teeth in the former is, of course, fixed, while that in the latter will depend upon the distance between the centers of the two during the first revolution; or, in other words, upon the pressure exerted on the knurl in starting. If, owing to the height at which the double knurling tool is set, the pressure is unequal upon the two knurls during the first revolution, the one exerting the less pressure will cut a larger number of nicks.

It is a well-known fact that the diameter of a piece of work is increased by knurling. In starting the knurls, the upper one acts upon the smooth stock, while the stock acted upon by the lower knurl has already been marked by the upper one, thus increasing its diameter. This produces a tendency for the lower knurl to cut a larger number of nicks than the upper one.

Waterbury, Conn.

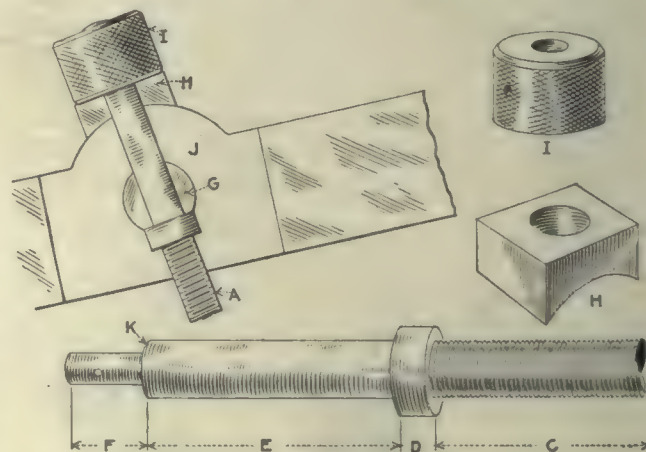
J. R. PUTNAM.

✱

From a Small-Shop Notebook

It is a cinch to improve on the other fellows' job unless he has made it perfect, which he and we seldom do. So here goes for an improvement on the improvement shown on page 563.

The head of the screw has a very poor bearing on the two semicircular projections from the body of the clamp. So we improve this bearing by putting in a little washer *H*, as shown in the illustration. The upper part of this washer is flat to form a full bearing for the head *I*



DETAILS OF IMPROVED CLAMP

of the clamping screw, and the under part is concave to fit the semicircular projections *J* from the body of the clamp.

When work is held, the rear screw of the clamp is in compression while the front one is in tension. This gives us an excuse for further improvement in the clamp. The screws should therefore be made to withstand both these conditions and to have the added advantage of not becoming dislocated when the clamp is not in use.

The screw *A* shows a design that will be satisfactory. The part *C* is threaded. The shoulder *D* takes the thrust if the screw is used (as a compression screw) at the back end of the clamp. The part *E* passes through the swivel *G* and the washer *H*. The part *F* is a snug fit for the knurled head, which seats on the shoulder *K*

next to *E*. The head *I* is pinned on after assembling, and the end of *F* may be riveted over to take the pull when the screw is located at the front of the clamp and is under tension. It would be quite possible to go on improving this clamp, but what is the use? No one would make a pair.

E. A. DIXIE.

New York City.



The Shop Suggestion Box as a Psychological Problem

Why does the alert and resourceful American mechanic of average intelligence, employed by manufacturing corporations, view the suggestion box or suggestion system with distrust, disdain or open hostility? Why is this attitude of suspicion or antagonism less apparent in some shops than in others? How can helpful coöperation be engendered within a manufacturing organization, so that the accumulated knowledge and experience as well as the intelligence of its employees may contribute to the success of the company and the welfare of all who are connected with it? These and similar questions are being asked and discussed by many manufacturers who have instituted the suggestion system and have failed to realize the expected results. The problem involved in this situation is evidently psychological.

For purposes of illustration let us suppose that a man is driving through a region in which he is unknown and is so unfortunate as to break a wheel or some other vital part of his vehicle. Very soon he will be surrounded by sympathetic strangers, each anxious to help him out of his difficulty, although they have no selfish interest in the matter and no previous knowledge of his affairs. Suggestions are freely offered and discussed, without any thought of personal reward or profit, and the best plan for action is determined. Then these men, at considerable personal inconvenience, will assist in putting into execution the plan adopted and will be amply repaid by the satisfaction of seeing the stranger again started on his journey. Such helpful coöperation arises from the almost universal desire to be of service to any fellow human being who needs aid.

How very different may be the attitude of these same intelligent and resourceful men toward the corporation by which they are employed. On account of their close association with the actual operations performed in the shop they naturally see opportunities for improvements or ways and means for overcoming known difficulties that may be entirely overlooked by those whose attention is largely occupied by matters of administration and supervision. One might suppose that those who were so ready to help the stranger would be not only willing but anxious to impart useful suggestions to their employers. In this case their natural desire to be helpful would be augmented by their interest in the welfare of the corporation, the desire for advancement and increased wage, as well as the greater prosperity of the community that should always follow an increased earning capacity of its manufacturing organizations.

The reason for this difference in attitude is not difficult to find. The man with the broken wheel was an individual, and his need for help was recognized as an individual need. The likeness between a corporation and an individual usually is recognized only as an abstract truth of merely legal interest, if indeed it is recognized

at all. Unfortunately, to many an employee the corporation for which he works is a mysterious gigantic thing, without actual personality, whose interests are wholly antagonistic to his own. An oft-repeated and misleading statement is to the effect that a corporation has no soul. The real "soul" of a corporation is a composite to which all within the organization contribute a greater or less portion, depending on the influence they exert on its affairs.

Let us, for a moment, consider the case of the small shop owned and operated by one man. Here the employer is an individual, and his needs are recognized as the needs of an individual. He comes into personal touch with his men, each of whom feels a personal interest in the owner's success. If the personality of the employer is such as to merit the esteem of the men, they will be eager to give him the benefit of any knowledge they may have that will be to his profit. In so doing they will win the esteem of the employer and, under proper management, will benefit financially as the increased success of the business enables the individual employer to meet better the needs of the individual employee. In such cases direct payment or reward for a helpful suggestion is seldom made or expected. The "old man" is relied upon to do the fair thing.

In the case of a corporation, not recognizing the attributes of an individual in his employer, how is the workman to experience the same desire to help that he felt toward the stranger with the broken wheel or toward the individual shop owner? An appeal to his selfish interest by a system of fixed prizes for suggestion does not usually excite the cupidity of the average intelligent American workman. In an article in the *American Machinist* a few months ago an instance was cited in which a certain suggestion, backed by the enterprise, capital, knowledge and facilities of a certain corporation, resulted in a net profit of \$6,700 in a year. The company presented the suggester with a handsome gold watch, and it is probable that the resulting prestige and advancement on account of his demonstrated ability have been of far greater profit to him than the mere gift of appreciation. It is probable that he feels much satisfaction in having made this suggestion to the company. However, it appears from much published comment on this instance that many men believe that it would have been better if he had not made this suggestion and that the action of the company in presenting the gold watch was niggardly in the extreme. The writer believes that if the gift had come from some individual friend to whom a helpful suggestion had been made, it would have been considered as an unusually appreciative and friendly action.

Most suggestions that are of value to a manufacturer apply only to specific cases and are of no interest to others. For instance, a slight change in the spacing of machines or in the sequence of operations may result in saving a large percentage of the manufacturing cost of a given article, but such changes would be of no interest to the general public and could be of no possible value to the suggester unless imparted to his employer. Why, then, should the workman decline to make such suggestions?

Many workmen, apparently, are unwilling to come forward with suggestions on account of fear that they may "get in wrong" with their foreman. This fear is reflected to some extent in the anonymous suggestion, although the

unsigned suggestion is usually a criticism that the author apparently thinks the management might resent. Occasionally, we meet a foreman who thinks he should have a monopoly on brain power in his department, but fortunately, such cases are exceptions. The foreman by considerate treatment and friendly action can do much to encourage helpful suggestions from his men.

The writer believes that, when the suggestion system fails, it usually shows a lack of close personal relations between employer and employee, a lack of mutual confidence between man and man, or a lack or repression of that most altruistic human desire to be of service to one's fellowmen, whether those men are operating individually or are joined together for a common purpose under a corporate charter.

Barberton, Ohio.

FRED B. COREY.

Applying on a Printed Form for a Position

In the opinion of many the letter quoted by Mr. Holaday on page 604 was not answered because the first impression a reader would gather, before flinging it in the waste-basket, is that the dispatcher is a jack of all trades and master of none.

A more observing reader also will doubt many of the statements, as one may expect a writer of worth-while articles to be able to state his thoughts properly, to use correct English and abstain from unnecessary repetitions. A letter of application should at least be polite; its statements should be definite and to the point, unmarred by commonplace remarks. There should be a punch to such a letter.

The letter of the all-round excellent mechanic-inventor-author lacks every one of the essential requirements.

Its "Mr. Manufacturer" sounds like "Say, Bill," of the passing butcher boy on a bicycle, asking the road. The profuse use of the hateful capital "I" reminds one of the youth just graduated from a manual-training course, who through lack of worldly wisdom, thinks his achievements unique. Proclaiming oneself a first class mechanical executive is ridiculous.

The allusion to patents should be contained in one short sentence, not two, and there is a doubling-up on the statement concerning magazine writing and minor points. Moreover, who contributes "labor-saving devices" to mechanical magazines?

What surprises me most is that three, out of two hundred people addressed, answered this peculiar communication. It gives me occasion to revise my views on American manufacturers; they are polite, after all.

Brooklyn, N. Y.

JAN SPAANDER.

Design of Crossfeed Screws for Lathes

M. H. Ferguson suggests on page 646 that the threads on crossfeed screws for lathes be turned down to the root of the thread on the end next the operator for a distance equal to the length of the nut, in order that breakage of parts may not occur in case the feed is allowed to remain in too long, the idea being that the nut will run off the threaded portion of the screws before the nut jams against the carriage.

The suggestion will probably not be favored by many lathe builders or users, for the reason that it is bad practice to run a nut and screw apart under load. A section of the thread on either nut or screw will be injured each time it is done, and in a short time the threads on both screw and nut would be ruined.

There probably is no more need for such provision than there is for safeguarding against the operator neglecting his feeds in all other directions, any of which may result in injury to work or machine if thrown in and allowed to run to their limit of action.

H. R. GILLIAM.

Zanesville, Ohio.

What's the Matter with Our Methods of Threading?

Referring to Mr. Smart's article on threading speeds, Vol. 44, page 915, allow me to point out the impracticability of his theory. I made a formula for determining what I thought would make an ideal threading-speed table, on a basis of the removal of 0.5 cu.in. of stock per minute. However, after calculating such examples as $\frac{1}{8}$ in. $\times$ 40 U. S. and $2\frac{1}{2}$ in. $\times$ 4 U. S., I obtained the following results: $\frac{1}{8}$ -in. was running at 237 ft. per min., and the $2\frac{1}{2}$ -in. at 2 ft. per min. There is not a die in the world that could be operated at such a speed as 7,283 r.p.m. on $\frac{1}{8}$ -in. diameter. On the other hand, we find that the larger pitches and diameters are entirely too slow.

The consequence is that it would be necessary to make a change in the amount of stock removed per minute according to pitch and diameter, thereby making it impossible to establish any form of practical table from this basis.

CECIL K. PERKINS.

Beaver Falls, Penn.

Cutting U.S.S. Threads

One method of cutting a very good, everyday U.S.S. thread, which I have not as yet seen described, is as follows. Turn the piece to size, plus one-eighth of the pitch. Take cut after cut until the tops of the threads are just sharp, like a V-thread. Then, if the thread is a short one and the pitch $\frac{1}{8}$ in. or less, the sharp edges can be easily filed down to size or, better, a good thousandth under size. A long thread or one of coarser pitch can be more profitably turned to size.

The advantage of cutting a thread in this way is that the thread itself is the depth gage, and all threads may be cut fairly true for root diameter. This idea is of more value in the jobbing than in the modern manufacturing shop, where thread "mikes" are available and the lathe screws are equipped with the usual form of graduated dials.

J. B. MURPHY.

Plainfield, N. J.

Questions of Lathe Design

Replying to J. H. Davis' query on page 692: A man always uses his right hand in testing work in the lathe—and also traverses by hand while making a test with calipers or gages. For these reasons the handwheel is placed at the left.

W. R. HAMMER.

Connellsville, Penn.

Editorials

Cure for a Machine-Tool Building Disease

Amid the ups and downs of the business of building machine tools may be traced a condition that is not inaptly described as "malnutrition." At no time has the industry as a whole possessed a sufficient amount of capital to permit carrying it along in the best way possible. As a business policy, every builder will agree upon the advisability of stocking up heavily with machine tools during periods of slackness in demand. But very few have ever followed this course. There are some striking exceptions, where success has clearly demonstrated the wisdom of building for stock. The great reason why it has not been done generally is a lack of money.

But this condition of malnutrition due to a lack of capital seems about to be cured. American machine-tool builders have made money during the past two years. There is reason to believe that they will continue to do so for some considerable time to come. Thus, when the next spell of hard times spreads over this country, they should be in the happy condition of having available funds to be put into machinery for stock. The experience of the past shows that machine tools are as stable in value as any of our great staples of commerce. There is a place for every type and grade of machine tool built, and the possibility of revolutionary discoveries in machine-shop practice is exceedingly remote. Not only does the policy of stocking promise rich profit returns, but it also has the strong advantage of holding together a manufacturing organization in readiness for the boom times that must finally follow every period of business depression.

The prospects for permanent improvement in the machine-tool building industry as regards this feature of capital are exceedingly bright. But there is one great responsibility, the conserving of the present income and so administering it that it will be available for use under other business conditions. Now is the time to build up a surplus—not to pay extraordinary dividends.

Report of Machine-Gun Board

Twenty-six days after the Secretary of War appointed a mixed board to consider the subject of the character and quantity of machine guns to be supplied for our military service the board submitted its findings to the War Department. Congratulations are in order for diligence and speed.

The recommendations are intended to guide the expenditure of about \$10,000,000 appropriated by Congress for the purchase of machine guns (or machine rifles) during the present fiscal year. The board also recommends that it be continued so that it can conduct further tests. These are scheduled to begin on May 1, 1917, at the arsenal, Springfield, Mass. The investigation will include ballistic, endurance and airplane tests. All in-

ventors and manufacturers of automatic machine rifles are to be invited to enter their guns in competition.

With respect to the needs of the army, the board reported as follows: "That a total of 8,015 heavy-type and 9,268 light-type machine rifles will be required for the army and National Guard, authorized under the National Defense Act approved June 3, 1916, and recommends that the appropriation for the required supply of machine rifles be obtained in four years, in order that the rifles be available when the yearly increments are raised." Immediate needs are to be met by the procurement of 4,600 Vickers machine rifles.

General interest in these important findings is overshadowed by curiosity as to which type of gun has been approved. On this point the board makes a specific recommendation based upon a careful study of tests made by army officers. At the outset, machine guns (or machine rifles) are classified into two types: Light type—comparatively light weight, highly portable, without tripod mount, air cooled, fed from a magazine; heavy type—relatively heavy, with substantial tripod mount, sufficiently cooled for continuous fire, fed from a belt.

The report enumerates the special advantages and peculiar functions of each type of rifle and then briefly defines the respective spheres of usefulness as:

"There is known to the board at the present time no rifle, other than that cooled by water, which answers the requirements of the heavy type. The greater weight and strength and the reduction of heat with water give to the heavy type of machine rifles a reliability of functions and endurance which probably could never be attained by the lighter air-cooled type.

"On the other hand, the light rifles enable us to effect a greater economy of infantry in the attack. A captured position can be quickly consolidated and can be held by a comparatively small number of men armed with light machine rifles. After a successful assault the bulk of the infantry can be quickly withdrawn to escape the destructive effect of the enemy's artillery fire with measured ranges."

The findings then go on to express the opinion that the equipment of the troops of the mobile army should include machine rifles in the proportion of two of the light to one of the heavy type. The report then says:

"The board finds that the tests heretofore made show that the Vickers machine rifle fulfills in a high degree the requirements of the military service for a machine rifle of the heavy type. The board is not able at this time to recommend a machine rifle that will fulfill the requirements of the military service for a machine rifle of the light type, but expects the results of the tests, hereafter recommended to be conducted by it, will enable such recommendations to be made."

That is, the board definitely places its stamp of approval upon the Vickers machine gun as the heavy-type arm for the United States Army and recommends that several thousand be purchased. With regard to the light

type, it is unable to make a definite recommendation. But if a limited number are wanted immediately and must be taken from those makes that do not use United States caliber 0.30 ammunition, the board recommends the procurement of such guns from some one of the three following—Lewis, Vickers, Colt. If there is no advantage in time of delivery, preference shall be given in the order named. This places the Lewis gun in a preferential position for the light type of arm to meet emergency requirements.

The report seems to dispose of the so-called machine-gun controversy. The guns are classified into types, a definite recommendation is made in the heavy-type class, and the way is opened for further and probably final tests of the light types. Meanwhile, all other things being equal, the Lewis machine gun, around which the discussion has centered, is recommended as the preferred light type in case a limited number of guns are wanted in a hurry.

In the last analysis the American people are interested in getting the best guns for their needs. The findings of the board indicate that it has worked earnestly for this result.

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Complexity of Manufacturing

It is being said that "the way of a manufacturer is hard," and indeed, if it is not hard, it is complex. Truly, the simple days have gone, never to return. The vanishing of apprenticeship and of the relationship between master and learner is but one proof of the change.

Not so many years ago the machine builder who looked after his order-book, his payroll and his bank balance did about all that was necessary as regards keeping track of written records. Today he has all of these and many more, and the additions are far more complicated than the originals.

Not only does he now have his order-book, but he has a maze of other records connected with sales. There are the list of customers, the file of possible buyers, the records of dealers and agents, the accumulation of catalogs, circulars and form letters, and indeed all the paraphernalia that goes with an uptodate, highly organized sales force.

The former payroll, which was figured on either a daywork or a straight piecework basis, still remains, but with so many modifications and additions that in its simple form it would hardly be recognized. Many a shop now has a premium or bonus system, which may be worked out in any one of many ways and applied in any one of numberless fashions. And behind the premium or bonus rates are the time-study and rate-setting departments with numerous employees and a vast accumulation of statistics. Truly, the making up of the payroll is a complex operation today!

In the old days overhead expense was unknown. This ignorance was truly bliss compared with the discussions and differences of opinion that have divided men into various camps on the questions of how to determine and how to apportion shop burden. If the manufacturer of twenty-five years ago added anything to his costs to cover his indirect expenses, it was probably done by the simple expedient of an hourly rate added for every hour of direct labor. This was usually some rather trifling amount, as a charge of fifteen or twenty cents per hour. How differ-

ent this is from the method of apportioning by machine-hour rates!

Another group of complexities hinge around the obeying of state laws in regard to factory conditions, safeguarding machines and accident compensation. These laws are the product of only the last few years. How much the earlier manufacturer escaped in this direction!

Hand in hand with this multiplication of duties and responsibilities has gone a complication of product. Machines of today are vastly more complex than they were even ten years ago. The drift has been toward greater automaticity, and this in turn has meant more machine functions, more mechanism to care for them and a higher degree of human skill to develop, build and operate them with success.

A bit of looking backward shows us this increase in the complexity of manufacturing as an almost staggering total. Yet no one, if he could, would return to the old conditions. Each worth-while thing accomplished has been a step forward in the subduing of natural forces and the application of natural resources to the good of mankind. The highly developed machine-made product that brings comfort or well-being to us all would never have been produced except for the overcoming of difficulties on the part of the machinery builder. These he has met and mastered, even although it has been at the expense of introducing complexity after complexity into his own business. So the reward for the increased difficulties of manufacture comes through a better product and finally the better service of mankind.

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The Machine-Tool Platform

A platform is something upon which somebody or something stands. It is supposed to be firm, steady and enduring. In kinds, platforms range from those of our political parties to the gun decks of our battleships. And "machine-tool platform," when used in the sense intended by the title of these comments, is none other than the shop floor, or machine deck, of the shop building.

But how often is the shop floor really considered from the viewpoint that it is primarily intended as a support for machines? The architect looks upon it as a part of the structure he is designing, and figures that it must hold up so many pounds per square foot; the equipment engineer looks it over to see how much difficulty he is going to have in attaching machines: someone, perhaps, wonders if it is in and whether it will keep in a sanitary condition; while the production superintendent asks, "Is this floor suitable for supporting high-speed machines when run to capacity?"

The importance of this question is shown by a recent experience in a machine-tool building shop. A new building had been erected. A group of gear cutters was moved from an older mill-construction building to a new one which had heavy concrete floors. The production from the machines increased some 20 per cent. A little investigation showed that they were running faster than before, and this factor alone had brought up the output. This increase in speed was made possible by the rigidity of the new concrete floor.

If such an increase in production from machines is made possible simply by a change in the type of floor, it is clearly necessary to study shop floors from the standpoint of their use as a machine platform.

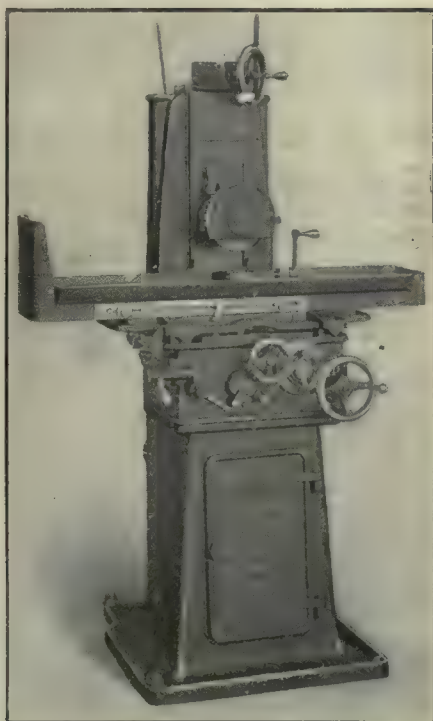
Shop Equipment News

Automatic Surface Grinder

The type of automatic grinder shown was designed to be especially adapted for grinding and finishing dies, punches, gages and work of a similar nature. The machine is a late product of the American Machine Tool Co., Hackettstown, N. J.

The box construction incloses all belts. All slides and working surfaces are provided with covers to protect them from dirt and grit.

The wheel adjustment is by means of a screw located between the housings and actuated by a handwheel graduated



AUTOMATIC SURFACE GRINDER

Capacity, with 7-in. wheel, 18 in. long, 6 in. wide, 9 in. high; table, 46 in. long, 8 in. wide; countershaft tight and loose pulleys, 8-in. diameter, 3¼-in. face; drive pulley, 16-in. diameter, 2¼-in. face; speed, 450 r.p.m.; floor space at right angles to spindle, 65 in.; parallel to spindle, 30 in.; weight, 1,490 lb.

uated to 0.00025 in. The screw is operated by a pair of spiral gears designed to give a smooth and easy movement. Both screw and gears are protected from dust and dirt.

The spindle housing is locked in position by a lever-actuated cam that is positive and rapid. The spindle is hardened, ground and lapped and runs in tapered split-type phosphor-bronze bearings provided with adjustments for taking up lost motion in any direction. The spindle has a tapered end to receive wheel flanges.

The belting arrangement to the spindle is simple, working on the double-loop principle, providing more belt lap to the pulley, the length of belt always remaining the same. The mechanism box, cast in one piece, is bolted to the main frame and can be easily removed for repairs and adjustments. In and on this box the entire mechanism for the various feeds is located. All

running shafts in this box have phosphor-bronze bearings, lubricated from the outside. Spur gears only are used.

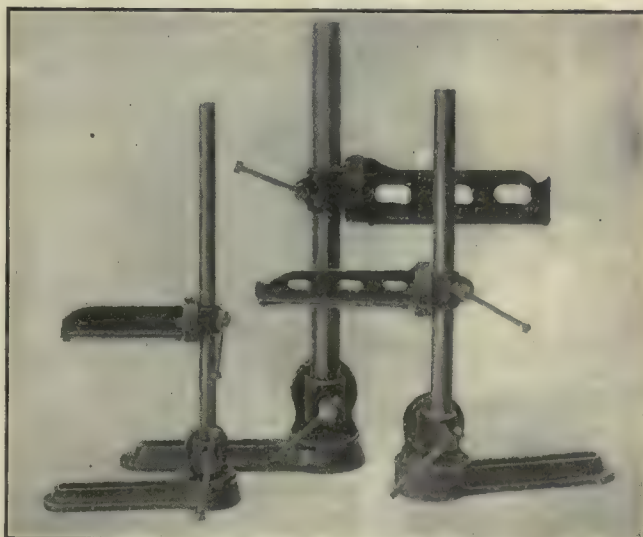
The travel of the table is automatic and is controlled by adjustable dogs operating against a reversing lever. This lever can be turned down and the table moved beyond the reversing point without changing dogs. The traverse movement of the saddle is automatic, feeding at each reversal of the platen and in either direction. An adjustable automatic stop is provided which throws out this feed at any desired point. The traverse feed is from 0 to 3/8 in. at each reversal of the platen.

By throwing out the automatic traverse-feed mechanism, work requiring side grinding can be ground to 0.001 in. by means of a graduated handwheel. The clutch-actuating device in the gear box is always thrown regardless of speed momentum, working on the break-back principle.

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Adjustable Drilling Brace

The illustration shows a drilling brace, commonly called an "old man," manufactured by the Adjustable Drill Brace Co., 100 High St., Boston, Mass. The post is secured to the base by an angle plate which permits the post to be adjusted to any angle. Teeth are provided on the angle plate and the post clamp to prevent the adjustment when once set being changed by the



ADJUSTABLE DRILLING BRACE

Dimensions of post on No. 1, 1½ in. in diameter, 24 in. long; No. 2, 1½ in. in diameter, 24 in. long; No. 3, 2½ in. in diameter, 28 in. long; weights, 22, 35 and 55 lb.

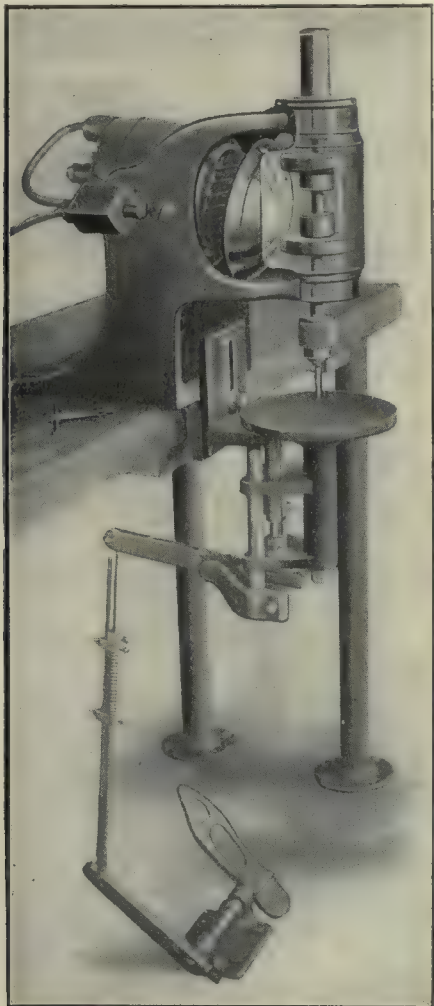
drilling pressure. The arm is clamped to the post in a similar manner and can also be swung through a large arc and securely fastened when set to the desired angle.

This drilling brace is built in three sizes. Binder handles are provided at all clamping points, thus dispensing with the use of wrenches. The posts are of steel tubing with a wall thickness of 1/4 in. The device is readily dismantled and can be packed in a small space.

Vertical Tapping Grinder

In the design of the machine shown the aim was to provide a cutting speed that could be varied without affecting the time per operation; that is, have the reverse compensate for the slow cutting speed. By a direct connection between the motor and spindle and by the use of ball bearings it is possible to run the machine on a lighting-service wire without undue disturbances.

The spindle is made from high-carbon steel, turned and ground, and is mounted in ball bearings. The in-



VERTICAL TAPPING MACHINE

Capacity, standard tap in cast iron, $\frac{1}{8}$ to $\frac{1}{4}$ in.; in steel, $\frac{1}{16}$ to $\frac{3}{8}$ in.; depth, up to $1\frac{1}{2}$ in.; distance from spindle center to slide, 4 in.; diameter of spindle, $\frac{3}{4}$ in.; size of table, 7 in.; vertical adjustment of table, 3 in.; motor, $\frac{3}{4}$ hp., 1,750 r.p.m.; net weight, 115 lb.

ner ball race, in which the spindle moves endwise, has been increased in length by forcing into it a sleeve $11\frac{1}{2}$ in. long. This sleeve is made from high-carbon steel. Owing to the spherically faced disk on which the spindle frictions operate, the slipping tendency is reduced.

The face of the friction driving disk is spherical and is mounted direct on the armature shaft of the motor, thus eliminating intermediary transmission devices.

A spring, at the upper end, can be adjusted so as to balance the weight of the spindle. This spring is inclosed. The motor bracket has two brackets fitting any of the standard motors.

The work table has a movement on two way rods. An adjustment of 3 in. is provided for the way rods and table, giving ample space between chuck and table, where

fixture and lugs are employed. A spring, under the table, can be adjusted so as to balance out the weight, making the movement to and from the tap sensitive for the use of small taps. A foot treadle is provided for operating the table.

The column or body, which supports the table proper, is hollow and of large diameter. This chamber can be filled with oil, so that when tapping work where the tap can go through, it will dip into the oil. As the chamber becomes filled with chips, the oil level is maintained until exhausted or displaced by chips. These can be removed by taking out a plug at the bottom of the chamber.

The motor is pivoted in the frame of the machine on the center of the spherical face of the friction disk mounted on the armature shaft. By tilting the motor various cutting and return speeds can be secured. It is evident that if the speed is reduced in either direction, it will be increased in the opposite. Unless otherwise ordered, the machine is equipped with a two-jaw positive-drive type chuck.

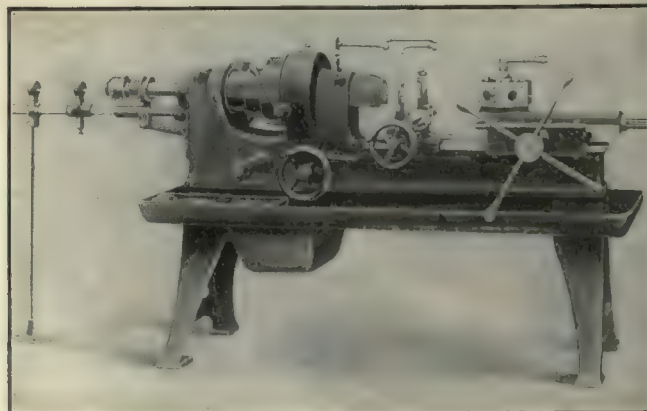
This machine is a recent product of the Anderson Die Machine Co., Bridgeport, Conn.

Hand Screw Machine

The illustration shows a hand turret screw machine recently developed by the D. & W. Machine Co., Inc., 149 Broadway, New York City.

The head and bed are cast integral. The back gears, which are completely covered, are operated by friction clutches. A geared-friction head provides two instantaneous speed changes for any one of the cone.

The automatic and wire feed are controlled by the same lever. The cross-slide is actuated by a handwheel and screw. The hand longitudinal feed provided is calcu-



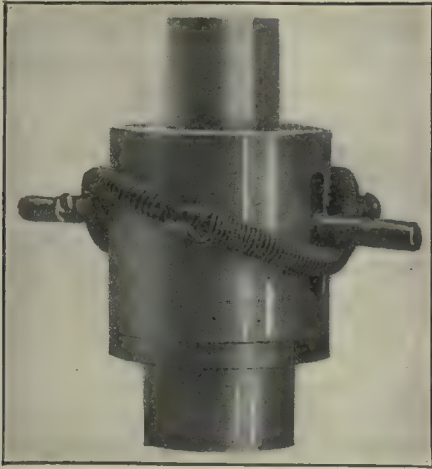
HAND TURRET SCREW MACHINE

Automatic chuck capacity, $1\frac{1}{2}$ in.; diameter of hole in spindle, $1\frac{1}{8}$ in.; thread on spindle, 3 in.; diameter of holes in turret, $1\frac{1}{2}$ in.; center of holes to top of slide, $2\frac{1}{8}$ in.; diameter across flats, $8\frac{1}{2}$ in.; swing over bed, 16 in.; swing over cross-slide, 7 in.; length that can be turned, 8 in.; greatest distance, end of spindle to turret, 21 in.; largest diameter of driving cone, 11 in.; width of belt, 3 in.; horsepower required, approximately, 2; floor space of machine, 7 ft. 8 in. by 2 ft. 7 in.; weight, 2,150 lb.

lated to be especially useful for certain operations in moving the cross-slide along the bed. The turret is hexagonal, having six tool holes. The turret revolves automatically by the backward movement of the slide. The vertical locking bolt is at the front end of the slide, directly under the cutting tool. Independent stops operate automatically for each hole of the turret. The turret saddle has a taper base, so that the tool holes in the turret can be brought to exact center.

Return Mechanism

The illustration shows a mechanism that is employed to operate the return for the knockout of a die. The use of this device is not limited to this application. It consists of a helical spring arranged in a manner sim-



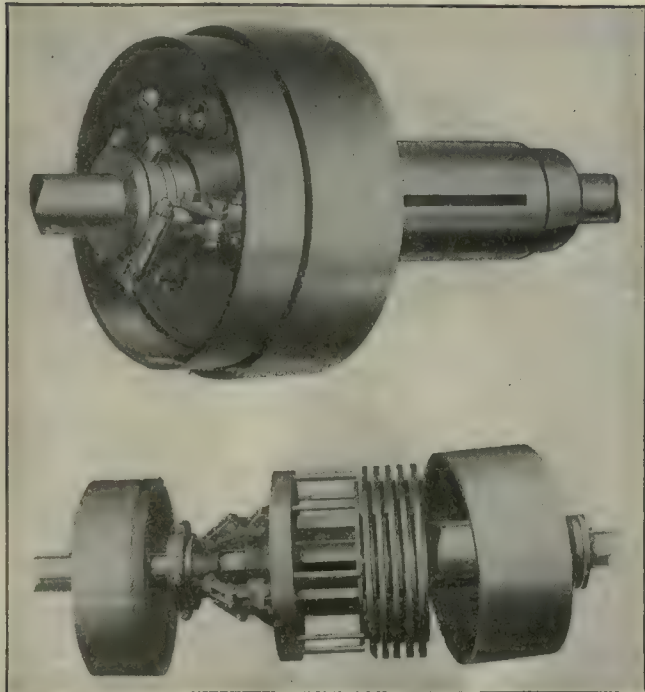
RETURN MECHANISM

ilar to that shown in the illustration. Thus applied the spring is always in plain view of the operator, can be made much longer than the springs generally used for this purpose and is therefore less liable to be overstressed and broken.

The device is manufactured by B. Menkin, 2141 Honeywell Ave., New York.

High-Speed Friction Clutch

The clutch here shown was especially designed for high speeds. It is of the metal-to-metal type, having bronze



HIGH-SPEED FRICTION CLUTCH

disks alternating with cast iron. The disks are lubricated, but do not run in an oil bath. They are fully inclosed, and all important parts are machined all over, so that the

clutch is balanced. Engaging mechanism is such that there is no tendency to grab or drag when the clutch is released.

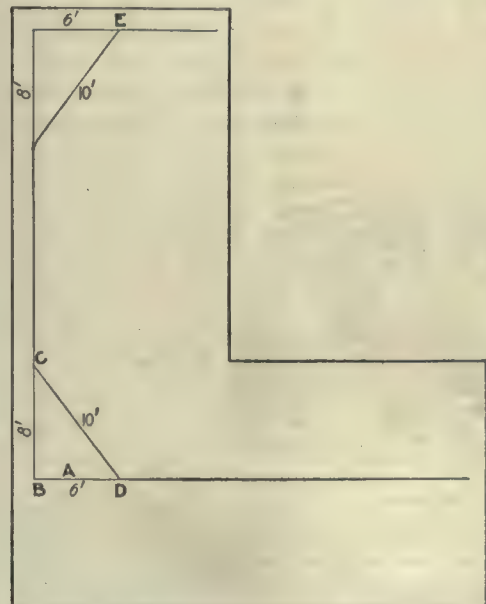
The clutch is made in loose-pulley and cutoff coupling types. It is available in sizes from 5 to 25 in. in diameter of bronze disks. Each size has from one to six disks, according to the capacity desired. The smallest size can be run up to 3,000 r.p.m., and the largest size up to 750 r.p.m. Powers transmitted are up to 630 hp. In sizes from 5 to 13 in. the clutches can be fitted directly on an extended hub of the pulley, gear or other member.

These clutches are intended for use with alternating-current motors when required to start under load, also for group drives to high-speed machinery and individual drives to woodworking and other heavy high-speed machines. They are made by the Moore & White Co., Philadelphia, Penn.

Lining Up Widely Separated Line and Counter Shafts

BY GEORGE B. FAIRMAN

The illustration shows how I lined up a countershaft for a planer. The room was L-shaped, and it was necessary to use the long, narrow part. The countershaft was to be 35 ft. away from the lineshaft. Using a plumb bob I drew a line *A* on the floor in line with the lineshaft. I first laid off 6 ft. at *BD*. Then with a stick



HOW THE SHAFTS WERE LINED UP

that had two nails in it 8 ft. apart I struck a circle *BC*. With the center *D* and a similar tram, but 10 ft. long, I then struck the circle *DC*. Connecting *BC* gave me a line square with the line *A*. I then ran a chalk line over *BC* clear to the other end of the room. Repeating the squaring operation, I got the line *E* square with *BC* and parallel to *BD*. It was an easy matter to plumb from this to the ceiling and set the hangers for the countershaft.

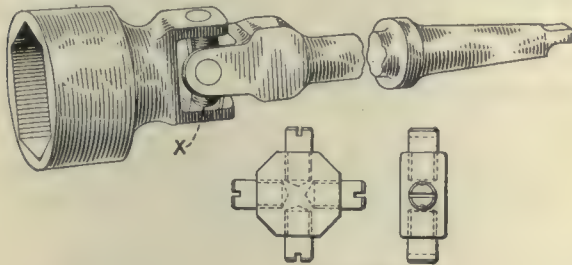
Where it is desirable to level two or more elements, the work can be accurately done with a garden hose and two gage-glasses. The gage-glasses are stuck in the ends of the hose, and the hose is filled with water so that the gage-glasses are about half full.

Socket Wrench with Flexible Joint

By J. V. HUNTER

On numerous occasions there come into the shop assembling jobs that involve the use of large quantities of fair-sized bolts, say $\frac{3}{4}$ or $\frac{7}{8}$ in. The driving of nuts on these bolts is a somewhat wearisome job when it becomes necessary to pull up an inch or more of tight thread on several hundred bolts a day.

To take care of this problem a powerful air motor (drill) has often been used by providing it with a socket



Detail "X"

THE SOCKET WRENCH

wrench on the butt end of which a heavy drill shank has been welded to insure the necessary fit to the corresponding drill socket in the air motor.

Usually such motors are quite heavy and require the services of two men to handle them readily, unless they can be counterweighted from some ceiling support. Even then two men are often advisable, because the pull on the handles of a big motor puts a heavy strain on one man.

However, with two men operating, the motor will more than double the output of the same men working with hand socket wrenches. The motor can likewise be made to pull the nuts tighter than by hand, for when the motor has exhausted its own power it will still hold the nut as in a ratchet wrench. The operators, throwing their weight against the long handles of the motor, as though using a powerful T-head socket ratchet wrench, can give the final twist to the nut.

Recently we had occasion to drive a large number of bolts in a frame where certain flanges threw an ordinary power socket wrench enough out of line with the bolt to cause the socket to bind on the nut, so that it was impossible to turn it even when the socket was slightly enlarged.

To meet this condition a socket wrench was devised similar to the one shown. This was provided with a small universal joint (such as one will find on almost any automobile drive shaft).

Using a piece of good alloy steel, or even a good grade of mild steel, small jaws can be forged that will be light in weight and still more than sufficiently strong for the purpose.

For trunnion pins, as shown on the center block X, a good grade of steel should be used that may be hardened and tempered or else given a good depth of case-hardening. Case-hardening can also be applied to the bearing holes in the jaws. The two hardened surfaces, kept well oiled at the start, will polish together in nice shape, without cutting, and the joint will then run for almost an indefinite length of time without developing an annoying amount of vibration or rattle.

This wrench was designed and built with only one particular job in view, consequently it will fit only one size of nut. It has since occurred to me that it should be made interchangeable in order that the same flexible joint may serve several sizes of sockets for different nuts. This could readily be accomplished by providing either a threaded or a square stub end to the jaw, with the insertion of a lock pin or setscrew to prevent it from turning or slipping off. Any number of socket sizes could then be made up to fit the stub end, and the usefulness of the tool would thus be correspondingly multiplied.

Hiram Maxim

Sir Hiram Maxim, inventor of the automatic system of firearms, and world-wide authority on explosives, died at his home in London, on November 23. Mr. Maxim was born in Sangerville, Maine, in 1840. He took up residence in England in 1883 and became a British subject in 1889.

Personals

Harry S. Graves, formerly connected with the General Motors Co., has been appointed sales engineer of the Russel Motor Axle Co., Detroit, Mich.

Frederick Fisher, formerly associated with the Bucyrus Company, has joined the recently incorporated R. E. Ellis Engineering Co., Chicago, Ill., with which organization he will act as vice-president and treasurer.

Louis Ruthenberg, for some time past chief inspector of the Dayton Engineering Laboratories Co., Dayton, Ohio, has been appointed general superintendent, succeeding W. P. Anderson, who has resigned to establish himself in business.

Trade Catalogs

"Cushman" Chucks. The Cushman Chuck Co., Hartford, Conn. 1917 Catalog and Price List. Pp. 40; 4x7 in.; illustrated.

"Ingersoll-Rogier" Air Compressors. Ingersoll-Rand Co., 11 Broadway, New York. Form No. 3130; pp. 24; 6x9 in.; illustrated.

Hydraulic Valves and Fittings. The Watson-Stillman Co., 42 Church St., New York. Catalog No. 94; pp. 96; 6x9 in.; illustrated.

Mosher Adjustable Drill Brace. The Adjustable Drill Brace Co., 100 High St., Boston, Mass. Catalog; pp. 16; 5x7 in.; illustrated.

"Little David" Pneumatic Riveting Hammers. Ingersoll-Rand Co., 11 Broadway, New York. Form No. 8311; pp. 16; 6x9 in.; illustrated.

Scientific Lubrication of Cutting Tools. The Cincinnati Lubricant Pump Co., Cincinnati, Ohio. Pamphlet; pp. 16; 4½x7 in.; illustrated. This describes and shows application of the "Fulfo" pump.

Vasco Vanadium Steel. Vanadium-Alloys Steel Co., Pittsburgh, Penn. Folder describing various types of this steel and containing information as to the study of alloy steels in general and uses of same.

Facts About Gears. The Van Dorn & Dutton Co., Cleveland, Ohio. Booklet; pp. 40; 5x7½ in.; illustrated. This ought to be of use to users of gears as it contains tabulated data on gearing terms, drawings and specifications, etc.

Forthcoming Meetings

American Society of Mechanical Engineers. Annual meeting, Dec. 5-8, Engineering Building, New York City. Calvin W. Rice, secretary, 29 West 39th St., New York City.

American Society of Mechanical Engineers. Monthly meeting, first Tuesday. Calvin W. Rice, secretary, 29 West 39th St., New York City.

Boston Branch National Metal Trades Association. Monthly meeting on first Wednesday of each month, Young's Hotel. W. W. Poole, secretary, 40 Central St., Boston, Mass.

Providence Association of Mechanical Engineers. Monthly meeting, fourth Wednesday of each month. J. A. Brooks, secretary, Brown University, Providence, R. I.

New England Foundrymen's Association. Regular meeting, second Wednesday of each month, Exchange Club, Boston, Mass. Fred F. Stockwell, 205 Broadway, Cambridgeport, Mass.

Engineers' Society of Western Pennsylvania. Monthly meeting, third Tuesday; section meeting, first Tuesday. Elmer K. Hiles, secretary, Oliver Building, Pittsburgh, Penn.

Rochester Society of Technical Draftsmen. Monthly meeting, last Thursday. O. L. Angevine, Jr., secretary, 857 Genesee St., Rochester, N. Y.

Superintendents' and Foremen's Club of Cleveland. Monthly meeting, third Saturday. Philip Frankel, secretary, 310 New England Building, Cleveland, Ohio.

Western Society of Engineers, Chicago, Ill. Regular meeting, first Wednesday evening of each month, excepting July and August. J. H. Ward, secretary, 1785 Monadnock Block, Chicago, Ill.

Philadelphia Foundrymen's Association. Meetings first Wednesday of each month. Manufacturers' Club, Philadelphia, Penn. Howard Evans, secretary, Pier 45 North, Philadelphia, Penn.

Technical League of America. Regular meeting, second Friday of each month. Oscar S. Teale, secretary, 35 Broadway, New York City.

Special Lathes for 8-In. Shells

By H. V. HAIGHT*

SYNOPSIS—Owing to the difficulty of obtaining machine tools, manufacturers of munitions were in many cases compelled to design and build them. The following article covers the essentials of a line of machine tools designed and built for the manufacture of 8-in. shells.

In undertaking a large contract for 8-in. shells, we decided to build most of the machinery ourselves. This has involved building over 160 lathes (including thread milling machines), besides two band presses, twelve shot

while the lathe takes inserted cutters, made in our own toolroom and costing about \$2 each. The two operations are also performed at one setting, and can even go on simultaneously, thus making a great saving in time. The cutting-off device shown in Fig. 1 is designed with large wearing surfaces for both slides and feed mechanism, and has given less trouble than any cutting-off machines with which we have had experience.

2. Another advantage of special machines is the saving in floor space. By chucking the shells inside the spindle for all operations on the inside and base, a saving of about three feet is made in the length of each of these

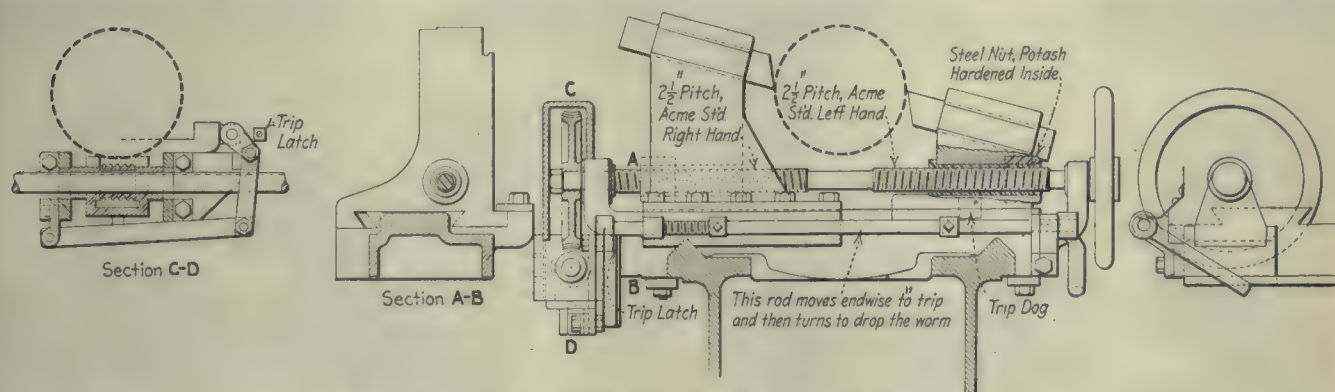


FIG. 1. THE CUTTING-OFF SLIDE AND TOOLS

blast machines, varnishing, painting and washing machines, air hoists, trolleys, etc.

There are a number of advantages in building special-lathes, and the illustrations show several of the lathes and thread millers.

There are a number of advantages in building special purpose lathes for shell making, rather than buying

lathes. With seventy lathes on these operations, this one feature represents a large saving in floor space. Then all the lathes have the shortest length of bed which will do for the work. Taken altogether, it would probably

TYPICAL SINGLE-PURPOSE LATHES FOR 8-IN. SHELLS

	Cut Off and Drill	Rough Turn	Bore	Adapter Lathes
Length of bed.....	8 ft. 6 in.	7 ft. 0 in.	8 ft. 6 in.	5 ft. 8 in.
Width and depth of bed at center.....	22x16 in.	22x16 in.	22x16 in.	22x16 in.
Height from floor to center.....	52 in.	52 in.	52 in.	52 in.
Swing over bed.....	24 in.	24 in.	24 in.	24 in.
Swing over cross-slide.....	10 1/2 in.	12 in.		8 in.
Front spindle bearing, diameter x length.....	8 1/2 x 10	8 1/2 x 10	12 1/2 x 7 1/2	6 1/2 x 8
Rear spindle bearing, diameter x length.....	8 1/2 x 10	8 1/2 x 10	12 1/2 x 7 1/2	4 x 6
Intermediate shaft bearing, diameter x length.....	2 3/8 x 5	2 3/8 x 5	2 3/8 x 4 1/2	
Back-gear shaft bearing, diameter x length.....	2 3/8 x 5	2 3/8 x 5	2 3/8 x 4	2 1/2 x 4 1/2 2 3/8 x 4
T & L pulleys (on headstock).....	14x5 10x3	16x6	14x5	10x5
Diameter and face of spindle gear.....	20x4 1/2	20x4 1/2	20x4 1/2	15x4
Diametral pitch of spindle gear.....	6	6	6	6
Total back-gear ratio.....	15 to 1	22 1/2 to 1	10 to 1	5 to 1
Hole in spindle.....	4 1/2	4 1/2	8 1/2	2
Tailstock spindle, diameter and travel.....	None	3 1/2 x 12	None	None
Tailstock center, Morse taper.....	None	No. 5	None	None
Saddle bearing on V's.....	32 in.	32 in.	32 in.	32 in.
Saddle, width of bridge.....	18 in.	10 in.	18 in.	10 in.
Rack, width and length.....	4x36	1 1/2 x 30	4x48	1 1/2 x 30
Rack, diametral pitch.....	4	7	4	7
Rack, material.....	Cast iron	Steel	Steel	Steel
Rack pinion, number of teeth.....	14	12	14	12
Feed reduction, pinion to feed rod.....	240 to 1	80 to 1	240 to 1	80 to 1
Longitudinal feeds.....	0.009	0.050 and 0.089	0.026 and 0.037	0.067
Crossfeed.....	0.015	Hand	None	0.063
Thrust bearing.....	Ball	Fiber	Ball	Fiber
Weight (with cast-iron chip pan).....	6,900	6,700	6,750	4,150

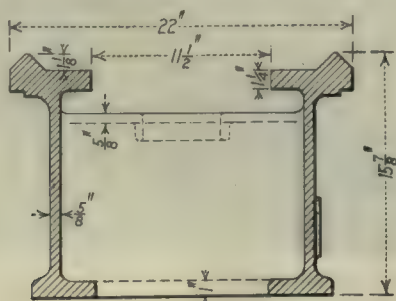


FIG. 2. SECTION OF BED

standard machines in the open market and adapting them to the purpose. Some of these advantages are as follows:

1. The machines are better suited to the special operations for which they are designed than any general machine can be. This is well illustrated by the lathes which perform the first operation—cut off and drill. Ordinarily, this would require two machines, a cutting-off machine and a drill press. The drill press would require high-speed twist drills costing over \$40 each,

Main headstock spindle of cast iron with driving gear cast integral.
T & L pulleys on headstock, no overhead countershaft.
Double plate apron. Power crossfeed on back, independent of apron.
Drop worm feeds. Cast-iron worm gear, steel worm.
Belt feed drive, main spindle to feed rod. Commercial split pulleys on feeds.
Central rack for drilling and boring. Air quick traverse for boring.

have required an extra \$50,000 for shop extension to house purchased lathes.

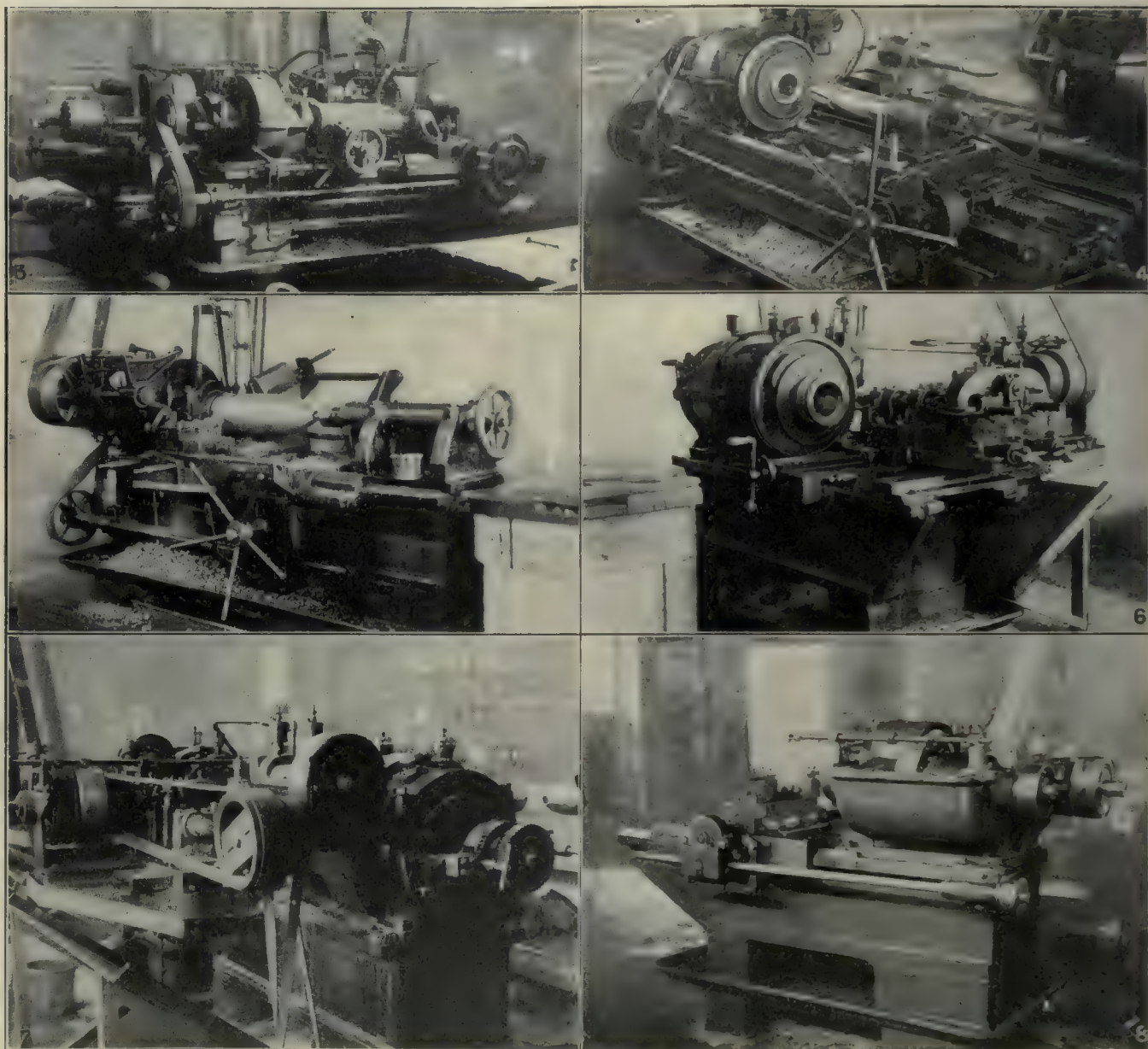
3. The elimination of overhead countershafts has greatly simplified the location and erection of machines.

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as well as removing a constant source of trouble and making a big saving in belts, pulleys, timber stringers, etc.

4. The lathes are, of course, much simpler than engine lathes, and they are simpler in some respects than even purchased single-purpose shell lathes, as they do not require to have any "selling" features. Shell work wears

6. Building one's own machines makes the question of increase of capacity much simpler. The production on some operations will be found lower than on the rest, and it becomes necessary to increase these in order to bring up the net capacity of the whole plant. With purchased machines, it may be impossible to get good



FIGS. 3 TO 8. LATHES FOR VARIOUS OPERATIONS

out almost every part of a machine, and the fewer parts there are the less will be the chances of trouble and shutdowns. For example, no lathe manufacturer, so far as I know, uses plain belt feed drive, with commercial split pulleys to provide for feed changes, and yet the gear feed drive is a common source of trouble.

5. Another advantage of building rather than buying shell-making machines lies in the facility of making repairs. A good many spare parts are required, and when the machines are being built it is easy to provide some extra parts. On the other hand, in purchasing lathes, the question of delivery makes it necessary to buy many different kinds, and this complicates the matter of repair parts.

delivery on more machines of the same kind, while to get a different kind will cause delay.

In reference to the special features of the lathes themselves, the general design embodies a comparatively light framework, but powerful driving, feeding and holding devices. The bed, as will be seen by the section, Fig. 2, is comparatively light, and the body of the headstock, the saddle, apron, etc., are not very heavy. The main spindle is, however, exceptionally large, the back gear ratio high, and the belt power large. The tailstock spindle, which is a particularly weak point in most lathes, is made much larger than ordinary. The feed is powerful, especially with the central rack, used on the lathes for drilling and boring, Figs. 3 and 4.

As to the special features of design the most radical is the cast-iron main spindle, with driving gear cast integral. This is strong, stiff, simple and cheap and has proved entirely satisfactory. I believe the use of hammered high-carbon steel for lathe spindles is really an unconscious attempt to cover up an error in design. If lathe spindles were made as large as they should be

the rack, the feed is taken up by a cam and roller, which feeds about $\frac{1}{16}$ in. more and then dies out. This not only makes a positive stop to the feed, but gives the feed time to die out. The depth of feed is changed by adjusting the rack.

The waving lathe, Fig. 5, has the wave-forming tool on the front and the two undercutting tools on the back.

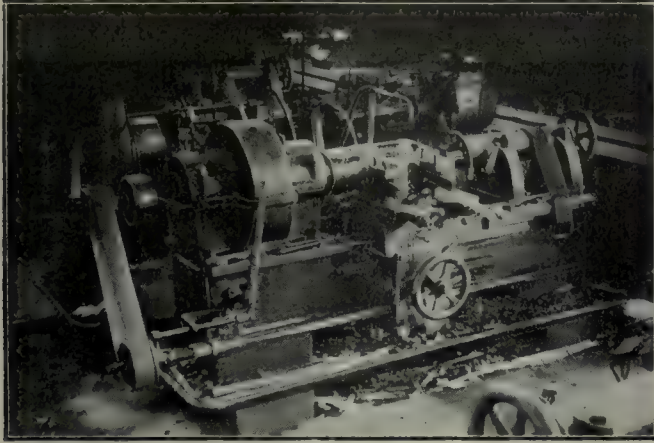


FIG. 9. ROUGH TURNING

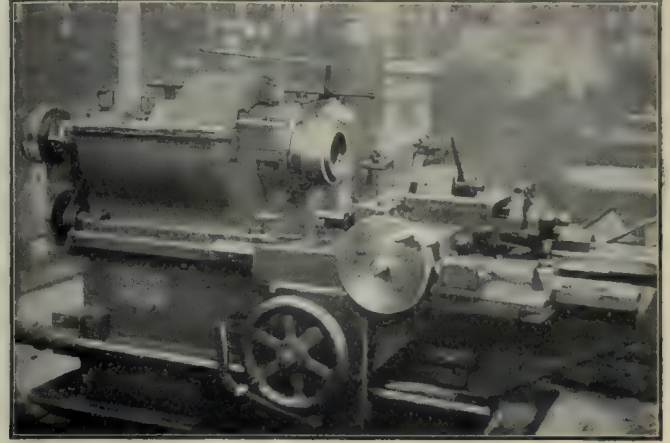


FIG. 10. FINISH AND THREAD ADAPTERS

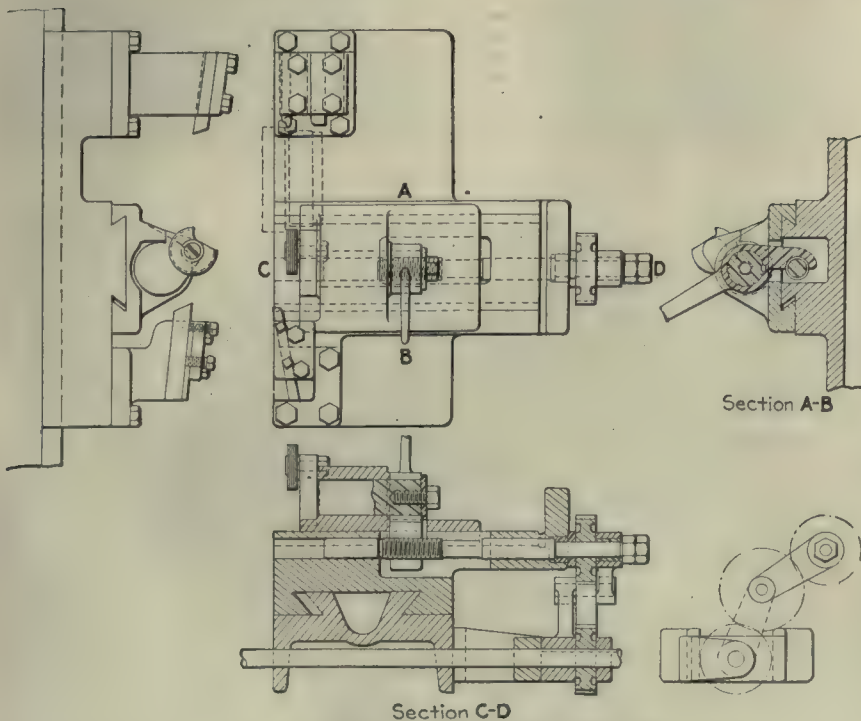


FIG. 11. THE CHASING ATTACHMENT

for stiffness, they could be made of low-carbon steel or cast iron with entire satisfaction.

The belt drive to the feed is simple, and as the driving pulleys are commercial split pulleys, it is possible to get the exact feed that is found best suited for each operation. This is impossible with an ordinary lathe. A single-purpose lathe with gear drive to the feed might provide feeds of $\frac{1}{8}$, $\frac{1}{16}$ and $\frac{1}{32}$ in., but if the desired feed were $\frac{1}{12}$ in., it would be impossible to obtain it. Some of our lathes have two feeds, with a jaw clutch between. The parts of the clutch are cast iron, with cast teeth. This is shown in Fig. 4.

A special form of feed stop is provided on the boring lathes, Fig. 4. When the pinion gets to the end of

The waving slide is actuated by a crank on the intermediate shaft, which is geared 8 to 1 to the main spindle and thus gives the eight waves per revolution. This crank, acting through a link, rocks the feedscrew of the waving slide. The feedscrew is 1 in. lead, cut quadruple, and is rocked one-eighth of a revolution, giving $\frac{1}{8}$ in. of wave to the ribs. The feedscrew has two nuts, one of which can be tightened to take up slack in the thread. The thread miller, Figs. 6 and 7, is included with the lathes, as it uses some of the same details of headstock, chuck, bed, pan, etc. It is a two-spindle machine, one spindle carrying regular milling cutters for finishing the counterbore, and the other spindle carrying a thread milling cutter for milling the thread for the adapter or base plug. The feed mechanism is different from the usual type used on thread millers. The feedscrew forms an extension of the main spindle, and is always

in engagement with the feed nut. For circular milling the nut is locked to the screw and turns with it, while for thread milling the nut is locked to the thrust bracket and remains stationary while the screw feeds through it. This result is attained by having an arm attached to the feed nut and carrying two pawls, which can be engaged either with a stationary ratchet or with a ratchet attached to the feedscrew (see Fig. 7).

The lathe for facing and rough turning adapters (the official name of the base plug) has a crossfeed, as shown in Fig. 8. This is a drop wormfeed on the back. The crossfeed is entirely independent of the longitudinal feed, and either can be adjusted as desired by changing the pulleys. The body turning lathe is shown in Fig. 9.

The lathe for finish turning and chasing the thread on adapters is shown in Fig. 10. The chasing attachment is shown also in Fig. 11. The principle is similar to that of a chasing bar. A half nut is thrown into engagement with the lead screw, and the same movement brings the chasing cutter against the work. It has advantages over the chasing bar, as the whole mechanism is well supported and guided by a dovetail slide, and the tool does not require to be held into the cut. The circular cutter is also an economical design permitting regrinding until the circumference is entirely ground away. This attachment will rough a thread to within a few thousandths of finished size at one cut.

The "unit assembly" method was followed in designing and building these lathes. Various styles of headstocks, tailstocks, aprons and special fixtures for cutting off, waving, thread milling, etc., were made up in lots, also beds of different lengths. The special lathes for the various operations were then made by assembling the proper combination of these units.

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Three Departments in a Typewriter Factory

BY FRANK A. STANLEY

Much of the work handled in the Noiseless Typewriter factory at Middletown, Conn., and a large number of tools used in this plant have been illustrated in previous articles, and it is believed that the arrangement and organization of some of the principal departments in the plant may be of interest to readers.

Without counting up the columns along the central aisle one would hardly have a definite idea of the length of this factory. Some idea may be gathered, however, from the fact that the lineshaft passing over the center of the aisle is 900 ft. in length over all, one length of this, 600 ft. in all, being driven by the motor near the center, while the other length of 300 ft. is operated by a motor at the far end of the shop.

The broad central aisle is kept clear and is used solely for a passageway and for handling material up and down the shop. At the rear of this main building there is a series of wings, in one of which the press department is installed, while another is utilized for the enameling department.

Fig. 1 is a view in the tool department, showing the foreman's headquarters and the temporary tool storage nearby. There are in this department some 30 or more Pratt & Whitney 10-in. tool makers' lathes, a number of high-grade shapers, millers, and so on. Like the other departments in the building, this floor is open from one end to the other, so that a clear view is had from the foreman's desk to all parts of the department.

The benches in this section are provided with large-sized accurate surface plates, and some of the most interesting operations here conducted have to do with the laying out and testing of jigs and fixtures, and other tools of a similar nature. There are a large number of snap gages and height gages of various kinds, as well as micrometer and flush pin gages used in testing parts of the typewriter at different stages of manufacture. Practically all these gages are made in this department.

Fig. 1 shows the cabinet used for tools which are undergoing inspection or which are being examined and modified in some respect or other. In this section a large

number of big jigs and milling and profiling fixtures are stored prior to being inspected and sent back to the tool stores. In connection with this temporary storage space trucks, like the one shown at the right of the view, are found very convenient. This truck, like some which are used in the press department, is mounted upon substantial casters, it has upon its top a large surface plate which may be wheeled about to any point in the toolroom where it is necessary to make some special test of a jig or fixture, or for laying out new work. In the view shown a drill jig is seen in place on the surface plate, while immediately back of it are a number of other jigs ready for service. This equipment enables the tool makers to handle their work with facility, and it is always possible when a man wishes to lay out a job of toolwork to get access to a surface plate which can be moved readily with the truck to any convenient place as regards lighting conditions or machine tool or other equipment which he wishes to have nearby during the operation.

A great deal of material in the way of sheet stock cut to various widths, as well as bar stock of all sizes, is constantly passing through the plant and being worked up into typewriter parts. This material, prior to being issued to the shop departments, is taken care of in a general storeroom, illustrated in Fig. 2. Here a number of substantial stock racks have been installed. These consist of heavy cast-iron brackets in the form of double arms, cast on a central hub which slips over 2-in. pipe secured in a substantial base which is fastened to the floor. By merely extending the length of the pipe and increasing the number of cast arms the racks may be made to any height and with any number of supports for different sizes of material.

Of course a number of grades of steel are carried for different parts that have to be manufactured from this material, and in addition to flat stock carried in numerous widths a large supply of seamless drawn steel tubing is kept always on hand, as this is used for the interior of the rubber platens, or paper feed rolls, one of which is required for each typewriter.

The view, Fig. 3, is a general illustration of the japanning department, where such parts as the typewriter frame, covers for the mechanism, the center tie for the platen carriage, and numerous other parts are finished prior to assembling.

Before the work comes to this department the castings are ground off and polished smoothly on all faces that are exposed, this being done in the polishing room. Then they are sandpapered in the japanning department and dipped in rubber enamel. This constitutes the first coat, which is baked at 380 deg. F. for 3½ hr., with the work suspended in metal trucks which are run on tracks into ovens shown in the background of Fig. 3. These ovens, or furnaces, are fired by fuel oil, and the temperature is closely regulated at what has been found to be the proper heat for obtaining the desired results.

After a period of 3½ hr. at the temperature specified, the work is removed from the furnaces, sandpapered again, dipped into a second coat of what is known as finish enamel, then baked again for 3½ hr. at a temperature of 400 deg. F. A similar process is followed for the third coat. Following this the work is removed, sandpapered and rubbed over with French emery paper or with 120 D. carborundum paper. There are in all four dipped coats of enamel, and before the final coat is applied the work

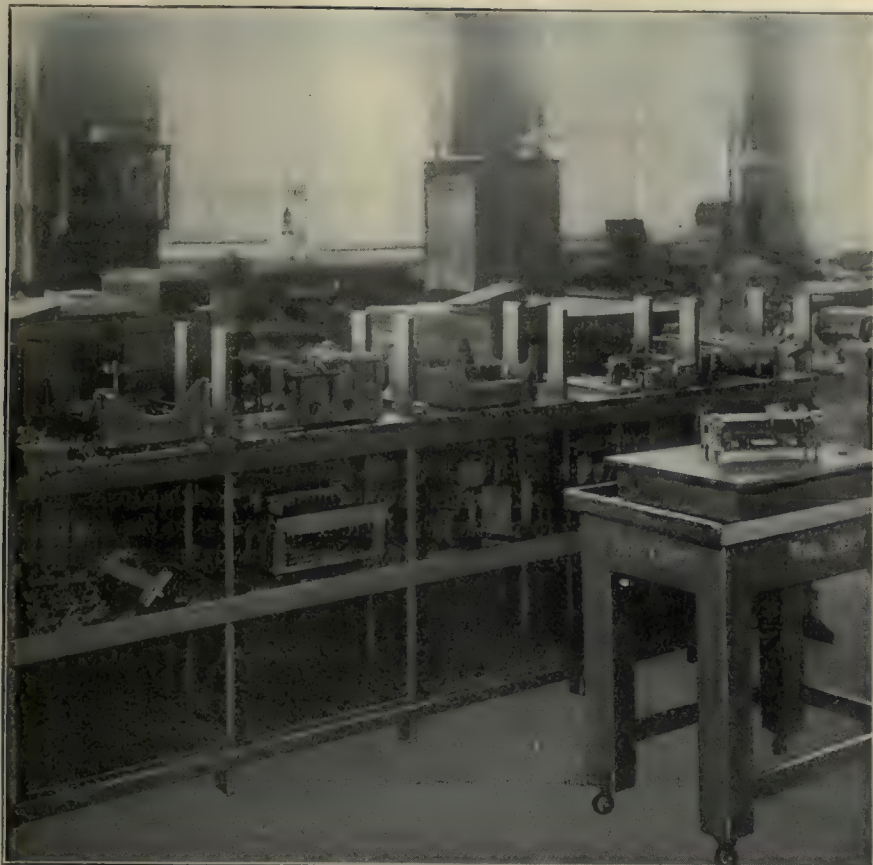


FIG. 1. STORAGE RACKS IN TOOL DEPARTMENT

to stripe and varnish the pieces, so that a total of about six days is required to put a certain casting through the department. The character of the ovens in which the work is suspended is clearly shown in the illustration, and certain features of some of the drying racks are also visible. There are, however, a number of interesting designs of racks not seen in this view, most of which have been developed to suspend some one particular piece in large quantities, and to hang these parts so compactly that although they do not touch one another, a great number may be carried in a small space. This is essential when passing through so much material at a given time, and every facility must be adopted to put the work through in its regular routine without confusion and without the possibility of individual parts marring or injuring one another through possible contact in the moving of the racks about the room. In handling parts in and out of the room, to and from other departments, a number of interesting forms of boxes and racks are used, these being made on the premises in



FIG. 2. THE STOCKROOM



FIG. 3. THE JAPANNING DEPARTMENT

is rubbed down with pumice powder and water. Then the transfer—that is, the name of the company and other decorations—is put on, after which a coat of white copal varnish is applied and the work again baked, this time at 180 deg. F., for a period of 4 hr. This coat of varnish, by the way, is baked on by steam and not in the oil-fired oven.

It is customary with this work to put it through at the rate of two coats a day, and two more days are required

as large quantities as are required at the time. They are usually of skeleton form, to make them light in weight and convenient to pick up and stack. They are piled up with the convenience of sectional furniture, and their interior is such that work of all kinds may be closely packed therein and still be sufficiently far apart to prevent contact between facing surfaces. Several of these skeleton boxes or trays will be seen behind the bench in the middle of the japanning department.

Tools Used in the Machining of Motor Parts

BY ROBERT MAWSON

SYNOPSIS—In this article are shown some of the tools used in the machining of elements for automobile motors. The jig for the accelerator pedal-shaft bracket is fitted with a sliding V-block as the locating medium. Two screws over which are arranged tension springs return the V-block when pressure is released by means of the knurled head screw. On the jig used for machining the emergency-brake latch the part is located by a tongue.

On page 936 some of the jigs employed by the International Motor Co., Mack Works, Allentown, Penn., in

the manufacture of parts for commercial-vehicle motors were shown. In this article are illustrated a few of the other tools used at the same factory in securing rapid production.

The locating devices are designed to be both effective and rapid in operation on the general class of castings described.

These small tool jigs are of modern design and construction. They have been given sufficient usage to prove their value both as regards the quality and quantity of production obtainable from them. Special efforts have been made to reduce the fastening devices to the smallest possible quantity, and these are of the quick-acting type.

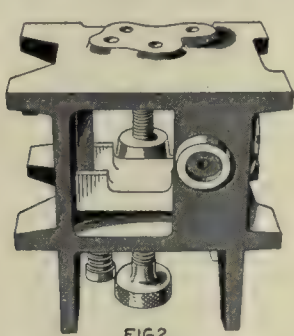


FIG. 2

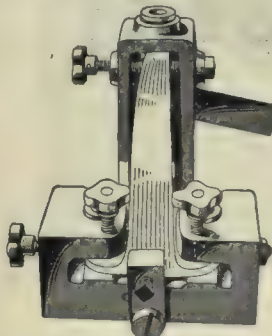


FIG. 4

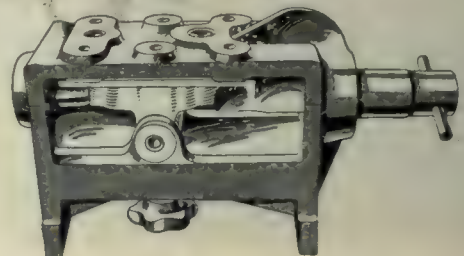


FIG. 6

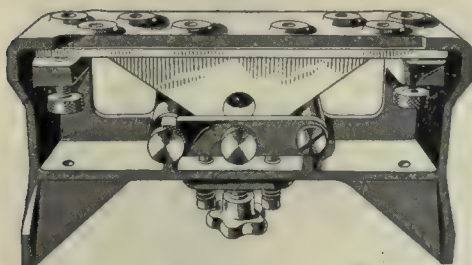


FIG. 8

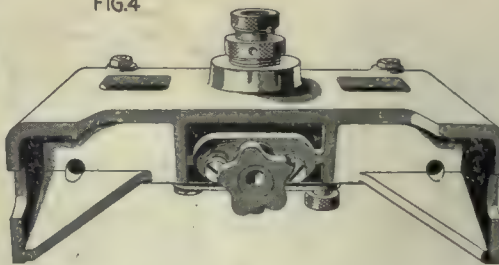


FIG. 9

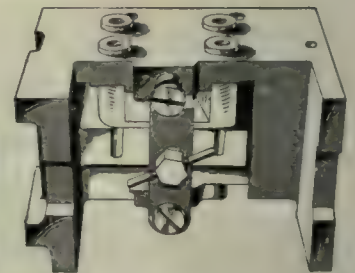


FIG. 11

DRILLING JIGS USED IN MACHINING MOTOR PARTS, WITH WORK SHOWN IN POSITION

FIGS. 2 AND 2-A

Operation—Drilling accelerator pedal-shaft bracket, Fig. 1. The rough casting is located in a sliding V-block, which is forced against the piece by a knurled head screw. After the piece has been forced into position the knurled head screw is tightened, so as to hold the work. Two setscrews, over which are fitted tension springs, force back the locating block when the knurled head screw is drawn back.

Holes Machined—Two $\frac{3}{8}$ -in. drilled, four $\frac{1}{2}$ -in. drilled, one $\frac{3}{8}$ -in. drilled and one $\frac{1}{4}$ -in. drilled. The last hole is then tapped with $\frac{3}{8}$ -in. 20 U.S.S. threads.

FIGS. 4 AND 4-A

Operation—Drilling and tapping jackshaft brake-support bracket, Fig. 3. After the base has been disk-ground, the casting is slid into the jig, being forced against a stop at the base by a swinging clamp. The upper and lower ends of the piece are held against adjustable stops by means of knob-headed screws and a latch screw.

Holes Machined—Three $\frac{1}{2}$ -in. drilled. The hole in the arm is then tapped with $\frac{1}{2}$ -in. 20 U.S.S. threads.

FIGS. 6 AND 6-A

Operation—Drilling hood catch bracket, Fig. 5. The rough casting is forced into a fixed V-block by a sliding V-block. The later V-block is operated by a pin-headed screw. After the casting has been correctly located a knob-headed screw is tightened against it from the underside of the jig, thus holding the piece securely.

Holes Machined—Six No. 11 drilled, one $\frac{3}{8}$ -in. drilled, one $\frac{1}{2}$ -in. drilled and two $\frac{1}{4}$ -in. drilled.

FIGS. 8 AND 8-A

Operation—Drilling dumper-body end hinge, Fig. 7. The rough casting is located in a V-block that fits around the central boss. After the casting has been forced against the underside of the upper wall of the jig by the V-block, two knurled head screws hold it in position. Another knurled head screw fitting in the swinging strap that comes against the lower part of the casting also assists in holding the piece and forcing it back against the adjustable stops. The V-block is fitted with screws and a tension spring, to force it away from the casting when the pressure is released on the V-block.

Holes Machined—Eight $\frac{33}{64}$ -in. drilled.

FIGS. 9 AND 9-A

Operation—Drilling and reaming dumper-body end hinge, Fig. 7. The method followed to locate and hold the casting in this jig is the same as that described in Fig. 8.

Hole Machined—One $1\frac{1}{2}$ -in. spot-drilled, afterward being reamed to $1\frac{1}{2}$ in.

FIGS. 11 AND 11-A

Operation—Drilling and tapping emergency brake-latch box, Fig. 10. The milled casting is forced against a finished surface with knob-headed screws and fits inside a machined tongue of the jig. The front latch is then swung up. A pin-headed screw tightened against the piece holds it securely in position.

Holes Machined—Four $\frac{17}{64}$ -in. drilled, one $\frac{17}{64}$ -in. drilled and one $\frac{3}{8}$ -in. drilled. The $\frac{3}{8}$ -in. hole is then tapped with $\frac{1}{4}$ U.S.S. threads.

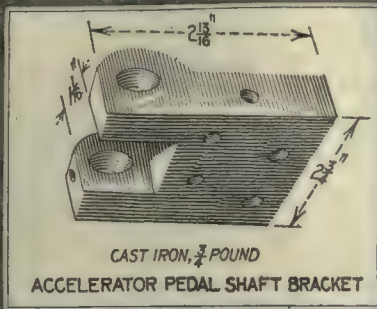


FIG 1

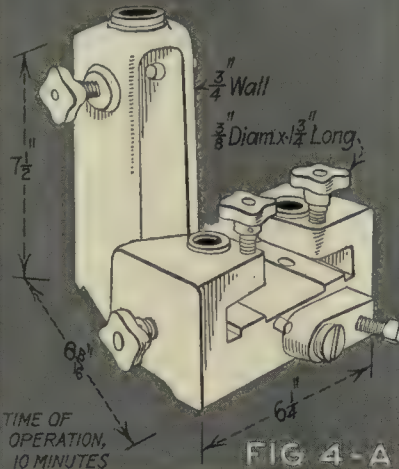


FIG 4-A

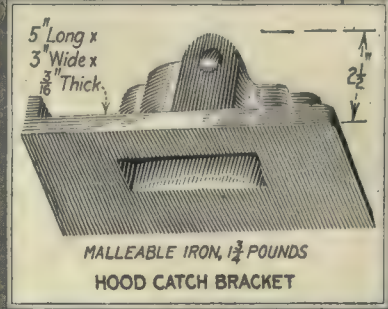


FIG 5

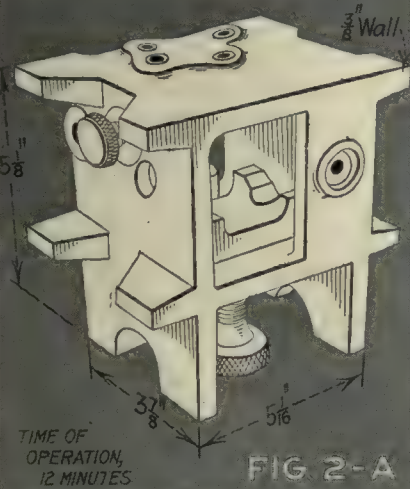


FIG 2-A

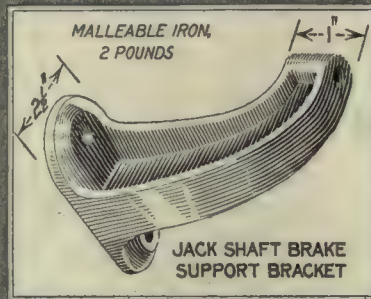


FIG 3

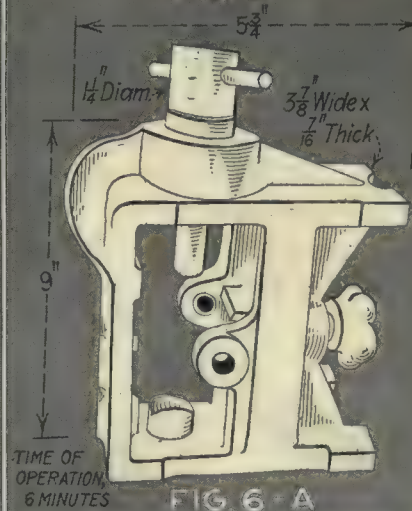


FIG 6-A

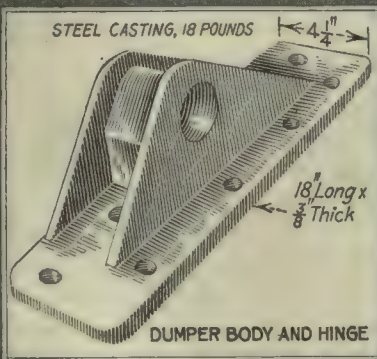


FIG 7

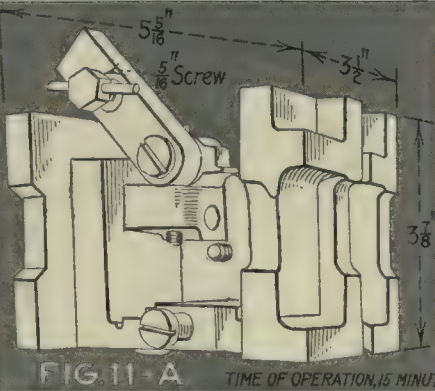


FIG 11-A

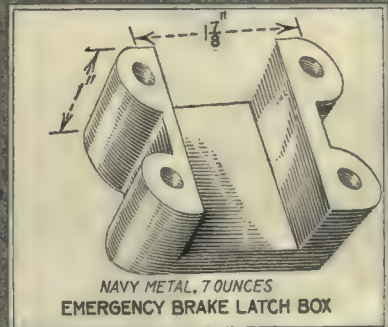


FIG 10

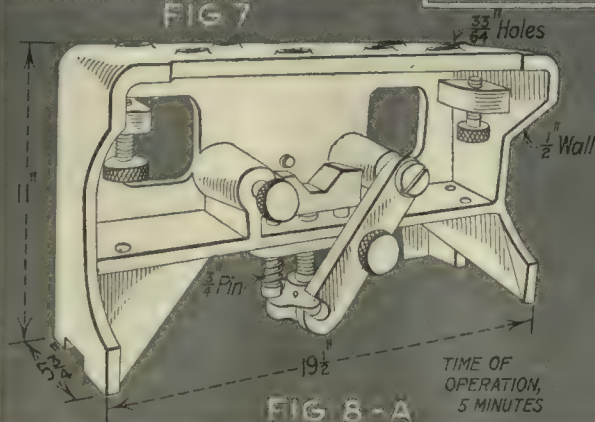


FIG 8-A

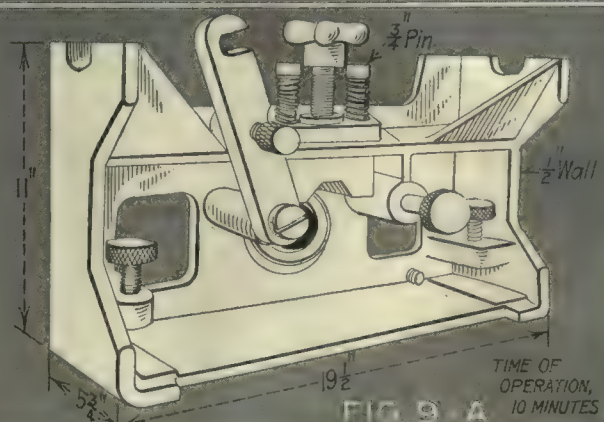


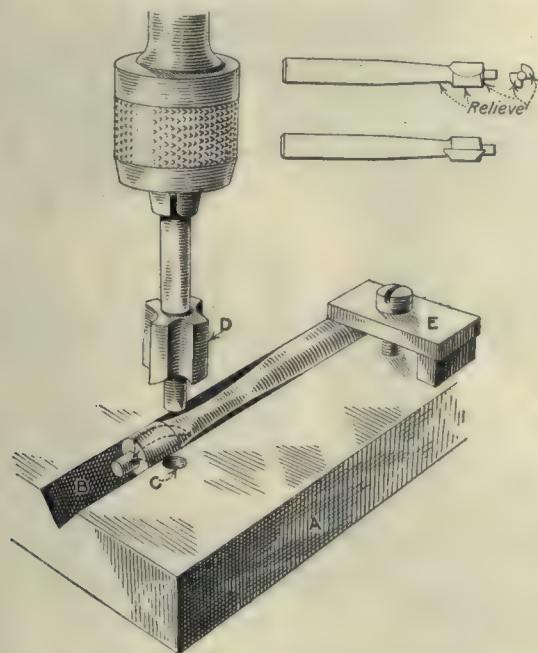
FIG 9-A

ALL BUSHINGS USED FOR GUIDING TOOLS ARE BLACKENED. ALL JIG AND FIXTURE BODIES ARE CAST IRON. STRAPS AND FASTENINGS, MACHINERY STEEL; GUIDE BUSHINGS ARE TOOL STEEL, HARDENED AND GROUND

Making Counterbores on the Drilling Machine

By M. J. ZIMMER

Small counterbores can be made on a drilling machine a great deal faster than on a miller, and without the use of special appliances. I have made counterbores as small as $\frac{3}{8}$ in. in diameter with a pilot for a No. 60 drilled hole. This was for work that required accurate drilling. It was first laid out, prick punched and then drilled with a No. 60 drill. I then used the counterbore 0.120 in. in diameter with No. 60 pilot, afterward



THE WORK AND THE FIXTURE

reaming with a $\frac{1}{8}$ -in. reamer. The correct size of counterbore with a $\frac{1}{8}$ -in. pilot was then employed. This gives excellent results without swinging the work on the lathe faceplate and indicating each prick punch mark.

Counterbores are a necessity in drilling thin metal and much other work, and they would be used more than they are if it were not for the time and trouble required to make them.

The block of steel or cast iron *A* has a 45-deg. groove *B* about $\frac{3}{8}$ in. deep. At *C* is a pilot hole the diameter of which is governed by the diameter of the pilot on the counterbore *D* to be used. The distance from *C* to the center of *B* is governed by the diameter of the counterbore used. This makes it possible to employ any counterbore that may be in stock.

To make counterbores from $\frac{1}{4}$ in. to $\frac{1}{2}$ in. I use a $\frac{3}{4}$ -in. counterbore with a $\frac{1}{4}$ -in. pilot, and for the smaller sizes I use a $\frac{1}{4}$ -in. counterbore with a $\frac{1}{8}$ -in. pilot. This means a smaller groove should be placed in the block alongside the other one and about $\frac{1}{8}$ in. deep, and another pilot hole drilled to suit. A number of holes should be drilled and tapped parallel to the groove and close together in order to accommodate the clamp *E* required to hold the work.

The blanks are turned in the bench lathe to the required sizes. A line is then scribed with a centerhead across the end of the shank. The blank is then placed in the groove and the line located parallel with the sur-

face of the block, care being taken to have the blank correctly located with relation to the pilot hole in the block *A*. The blank is then clamped with *E*, *D* is run down till its face is level with the center of the blank, and the blank is then turned halfway around. Line up again with the line on the end of the shank and again bore down to the same depth. The proper clearance is then filed where needed, and the counterbore is ready for hardening.

When making counterbores in this way too great speed should not be used, and the lost motion in the drill press should be taken up.

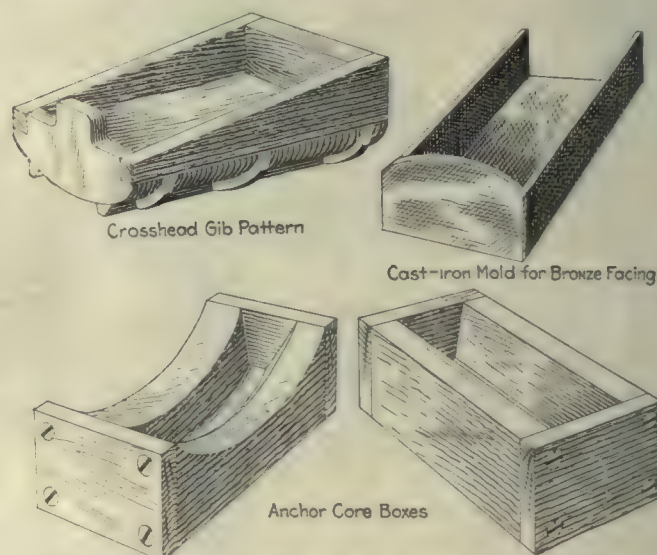
Bronze-Faced Crosshead Gibs

By FRANK R. CALKINS

Many engine builders still use solid bronze or composition crosshead gibs on their machines, and this feature alone proves a costly item.

Just as good results, at a great reduction in cost, may be obtained by using bronze-faced cast-iron gibs. The method of casting bronze to iron is a simple one.

The gib pattern is made in the usual manner, except that a reduction in thickness is made, to correspond to



PATTERN, COREBOX AND MOLD FOR THE GIBS

the facing of bronze to be added. Five core prints are fitted to the guide face of this pattern. These prints, three curved to fit the cross-surface of the gib and two straight, or lateral, ones, are tapered.

The cores, tapered to the same angle as the prints, extend nearly a half-inch into the iron casting, and their wedge-like form provides for a solid anchorage of the bronze to the iron.

The form, or mold, used to face the gib is made of cast iron. It rests upon the edges of the gib face and extends under the bottom. Extra finish on the sides of the iron gib is allowed for this.

The gib and mold are placed alongside the metal pots in the furnace until hot enough to prevent a "blow out" of the molten bronze, and the mold is then firmly clamped into position on the gib.

When poured and "set," the bronze face is found to adhere as closely to the iron casting as if both were one piece. This method of lining will also apply to cast-iron top and bottom main-bearing boxes.

Unusual Flue Work and Tools in a Railroad Shop

SPECIAL CORRESPONDENCE

SYNOPSIS—Operations on superheater flues constitute an interesting feature of railroad shop work. The practice described includes a number of unusual features. The swaging machine described is pneumatic and is of the home-made variety that meets special conditions often beyond the scope of standard tools. The machine consists of a vertical frame made up of 10-in. channels and suitable angles carrying an 8-in. freight-car air cylinder at the top.

Some interesting operations on superheater flues, as handled in the Minneapolis shops of the Minneapolis, St. Paul & Sault Ste. Marie Ry., are illustrated by the accompanying photographs and diagrams.

Fig. 4 represents a pneumatic swaging machine for flue ends, this consisting of a vertical frame made up of 10-in. channels and suitable angles, carrying an 8-in.

the piston, as indicated. The lower end of the piston rod is reduced to a diameter of $2\frac{3}{4}$ in., to carry a follower for the upper die. Thus it acts as a ram for the swaging process.

The pipe and valve connections for the cylinder are shown in Fig. 1. A 1-in. pipe from the air supply leads downward directly into the top of the foot valve at the bottom of the machine, and a short section of $\frac{3}{4}$ -in. pipe leads from the side of the valve to a 1-in. pipe passing upward to the top of the cylinder. A little more than halfway up this 1-in. pipe there is a three-way cock carrying a two-arm tappet. This tappet is acted upon to operate the valve by an arm pivoted at the side of the press and connected with the upper die, so that as the latter rises and falls the outer end of the arm is rocked slightly in the opposite direction to operate the three-way cock. The points of contact between the ends of the arm and the tappet jaws consist of button-head spring plungers, one of which is mounted in the end of each jaw

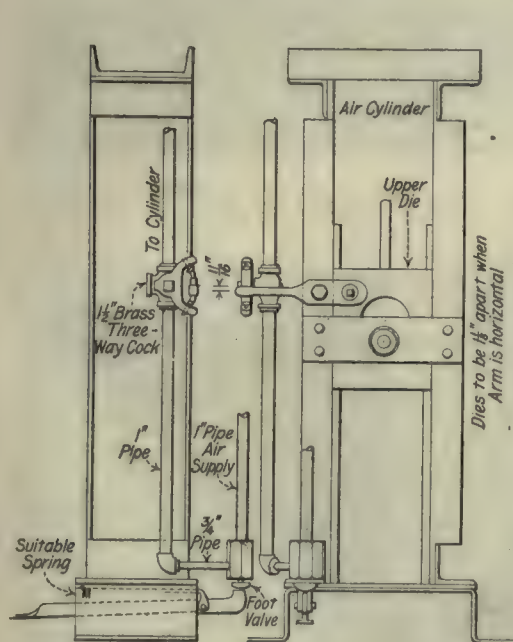


Fig. 1

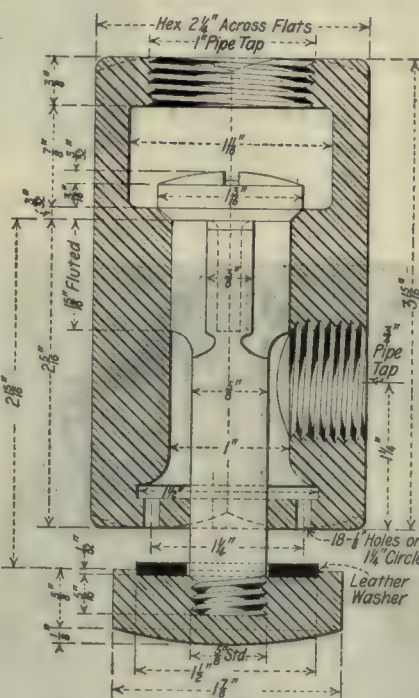


Fig. 2

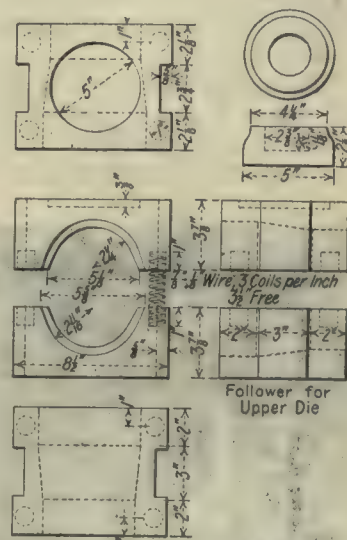


Fig. 3

FIGS. 1 TO 3. DETAILS OF SUPERHEATER FLUE SWAGE

Fig. 1—Operating device for swage. Fig. 2—Foot valve for swage. Fig. 3—Flue-swaging dies

freight-car air cylinder at the top and having along its inner faces vertical guides for the swaging dies.

This machine was built in the shop, and details of its construction are shown in Figs. 1 and 2, the dies being illustrated in Fig. 3.

DETAILS OF THE SWAGING MACHINE

The air cylinder is fitted with a piston whose stem, $2\frac{1}{2}$ in. in diameter, passes downward through the lower head of the cylinder, while around the stem there is a heavy compression spring acting upon the lower face of

The valve at the bottom of the press, which is manipulated by a foot lever, is constructed as shown in Fig. 2. It consists as there illustrated of an hexagonal body tapped at the top for a 1-in. pipe leading into a chamber with a conical seat at the bottom to receive the head of the valve, which carries at the bottom end of its stem a leather-faced disk. This disk, and the valve as a whole, has a vertical movement of about $\frac{1}{4}$ in., and in its extreme upward position with the valve open at the top it closes the series of eighteen $\frac{1}{8}$ -in. holes drilled through the bottom of the body. At the side of the body there

is a tapped hole for a $\frac{3}{4}$ -in. pipe. Pressure of the foot upon the lever opens the valve at the top and admits the air pressure as required through the three-way cock and upon the top of the piston, the pressure and speed of operation thus being conveniently controlled by the operator.

The die details in Fig. 3 show the form of opening for the swaging of the flue, the semicircular die faces flaring out slightly as they approach the open faces of the dies. This drawing also shows the arrangement of the four springs seated in the corner of the dies to throw them open when the pressure is released. Both dies, it will be noticed, are planed out along the sides to fit the vertical guides secured to the inside of the machine uprights.

A FLUE TESTER

Fig. 5 illustrates another important device made in this shop for testing flues under pressure after the ends have been welded.

The apparatus consists of a long section of very heavy hydraulic pipe with caps at the ends, which are closed against the tube ends to hold it securely during the test. The work is inserted from the end nearest the observer, the cap at this end being held tightly in place against its gasket by a powerful lever, fork-shaped and set up snugly by a handwheel and screw at the lower end. Water pressure is applied to the pipe connection shown near the middle of the length of the device, the pressure gage being clearly seen immediately at the rear of the illustration.

This apparatus allows the tubes to be quickly inserted and removed, and if there is any weakness at any point in the weld or elsewhere in the work, it is revealed at once upon simple and ready inspection of the tested tube.

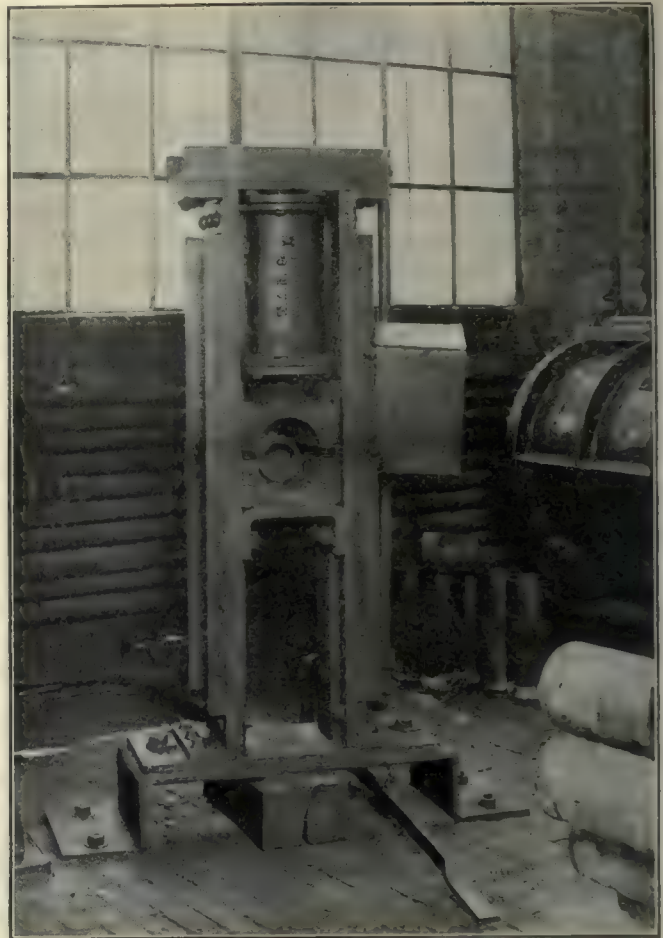


FIG. 4. VERTICAL PNEUMATIC SUPERHEATER FLUE-SWAGING MACHINE



FIG. 5. A HOME-MADE TESTING APPARATUS FOR SUPERHEATER FLUE TUBES AFTER THE ENDS HAVE BEEN WELDED

A Book on the Looks and Details of Machines--I

BY JOHN E. SWEET

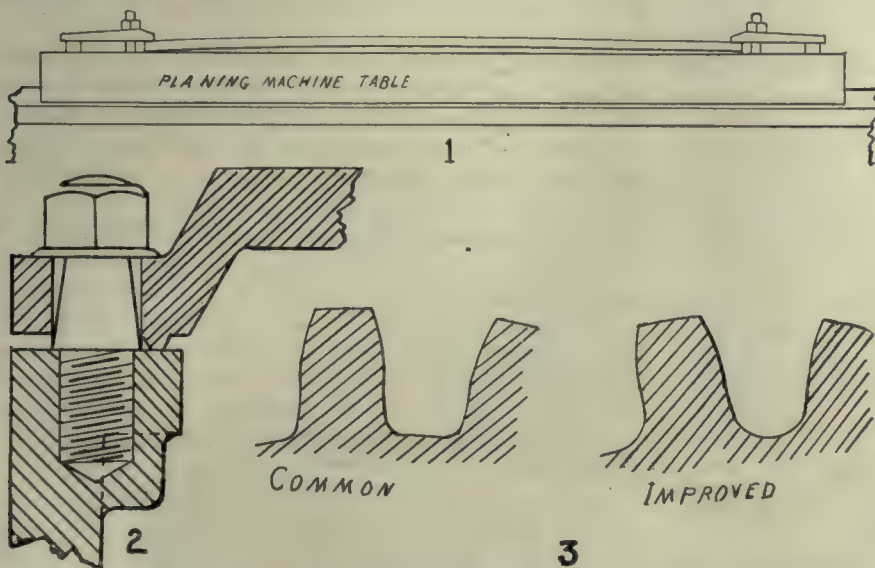
SYNOPSIS—This is the first part of a short book that at the time of Professor Sweet's death was left in manuscript form. In stating his purpose in preparing it, Professor Sweet wrote, " . . . so my readers will find that what is new in this work, if anything, will relate to the looks, durability and fundamental principles involved in the construction of machinery."

A mechanical engineer of an observing mind once made the remark that if the problem of designing a new machine tool be given to the principal designers in the country they would all bring out the work in about the same way. Admitting this to be true—and it likely is—then one of the two conclusions we must reach is

That is an idle remark, as those who do the selling full well know.

If the fundamental laws governing machine design are known and followed and the day of useful improvement is at an end, then were it possible to construct machines to last a hundred years, they might as well be so made. Some claim that there is no use in making machines to last over twenty years, for machines have so improved in twenty years that it is best to destroy all that are old and put in new, as the new will pay for themselves in a short time; moreover, that it will be the same ten years from now—that is, that machines and engines will have so advanced that these we now build will then be out of date.

If we are to judge from the past that such is to be the case in the future, then would it not be best to step ahead ten or fifteen years and build now the machines ten or twenty years ahead of our time? The businessman will say no, because we cannot sell them; and to a certain extent this may be true. It cannot, however, be wholly true, for all new departures have found enterprising purchasers enough to form an entering wedge that has brought the majority up to a higher level. It is easy to say—and to prove sometimes—that things are made well enough or too well, but the history of engines and machine tools proves that, while there are exceptions in the long run, those who have made the best work have made the most money and have lived to see those handling cheap machines fail. It is plain, too, to any observer that all successful firms are doing better work than formerly and striving for better still. It is possible—in fact, even probable—that the steam engine may not be wanted a hundred years from now. Hence, extra expense to gain a hundred years' endurance would be a waste of money; but in the case of machine tools no end to their use can be anticipated, so if they can be made right, no objection can be made to their lasting too long.



FIGS. 1 TO 3. THREE ELEMENTARY DESIGNING CONSIDERATIONS

Fig. 1—Spring of cast-iron straight-edge clamped at ends. Fig. 2—Detail of steam joint, showing narrow band of surfaces in contact. Fig. 3—Common and improved shape at root of gear tooth

that well-known laws and truths in machine design have been established and that the majority of machine designers know what these laws are and follow them, or that there is such a thing as fashion in machine design and that machine designers, like architects, follow the fashion. It is the belief of the writer that this latter is the true explanation, not only as regards the appearance of the finished product, but also as regards much of the working mechanism.

So much has been done by the most able men in the profession in regard to the theory and mathematics of machine design that the following will not in any way treat of the subject on those lines, so my readers will find that what is new in this work, if anything, will relate to the looks, durability and fundamental principles involved in the construction of machinery. Many will say, What do the people who buy and use machinery care about the looks so long as the machine does its work?

RULES REGARDING LOOKS

Ruskin, in his works on art and architecture, points out many facts in regard to why things look right and why wrong, and gives what may be called rules by which one may tell whether work is good or bad. May not a proper study of the art in designing machinery develop rules by which the designer can tell whether his work is right and looks right?

For instance, a post or a column should not have a capital unless it is tapered or has a substantial base—that is, not only a substantial foundation, but an en-

larged foot. So, too, a single-column machine never has been, nor ever can be, made to look right with the body of the same size at the top as at the bottom. The original Bement shaper and the Brown & Sharpe toolroom miller, in respect to looks, can no more be improved upon than a Tuscan column, to which nothing can be added and from which nothing can be taken away, to make it look better.

In a measure the same rules that hold good in architecture hold good in machinery. In the case of foundations, and superstructures also, the center of the foundation should be central under the center of pressure. So, too, in a machine where the structure is heavy, each support should rest central over its base; and when for utility that is not necessary, to look right it should so appear.

Again, when a column is set over another or over a short pedestal, the lower must be exactly central under the upper and must also be the larger of the two. So, too, with the posts of a marine-engine frame the diverging lines of the sloping posts, if continued, should never fall outside of the base casting below.

THE MIXING OF STYLES

In architecture the mixing of styles is never as happy in its results as a pure design in a single style. The same thing holds good in machinery. Though a machine need not be Greek or Gothic, it is not good designing to make some parts round, others square and others I-beam sections when the requirements are similar.

What looks correct in architectural designing is sometimes used as an argument to show that a similar arrangement must be right in a machine, but that is not true. The conditions cannot be alike, and the right process of reasoning in each case would at once show that different treatment is necessary. Examples that represent the proposition are a lathe mounted on two column-shaped closets and a two-column portico of a dwelling.

The columns of the portico rest upon a base that extends from one to the other, whereas the bases of the closets have no connection whatever. Besides, the portico is stayed to the building, whereas the lathe is a structure by itself. The lathe bed supported in that way appears wrong and is wrong, because the loads at the two ends are unequal and call for unequal supports. The end is not the proper place for the footstock end support, because the footstock is a moving load. The whole structure does not look right, as that kind of support implies a flexible bed. If the bases rest upon an uneven or changeable foundation or floor, the whole tendency is to spring or twist it out of truth; and a flexible bed is not what is wanted in a lathe bed either in fact or appearance.

BALANCE IN BASE AND CORNICE

In architecture a building with a prominent cornice and no visible base, or with a visible base and no cornice, does not look right. A column with a capital and no base or plinth or taper does not look well.

The Doric column with a cap and taper would not look well if set upon the ground. There is always a plinth, or the floor of the portico, to justify the capital. Windows and chimneys with ornamental pretentious caps and no visible base are bad examples of architecture. Machines do not want to be like columns,

windows or chimneys, but the principles that demand proper bases for these things are the same principles that govern the design in machines, and the principle is expressed in the one word "consistency."

To be consistent, innumerable conditions have to be considered, sometimes conflicting, and there is a question of judgment as to which it is most desirable to conform to. Assume that some machine is in the main like a square box and, so far as the mechanism or use is concerned, it could come down straight and square on the floor or foundation. If it is to be swept around, it would soon look bad, from the fact that the sweeping would soil it to an indefinite height, whereas if it had at the bottom a simple band for an inch or two in height, that would limit the disfigurement. This is a very little thing, but reason enough of itself for the band; though however elegant or plain the machine may be, it simply will not do credit to the designer without some show of a foot where it rests on the floor.

PROPORTION OF FOUNDATIONS

The center of a foundation should be not only directly under the center of pressure, but the size of the different foundations should be in proportion to their load.

The proposition is easy to understand, and the reason comprehensive when one realizes that nothing is absolutely rigid. The earth will settle beneath a foundation; masonwork is compressible, and cast iron will compress and spring. If the foundations are in proportion to the loads, all will go down uniformly.

The principle laid down by Eastlake, "The hole and not the material surrounding the hole should be the ornament," applies with as much force to machine framing as to architectural decoration. Examples of the two forms may be seen in a Sellers planer and those where other shaped openings have been adopted. No form of hole will weaken a member less than a round one, nor look better in a machine, though others do in architecture.

Machine tools that would never wear out, were such a thing possible, would be tools that never would wear out of truth, and it is in this branch of the subject—endurance—that it is hoped to make this work the most valuable. It is no new thing to consider whether there is or is not ample wearing surface. That is not the point to be emphasized, but the proper relative proportions of the wearing surfaces.

PROPERTIES OF MATERIAL

All of the material we use in machine construction, except lead, possesses the quality of tempered steel—spring to a certain extent—and all the material, but hardened steel, the plastic quality of lead.

To illustrate these two facts in a way that will forcibly impress the designer, first let us go into the road, where, after a rain, the mud has thickened, and level off a spot ten or a dozen feet long and lay a board flat upon it, then place upon each end of the board a heavy weight. The result will be that the board will go down at the ends and spring up entirely away from the mud in the middle. Put cast iron in the place of the mud and the board will do exactly the same thing. Take a cast-iron straight-edge and put it on a true planer table and see that they fit perfectly: strap down each end

as is usual in fastening things in such cases, and the piece will spring up at the center to a surprising degree (see Fig. 1).

This occurs in practice where joints are made to resist fluid pressure. If elastic packing is used, it yields to compensate for the springing of the metal; but when joints are made metal to metal—that is, without packing—the plates must be fairly rigid, the bolts not too far apart and the surfaces in contact a very narrow band not much exceeding, if any, $\frac{1}{4}$ in. in width (see Fig. 2).

Assume another condition—a flat place in the muddy road, as before, with two blocks, one 3 in. square and used as a stepping stone. If one steps squarely upon the center, it will take him safely over. Take the other block a foot square; if one steps an inch and a half from the edge, the chances are that he will go into the mud.

This is nothing but an exaggerated example of what occurs with pieces of metal, and it is the keynote of all foundation building. Further, it is one of the factors entering into the problem of properly proportioning sliding surfaces. A sliding block resting on oil and the board on the mud behave similarly.

GEAR TEETH

Cast iron and the other metals used in machines and tools possess the property of elasticity, which, while undesirable in a general way, is not always so. In a machine framing where the results vary in value according to their truth, then the nearer absolutely unyielding the frame is, the better. The tooth of a cast-iron gear wheel, on the other hand, is a cast-iron spring; and that shape that would be best for the strength of a steel spring would be the best form, so far as strength goes, for a gear tooth, except for the difference in relative lengths. Nearly all gears as now made would be greatly improved in strength by the simple application of this principle. In the wood handle of a nail hammer and in the case of axles of railway carriages this principle has been used so long that no one thinks of it or knows hardly how it came to be used. It is neglected in hundreds of cases where it would be equally valuable. Designers never think of it, or else have not the courage to apply it.

Some parts of machines may be best, strong and flexible; others, rigid and weak; and others best for possessing weight for no other purpose except that of simply weight. Every spring or beam, however rigid or heavy, has a certain rate of vibration—a rate that it will maintain if it vibrates at all; and it cannot be made to vibrate at any other rate without changing some condition or element. This principle comes in in the use rather than in the construction of a machine, except that in the construction the more the liability to vibrate is avoided the better.

Added weight reduces the rate of vibration, but successive impulses, however slight, if in harmony with the natural vibration of a machine will set up a tremor and chatter in a tool that in the case of frail framing become objectionable.

THE HAMMER BLOW

The force of a blow is in proportion to the weight and velocity of the element that delivers it; its effect depends entirely upon the density of the element that

delivers it and inversely as the distance the anvil moves while it is being brought to rest.

The usual measure of a blow is the weight multiplied by the square of the velocity; that is, the force of a blow given by a 10-lb. weight falling 10 ft. a second will figure the same as a 40-lb. weight falling 5 ft. a second, but the result when applied to doing work proves to be vastly different. A quick blow from a small hammer will only rivet over the end of a rivet, whereas the slow blow from a heavy hammer will upset it for its whole length. Forgings may be injured and even ruined by using too light a hammer, by drawing the outside surface of a bar and pulling the middle apart. Castings may be broken by using too heavy a hammer, by upsetting a rivet too much in a hole.

BREAKING PIECES

The ease or difficulty with which a piece can be broken depends upon whether the bending force is concentrated on one point or diffused through a wide distance. A bar of metal $1\frac{1}{2}$ in. in diameter nicked with a chisel or V-tool to $1\frac{1}{4}$ in. in diameter will break easily, whereas if turned down to $1\frac{1}{4}$ in. in size for a considerable length, it is difficult to break. This is another view of the fact presented by the hammer-handle illustration mentioned above.

One of the strongest forms to adopt for a given amount of metal to carry a load is that of an I-beam, if the beam is not too long or narrow so as to buckle; but the theory is based on the assumption that all the metal is of uniform quality. So far as this relates to castings it is not a safe assumption.

LENS SHAPE, HOLLOW SECTIONS AND POSTS

In large castings the center has very little strength, and in the case of thin edges of lens-shaped pulley arms and sections of like character the thin edges are much stronger than the body of the work, when not cracked in casting. This is one of the many things that interfere with the absolute reliability of mathematical determinations of the strength of machine parts.

A rectangular hollow section is nearly if not fully as strong as an I-beam of the same weight and form, and 12 to 16 times stronger to resist torsion than the ordinary form of framing consisting of two side plates and crossgirts.

Posts or parts subject to compression fail either by crushing or buckling. If too short to buckle, it is a matter of little moment whatever the form of the cross-section; but if long, a hollow cylinder is best because all parts are braced against buckling, whereas in a rectangle the center of the webs buckles easily. This is also true of channel or angle sections.

In machine framing, the circular section does not lend itself readily to the fastening of boxes and brackets. The angle and channel sections are costly for patterns and finish, and the rectangular hollow box has taken their places.



A Rust-Preventing Grease, said by a German exchange to be readily soluble in benzine even after many months' standing, can be prepared by emulsifying an aqueous solution of chromic acid or chromates with hydrocarbons, saponifiable fats and oils or the like. The fatty constituents serve as an adhesive, while the chromic solution prevents rusting, it is claimed. Equal parts of fat and a 5 per cent. solution of sodium bichromate are triturated in a mortar.

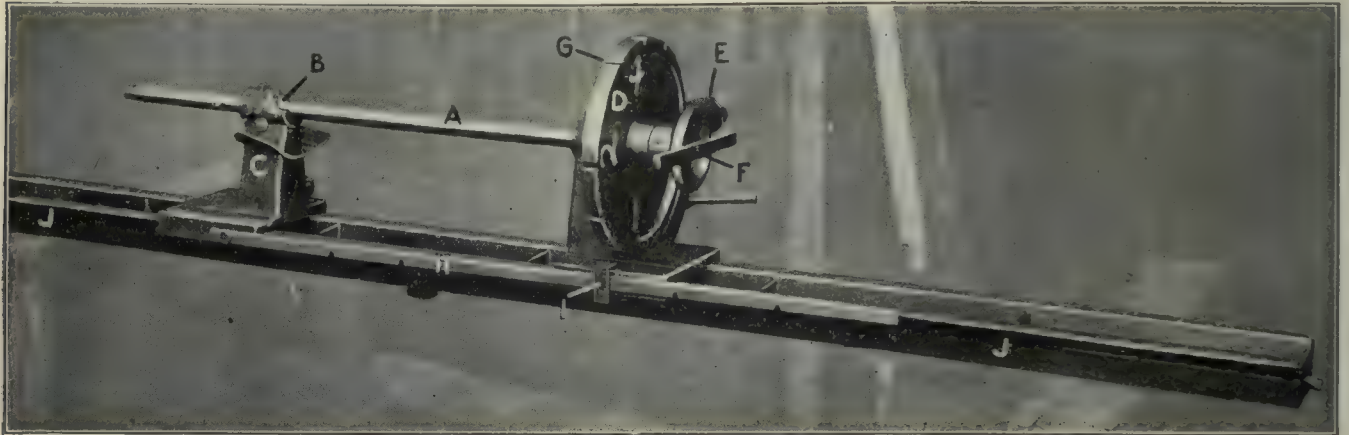
Milling Camshaft Keyways

By F. H. COLVIN

A camshaft fixture for cutting the keyways of a Fay & Bowen marine-engine camshaft is shown in the illustration. These cams are made separately and keyed on their shaft before the final grinding.

This fixture consists primarily of the long bed *J* which is bolted to the table of a hand miller. The block *C* sup-

ports the shaft *A*, which is to be milled at *B* for a Woodruff key. The plate *D* is accurately laid out for indexing the cams around the shaft, while the notched rod *H*, working in a pin at *I*, positions the keys lengthwise on the shaft. This plate is laid out to index for either two-, four- or six-cylinder motors, all the necessary notches being cut, as can be seen. To avoid errors in indexing, it has been found advisable to fill the other notches with a soft metal plug as at *G*, to prevent the latch *E* dropping into it by accident. The notches to be used are also marked with chalk, as indicated. This is a simple fixture, but has proved satisfactory for this work.



SIMPLE DEVICE FOR INDEXING CAMSHAFTS

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Boring Parallel Equidistant Holes in Castings

By H. H. PARKER

It was necessary to machine the iron castings, Figs. 1 and 2, so that the 1-in. holes, cored $\frac{3}{4}$ in. in diameter, would be parallel to the $2\frac{5}{8}$ -in. bore for the one in Fig. 1 and to the $2\frac{1}{8}$ -in. counterbore for that in Fig. 2. The center distance *C* was to be the same for both of the castings.

As my lathe was small and my equipment limited, the fixture shown in Fig. 4 was rigged up. After truing the faceplate the casting shown in Fig. 1 was strapped to the faceplate, the large cored hole bored and the casting faced off. Then the casting shown in Fig. 2 was counterbored and the bottom faced. The pieces *A* and *B*, Fig. 4, were turned up from a piece of iron bar, *A* being made a close working fit in the counterbore in the casting shown in Fig. 2 and *B* in the hole in that shown in Fig. 1. A shoulder was turned on the bottom of *B*, fitting tightly into *A*, as shown. Care was taken to make the bottom face of *B* and both faces of *A* square, and the cylindrical sur-

faces and the shoulder concentric. A $\frac{1}{2}$ -in. hole was bored through *B* for a $\frac{1}{2}$ -in. bolt; this hole must be square with the face, but not necessarily in the center. *A* was drilled and tapped for the bolt, in line with the hole in *B*. The parts *A* and *B* were then put together and bolted to the faceplate, which was again tested for trueness, the proper distance from the center of the plate. Pieces of paper were inserted between the surfaces to prevent slipping. The casting shown in Fig. 1 was slipped over the fixture

and clamped, it having been split and provided with clamping lugs for clamping to a column. Straps were bolted to the faceplate to hold the small end in position, and the 1-in. hole was bored, the boss at the small end also being faced.

The casting was removed, and the *outside* nut holding *B* was taken off, allowing *A* to be lifted off without disturbing *B*. Then the casting shown in Fig. 2 was located over *A*, the nut put on again and tightened, and the bolt

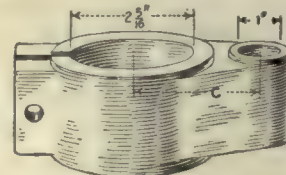


FIG. 1

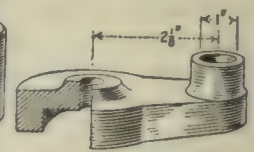


FIG. 2

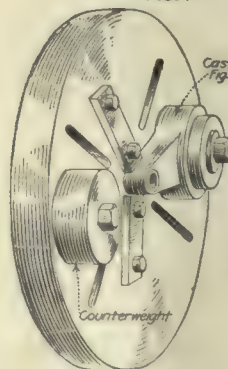


FIG. 3

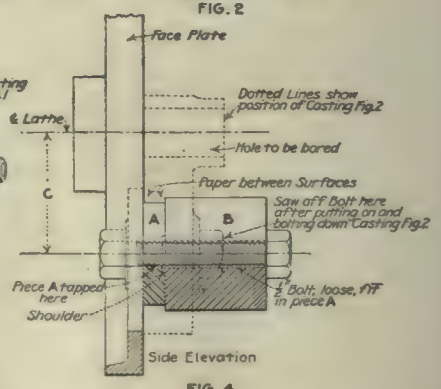


FIG. 4

THE WORK AND HOW EQUIDISTANT HOLES WERE BORED IN IT

sawed off flush with the top of the nut. Straps were put on to hold the small end of the casting in position and the hole was bored.

It can be seen that the success of this method depends upon the trueness of the faceplate and the fixture pin and also the previous facing of the two castings.

Efficient Formed-Tool Grinding

By J. B. MURPHY

In this article consideration is given to the grinding of circular forming tools of the sort used generally in tooling National Acme, Gridley and Cleveland automatic screw machines.

In a forming tool the wear occurs at two points—the first, and more easily remedied, takes place directly at the cutting edge. This, however, is never allowed to become very dull, for as soon as the tool fails to cut properly it is removed and reground.

This grind is quite simple and can easily be done freehand by a practical tool-grinder, it being only necessary to try the face with a small square; for if this face be

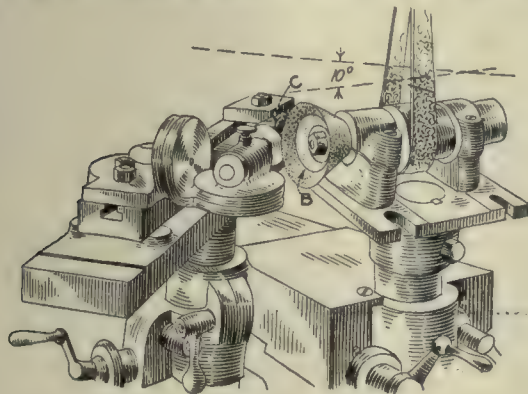


FIG. 1

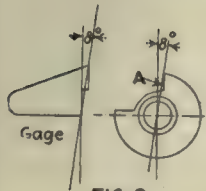


FIG. 2

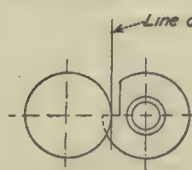


FIG. 3

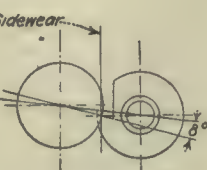


FIG. 4

EFFICIENT FORMED-TOOL GRINDING

not square with the clamping surface, the work produced will be tapered.

The second point of wear—the most troublesome and most difficult to remedy—is the wear produced on the sides of the cutting edges by the friction of the work as the tool is fed into the stock. This, of course, is caused by the absence of side clearance, or in some cases by insufficient side clearance, and will be far more severe at the part of the forming tool that serves as a parting cutter, as at *C* in Fig. 1.

Where a cutter with a sharp corner occurs in a formed tool, this corner is rapidly dulled, and more and more of the burden of the cut is moved from the edge toward the center of the tool. Since the cutting corner on the side marked *C* is weaker than the opposite corner, through having less support, it is rapidly worn away and the side of the cutter at *C* is more or less badly worn to a distance of from $\frac{1}{16}$ to $\frac{1}{8}$ in., or even more, from the edge. All this stock must be ground away before the tool is again fit for use, entailing a serious loss of both tool stock and time.

Practical experience with various screw machines teaches that this side wear usually extends about $\frac{1}{8}$ in., no matter how carefully the tool may be ground. I believe it would be impractical in the great majority of cases to give each cutting point of a formed tool side

clearance, for to do so would seriously weaken the tool; indeed, in the case of small forming tools, they would probably break at once upon being put into service. If the tool is small in diameter, or complex in face profile, side clearance might act as a "check," and cause a bad fracture. The method of grinding such formed tools, as shown in the illustrations, is the result of considerable experimenting, and while it does not entirely eliminate side wear, it reduces this trouble to a minimum and enables us to save much cutter stock and time and increases the production.

By experiment I find that satisfactory results may be obtained if the cutting face is ground off center and ground a little concave, then set in the screw machine below the center and the cutter revolved enough to bring the cutting edge of the tool about 8 deg. below a line passing through the center of the work and the center of the forming tool, as shown in the diagram, Fig. 4. For this a height gage is used, and by measuring with this gage from the tool holder every forming tool may readily be set correctly. By way of example, take the 2-in. cutter shown. In grinding, a line is scribed across the center; parallel with this line and about $\frac{1}{16}$ in. from it a second line is scribed. These lines must be located so that the last line mentioned will remove all the worn part of the cutter and leave the tool fit for use. If preferred the angles shown in Fig. 2 may be used for these two lines, and the layout as given in Fig. 2 followed. Next we set the cutter in a vise on the table of a No. 1 Cincinnati universal tool grinder, and see that the vise, turret and scale are all set at zero.

The cutter is now set by the vertical center line first mentioned, using a square on top of the vise jaw, and the vise tightened. A No. 2 Cincinnati (cup shape) grinding wheel is then placed on the spindle and the knee of the grinder swung around on the column 10 deg., as shown in Fig. 1. This latter setting of the tool-grinding machine throws the cut around on the periphery of the grinding wheel and "dishes" or concaves the face of the cutter in an amount proportionate to the distance the knee is moved around on the grinder column.

When the cutter is ground until the second scribed line is reached, three things should have been accomplished. First, the cutter will be sharp and square if it has been tested with a square during the grinding process and the proper minute adjustment of the table made; second, the cutting face will be off center an amount equal to the distance apart of the two scribed lines, and third, the face will be slightly concaved. This latter gives a freer chip passage, and the frictional contact of the chip upon the cutting edge of the cutter is correspondingly reduced, thereby greatly prolonging the life of the cutter and lengthening the periods of service between regrindings. The tool is now set in the automatic with a height gage as previously mentioned.

In dressing the grinding wheel all dressing is done at the surface *B*. The movement of the table of the tool grinder is along the line marked *A*, Fig. 1, and a lever feed is used. The gage shown in Fig. 2 is convenient for laying out the second of the scribed lines.

A study of the method described will show that if a tool is ground with the cutting face on a line with the center, it must also be set in the screw machine true to center; that is, the center of the work, the center of the forming tool and the cutting edge must all be true in the

same horizontal plane to operate the tool at its maximum efficiency; for if the tool so ground is set above the center of the work, there will be an excessively heavy side wear on all the cutting points of the tool, causing frequent regrindings and resulting in a serious loss of stock and time. If a tool so ground is set below the center of the work, we will have a scrape instead of a cut; a condition upon which comment is unnecessary.

The idea of grinding a forming tool off center and concaved is to permit the tool to be set below the center and yet counteract the scraping effect; to produce instead a *cutting* effect. As will be seen in Fig. 3 the wear, if a tool is ground true to center line, will be in a line paralleling the vertical center line of the tool and the length of the wear will be proportionate to the depth of cut. This condition is just what we are trying to get away from, because this action so greatly destroys the sides of the cutter.

If the cutting face is ground off the center and concaved, the tool may be set below the center and the cutting edge raised to the center line of the work and cutter *minus* the amount of offset. This will cause the cut to run from the center line of the tool instead of parallel with it, and the sides of the cutter are thereby preserved, as shown in Fig. 4.

The amount the cut will diverge and run from the center will be in proportion to the amount the cutting face of the formed tool is ground off center. This will also be influenced by the amount the tool is concaved. The maximum amount such a tool should be set below the center is the amount it is ground off center. This distance may be diminished if there is a tendency to chatter.

It must be remembered, however, that it is possible to increase these angles to the point where they become wholly inefficient. It is not difficult to overdo the matter. While, in practice, angles less than those given here may be used, the latter should never be exceeded. Our figures as given here are about the limit, in standard practice, and are for cold-rolled steel.

Equalizing Office and Factory Hours and Privileges

By CHARLES L. PEARSON

"In the good old days," when the office force consisted of a bookkeeper, a billing clerk, an order clerk and an office boy, and everybody had to work nights to get off "the balance," there was perhaps some justification for having the regular working hours of the office shorter than those of the factory and for extending special privileges to office employees.

But today, with office work as highly specialized as factory work, with the addition of stenographers, cost departments, planning departments and mechanical accounting methods, do the reasons that originally justified a distinction between office and factory still exist? Is there today any reason why the office employees should enjoy special privileges and work shorter hours than the factory?

There are many managers who, perhaps not having given the matter particular thought, feel that the office employees are really a class apart, that they are entitled to special privileges and to shorter hours than factory employees. It is doubtful, however, if anyone today who

will carefully analyze the matter will be able to discover any good reason for this distinction. There are, however, a number of reasons why uniform hours for both office and factory are desirable:

PAY FOR SERVICE ONLY

1. As a matter of economy. The present-day office force is much larger, in relation to the factory force, than formerly. The factory employee presumably is paid only for service rendered. There appears to be no good reason why the office employee should be paid on any other basis, work any shorter hours or enjoy any more privileges.

2. It is difficult to draw the imaginary line between "factory employees" and "office employees." Cost departments and planning departments merge office functions and factory functions so completely that it is difficult to keep up the class distinction, and many disputes arise, causing hard feeling and dissatisfaction among those who do not receive the special privileges, although little or no difference can be discerned in the nature of the work done by employees on each side of the "line." Anyone who has tried to solve this vexing problem is well aware of the difficulties involved.

3. One of the most serious causes of trouble is the granting of special privileges. It should be the aim of managers to abolish special privileges whenever possible.

4. As a matter of fact, office employees do not work any harder than shop employees; they are not required to concentrate any more closely, and their work is not as fatiguing as most factory operations. Modern development in manufacturing processes has so highly specialized operations that more intense concentration is required. Office operations are also more highly specialized, but require less individual skill and technical knowledge than formerly.

5. Uniform hours and uniform privileges will break down the fictitious class distinction that now exists in many plants. It may be argued that the people employed at office work are radically different both as to education and home environment from those who work in the factory. It is doubtful if any greater distinction exists in any plant between the factory and office people than may be found within the factory itself among the employees in different departments or on different classes of work. If a distinction is made between office and factory employees for "social" reasons, why not make similar distinctions between factory departments for the same reasons? It is just as fair and just as logical.

DEMOCRATIC FEELING ENGENDERED

6. Uniformity of working hours and privileges naturally leads to social intercourse between factory and office employees, which is very desirable, resulting in better feeling and better coöperation throughout the entire plant. It emphasizes very strongly that the company desires to deal fairly with all its employees and to deal with them as a whole rather than in classes. It is certain to develop a more democratic spirit in the entire organization.

There is at the present time a great deal of agitation throughout the country for shorter hours for labor. In many plants and industries the application of some form of so-called "scientific management" is so materially increasing the production of labor and improving working conditions that shorter hours are a logical sequence. In

this agitation for shorter hours for labor nothing is heard about shorter hours for office employees. Undoubtedly one of the potent reasons for the demand for shorter hours by factory employees is the fact that shorter hours have been granted to certain classes of employees. Shorter hours for factory employees seem assured in all industries. Will this be accompanied by a corresponding decrease in office hours, or will opportunity be taken of present conditions to make office and factory hours uniform, or at least more nearly so? It would appear that the present time, when factory hours are being reduced till they approximate more closely the hours that it has been customary for office employees to work, is the logical time to establish for these different classes of work a uniform standard of working hours.

Of equal importance are the special privileges it is customary to grant office employees, such as freedom from the requirement to register time, latitude as to exact time of starting and quitting, and vacations with pay. All these privileges and some others that are commonly granted to office employees are the cause of much dissatisfaction among factory workers.

PUNCHING THE TIME CLOCK

In the matter of registering time there appears to be no reason at all why office employees should not register their time, if it is customary for the factory employees to do so. If this is done, promptness in attendance will be a logical result.

The problem of equalizing vacation privileges is perhaps more difficult, but by no means impossible of solution. One way to handle this matter is to consider the vacation with pay as a form of profit-sharing and to grant it on a basis of merit. Employees who are irregular in attendance are not entitled to as much in the way of privileges as those who are always on time and who are rarely absent. A plan that has been used successfully by one con-

It is not my intention to recommend any revolutionary changes. The hours and privileges granted certain employees are apt to be based on long-established usage, and any radical change might be inadvisable. It is possible, however, during periods of change to bring different elements to a more nearly uniform basis. It is hoped that managers will give this matter more thought in the future and that, when changes in working hours or privileges are under consideration, efforts will be made to place all classes of employees in the plant as nearly as possible on the same footing.

It is possible that if opinion and experience are brought to bear on this subject, results may be obtained that will prove to be entirely satisfactory from the standpoint of both employer and employee. The desirability of the results in view is hardly to be questioned; the difficulty is entirely with the means, and no one would make the statement that this difficulty is by any means insurmountable.

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Installing Sugar Machinery in Hawaii

SPECIAL CORRESPONDENCE

One of the most interesting branches of work which the engineer has to deal with is the installing and erecting of heavy equipment. Whether this is done at mines and smelters, in logging camps, or in mills of one kind or another, there are always a number of novel problems arising owing to the peculiarities in the equipment itself, in the construction of the building where it is to be installed, or in the nature of the apparatus which is available for handling heavy and bulky machine parts.

Our readers are already aware that a large percentage of the engineering work in the Hawaiian Islands is in direct line with the manufacture of cane sugar. The



FIG. 1. LARGE SUGAR CRYSTALLIZER SET UP ON A SHORT FLAT-CAR



FIG. 2. RIGGING SLING FOR HOISTING LARGE SUGAR CRYSTALLIZER

cern is to grant one week's vacation with pay for each 25 consecutive weeks of perfect attendance. This gives every employee an opportunity to earn a two weeks' vacation with pay each year. The employee's record may begin on any Monday morning, the only requirement being 25 consecutive weeks without absence or tardiness. The vacation must be taken at a time approved by the company and not necessarily at the end of the 25-week period.

large number of sugar factories scattered about the Islands means that there is always a great deal of important work coming to the attention of trained engineers.

Sugar machinery in all of its details is of very heavy construction, and not infrequently it has to be erected in structures with rough and ready equipment that may be available, and frequently with the aid of workmen not overskilled in the rigging up and slinging of big, heavy

work. A great deal of this machinery is shipped to far-away parts of the world, where perhaps the sugar mill may represent the only industrial plant in the section and where there are few trained mechanics to assist in the installation or operation of the equipment.

In the Hawaiian Islands the building of this class of apparatus has been carried on for so many years, and has been in fact the principle machine-building industry for so many years, that practically all the engineers and me-

will be noticed, are very short affairs. The locomotive is a regular plantation engine used in large numbers about the Islands—every plant having several of these locomotives and a large number of the small cars, which are commonly utilized in running about the sugar plantations when bringing in the cane when cut for handling in the mills.

Fig. 1 also gives an excellent idea of the appearance of the crystallizer, showing the big driving gear at the end

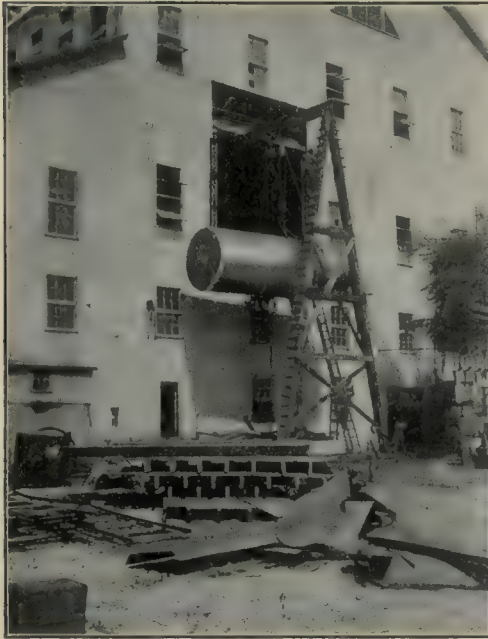


FIG. 3. CRYSTALLIZER NEARLY OPPOSITE MILL UPPER DOOR



FIG. 4. CRYSTALLIZER READY TO BE PUT ON SMALL CAR OR TRUCK IN MILL

chanics in general have had a more or less extended experience with the work.

Some time ago, in the installation of equipment at the Ewa Sugar Mill, some few miles out of Honolulu, a battery of 26 big crystallizers had to be placed in position. The methods adopted for handling this heavy work are illustrated by the photographs.

These crystallizers measure 8 ft. in diameter by 20 ft. in length and weigh 16,000 lb. each. They are built up of $\frac{3}{8}$ -in. boiler plate. The heads are of $\frac{1}{2}$ -in. plate. They have a shaft running through from end to end. The shaft when in operation in the mill is rotated slowly to revolve a series of blades which keep the mass of sugar moving constantly about with an easy motion in the cylindrical tank.

During this stirring process evaporation is constantly going on, permitting gradual crystallization of the material.

The hoisting machine used for lifting the crystallizers to the second floor of the structure was a steam plowing engine, which, as used on ranches, is fitted with a big winding drum underneath to pull a gang of plows.

To carry the hoisting tackle a monorail system was erected in the mill, the outer end of the rail projecting some 12 or 15 ft. from the building, where it is supported upon an A-frame, as seen in a number of the views. This structure outside of the mill was of heavy material with a base about 20 ft. wide, with ladders formed up either side of the legs.

One of the crystallizers, as brought in on a pair of flat-cars from the siding, is shown in Fig. 1. These cars, it

for operating the horizontal shaft and the beating vanes inside.

Fig. 2 illustrates the crystallizers with the men at work rigging a sling about the cylinder, which is to be hoisted. One end of the crystallizer is shown jacked up on the block to admit of the ropes being passed freely around the middle, while a steel yoke is seen at the top for seizing the ropes and forming a loop for the hook of the hoisting tackle. Fig. 3 shows the crystallizer going up alongside the big opening in the mill, through which it is to be passed to the floor of the building.

An 8-ton triplex block was used on the monorail, the workmen shifting the load from the rope tackle to the triplex hoist, the work remaining suspended on the tackle block while the hook of the triplex hoist was swung under the steel loop to take the load from the rope tackle.

Fig. 4 illustrates the manner in which the crystallizer is hoisted to place a car under the body to enable the cylinder to be transferred to the point of installation in the mill.

When the crystallizer has been brought approximately into position, the rope tackle is again applied to lift it from the car and suspend it while it is turned around crosswise into position with the rest of the battery of crystallizers. After it has been swung about into crosswise position it is dropped onto small rollers to enable it to be dragged and skidded into its permanent location.

The installation of crystallizers was conducted under the supervision of R. Renton Hind, consulting engineer of the Honolulu Iron Works.

United States Munitions*

The Springfield Model 1903 Service Rifle

Operations on the Bolt--I

SYNOPSIS—The bolt is not far behind the receiver in number of manufacturing operations involved. This article begins the detailed description of the successive operations performed on it.

The bolt, which fits inside the receiver, holds the cartridge in position in the chamber and against the recoil

of the powder charge. It is a drop forging of Class C steel, 0.89x0.70 rectangular section, in multiples of 7½ in. It is shown in detail in Fig. 565. The blanks are first heated and bent, as in Fig. 565A, then drop-forged in the dies shown in Fig. 567. Then follow the usual trimming and pickling, after which the ends are milled and the hole is drilled. This hole becomes the first working point for future operations. After the under side of the handle is milled in operation 12 it becomes a very import-

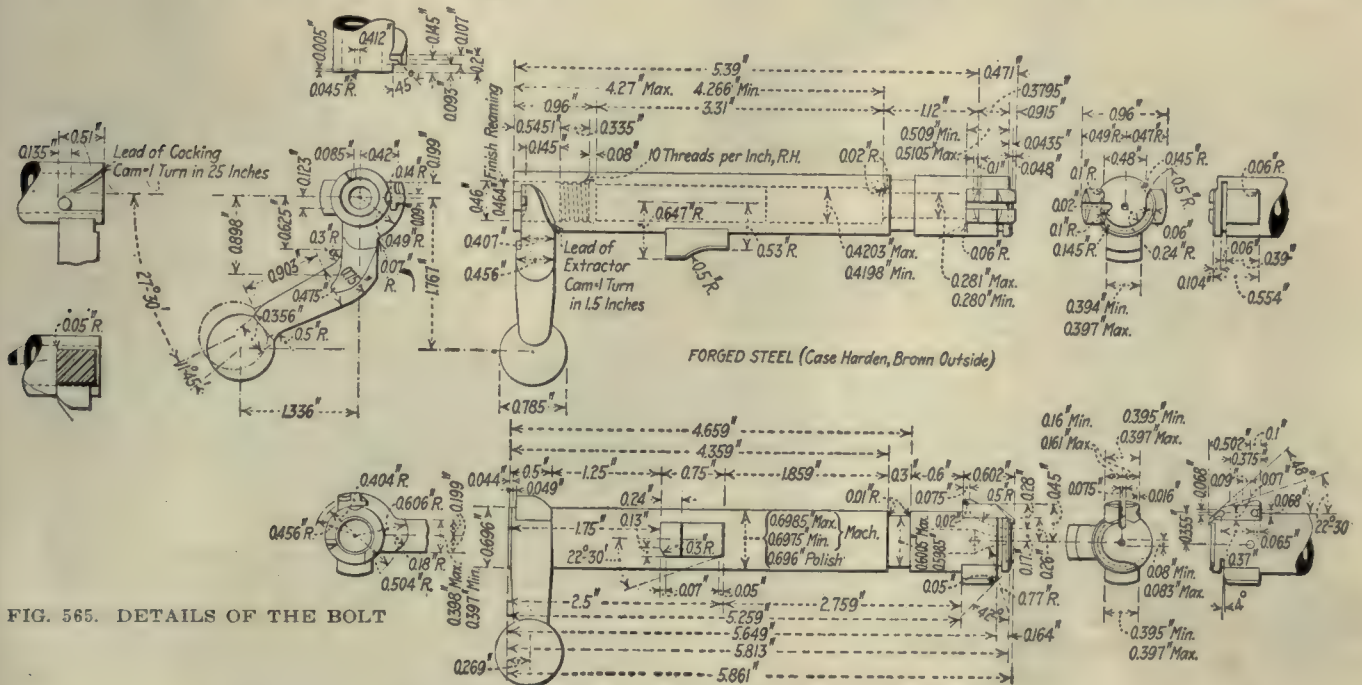


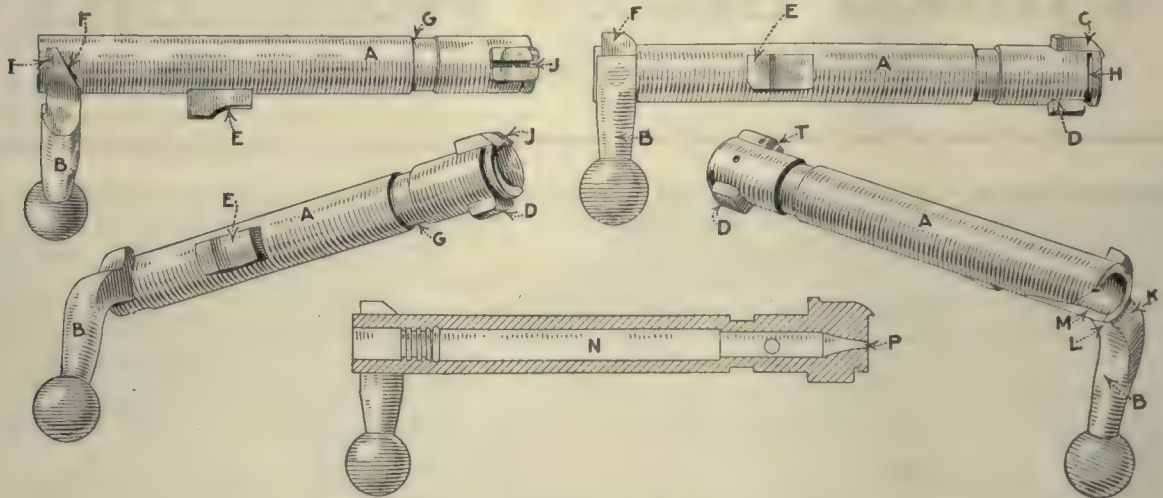
FIG. 565. DETAILS OF THE BOLT

OPERATIONS ON THE BOLT

- | | | | |
|-------|--|----------|--|
| A | Blocking from billet | 32 | Drilling gas and bolt stop pin holes |
| A-1 | Pickling | 16-19½ | Turning bevel, front end, and for extractor collar |
| C | Trimming | DD | Removing burrs from extractor-collar groove |
| D | Dropping to finish | 21-28-29 | Milling and counterboring for sleeve, and milling for safety lock |
| D-1 | Pickling | 25-26 | Profiling extractor cam, rough and finish |
| E | Trimming | FF | Removing burrs left by operation 28 with facing tool |
| F | Dropping to finish and twist | GG | Removing burrs left by operation 21, filing |
| G | Annealing | 36 | Hand milling for cock-notch |
| G-1 | Pickling | 32½-33 | Hand milling for sleeve lock |
| 1 | Milling ends | 22 | Hand milling top of handle |
| 2 | Drilling firing-pin hole | 27 | Hand milling extractor groove |
| 3½ | Drilling striker hole | 34 | Hand milling sleeve stop |
| 43 | Drilling and shaping striker seat | 35 | Hand milling for sleeve lock |
| AA | Reaming striker point hole, to finish (hand) | 31 | Tapping for sleeve |
| 5 | Countersinking front end in lathe | 37 | Hand milling for cocking cam, roughing |
| 6 | Facing rear end in lathe | 38 | Hand milling for cocking cam to finish |
| 7 | Clamp milling handle (Watershop) | JJ | Removing burrs left by operation 38 with reamer |
| 8 | Turning body, roughing | 39 | Milling to remove stock, front end (run with operations 20 and 46) |
| 10 | Turning lugs, front and rear, and front of handle on bolt | 44 | Hand milling top of upper locking lug |
| 9 | Turning body to finish | 40-41 | Hand milling ejector slot top and bottom |
| 11 | Burring | LL | Removing burrs from well with reamer |
| 12 | Milling body, under side and top of handle, and extracting cam | 44½ | Removing burrs with hand tool, rear of front lugs |
| 13 | Milling right and left side of safety lug | 45-45½ | Counterboring for head space, rough and finish |
| 14 | Milling right and left side of locking lugs | 46 | Milling front end to finish |
| 19 | Hand milling to remove stock left by operations 12 and 13 | 47 | Profiling to finish (matching head and space) |
| 15-24 | Hand milling front end of bottom lug and top of locking lugs | KK | Removing burrs left by operation 46 with hand space tool |
| 20 | Milling rear of handle to gage | 58 | Bending handle |
| 46-39 | Group capacity | 59 | Reaming firing-pin hole |
| 48 | Hand milling sides of locking lugs | 64 | Filing cam, fitting to receiver and general cornering |
| BB | Removing burrs from rear lugs and under handle | 53 | Casehardening |
| CC | Stamping stock mark | 54 | Assembling with extractor collar |
| 23 | Hand milling rear corners of rear lug | 55 | Freeing extractor collar in speed lathe |
| | | 56 | Filing ears of extractor collar |
| | | 52 | Polishing surface |
| | | 57 | Burring bolt stop notches (with oilstone) |
| | | 65 | Browning |

ant working point and is used on nearly all future operations. The body is turned with relation to this surface, so that the handle will come to its seat in the correct

position. These parts and the back end of the bolt give the measuring points from which all the other parts are gaged when making the various inspections required.



MAIN OPERATIONS ON BOLT

- | | | | |
|---|--|--|-------------------------------------|
| A—Body. Operations 8 and 9 | F—Extractor cam. Operations 25 and 26 | I—Sleeve lock notch. Operations 32½ and 33 | M—Cocking cam. Operations 37 and 38 |
| B—Handle. Operations 7 and 58 | G—Extractor collar groove. Operations 16 and 19½ | J—Ejector groove. Operations 40 and 41 | N—Firing-pin hole. Operation 2 |
| C—Upper locking lug. Operations 14, 15, 24 and 44 | H—Extractor groove. Operation 27 | K—Sleeve stop. Operation 34 | O—Striker hole. Operation 3½ |
| D—Lower locking lug | | L—Under side of handle. Operation 12 | P—Striker point hole. Operation AA |
| E—Safety lug. Operations 10 and 13 | | | |

OPERATION A. BLOCKING FROM BILLET

Transformation—Fig. 565-A. Number of Operators—One. Description of Operation—Blocking from bar, breaking down and bending. Apparatus and Equipment Used—Billings & Spencer 400-lb. drop hammer, two dies and bending block at right, Fig. 566. Production—40 per hr.

OPERATION A-1. PICKLING

Number of Operators—One. Description of Operation—Pickling: 1 part sulphuric acid to 9 parts water, same as on the receiver; the pickling time varies from 10 to 15 min., the same as on the receiver. Apparatus and Equipment Used—Wooden pickling tanks and wire-mesh baskets. Note—This is to be discontinued, but the same process will form operations D-1 and G-1.

OPERATION C. TRIMMING

Note—Abandoned.

OPERATION D. DROPPING TO FINISH

Transformation—Fig. 567. Number of Operators—One. Description of Operation—Dropping to finish. Apparatus and Equipment Used—800-lb. Billings & Spencer drop hammer and one pair of drop dies. Production—40 per hr.

OPERATION D-1. PICKLING

Note—Same as operation A-1.

OPERATION E. TRIMMING

Transformation—Fig. 568. Machine Used—Perkins back-gear press, 3-in. stroke. Number of Operators per Machine—One. Punches and Punch Holders—Trimming punch and die punch have a square shank. Dies and Die Holders—Die set in shoe and held by setscrews. Stripping Mechanism—None; pushed through die. Average Life of Punches—50,000 pieces. Lubricant—None. Production—600 per hr. Note—One operation only on trimming.

OPERATION G. ANNEALING

Number of Operators—One. Description of Operation—This is annealed in powdered charcoal in iron pots at a temperature of 820 deg. C. (1,508 deg. F.); the heat is shut off gradually as the temperature approaches the prescribed limit and is allowed to cool slowly. Apparatus and Equipment Used—Brown & Sharpe oil-burning furnaces, same as on receiver.

OPERATION G-1. SECOND PICKLING

Note—Same as operation D-1.

OPERATION F. DROPPING TO FINISH AND TWIST

Transformation—Fig. 569. Number of Operators—One. Description of Operation—Dropping and twist. Apparatus and Equipment Used—Billings & Spencer 400-lb. drop hammer, dies shown in Fig. 570. Production—100 per hr. Note—First twist of handle is done in foot vise, to allow bolt to sit in dies without rocking.

OPERATION 1. MILLING ENDS

Transformation—Fig. 571. Machine Used—Pratt & Whitney No. 2 Lincoln miller, Fig. 572. Number of Machines per Operator—One. Work-Holding Devices—Special vise, Fig. 573; work located endwise against hardened stop A; cam D draws swiveling jaw C with the work against the fixed jaw B. Tool-Holding Devices—Standard arbor. Cutting Tools—Two side-milling cutters, Fig. 574. Number of Cuts—One. Cut Data—Speed, 60 r.p.m.; ½-in. feed. Coolant—Cutting oil, put on by brush. Average Life of Tool Between Grindings—2,000 pieces. Gages—Fig. 575. Production—20 per hr.

Owing to the right-angle bend that the handle makes with the body of the bolt, the breaking-down operation is quite important; then, too, the bend in the handle itself requires careful attention.

The drilling resembles the work on the gun barrels, except that a vertical instead of a horizontal machine is used and the hole is much shorter. The form of drill employed is practically the same as that used for the barrels.

The machining of the bolts, however, has a number of interesting features that are not commonly found in ordinary machining operations. These are the methods used in turning the handle and the body of the bolt, as well as the outside of the locking lugs.

The handle is machined by what is in reality a turning operation, using two formed cutting tools, one at the back and one at the front. These tools are forced onto the work by means of right- and left-hand screws, as shown in Fig. 599, the tools themselves being shown in detail in Fig. 600. The bolt itself is held with a handle in line with the center of the lathe, by a special chuck that locates the hole in the bolt at right angles to the handle and drives it for the turning, or "clamp milling," as it is called here. This is done in a special machine belonging to the lathe family and built at the Hill shops.

The body is turned in millers of the Lincoln type, the bolt being driven by the miller spindle and supported at the outer end by a special center, as shown in Fig. 603. The tool is held on the table of the miller and fed under the work by the regular table feed. The cutter is of the regular flat forming type, made in sections to pass to each side of the safety lug and with the cutting edge at an angle to give a shearing cut. This is shown in Fig. 606. The lubricating of this broad cut is something of a problem, especially if the stock is tough, as sometimes happens. Both cutting oils and soda cutting compound are used, depending on the stock to be cut. In some cases the compound answers best and gives a smooth.

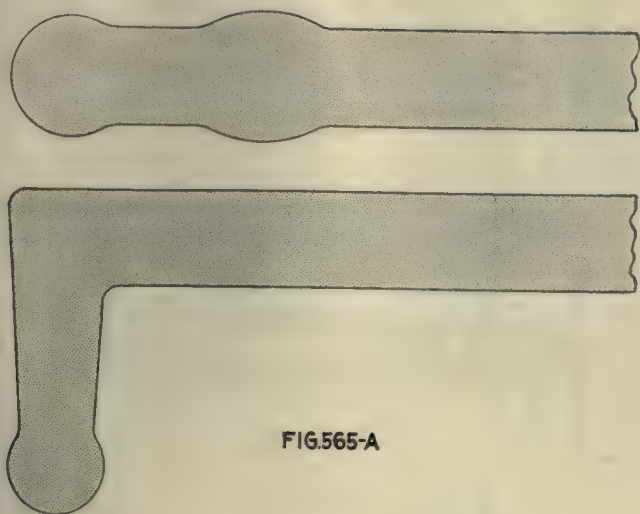


FIG. 565-A

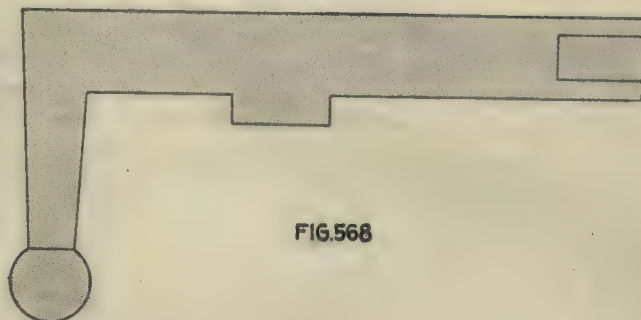


FIG. 568

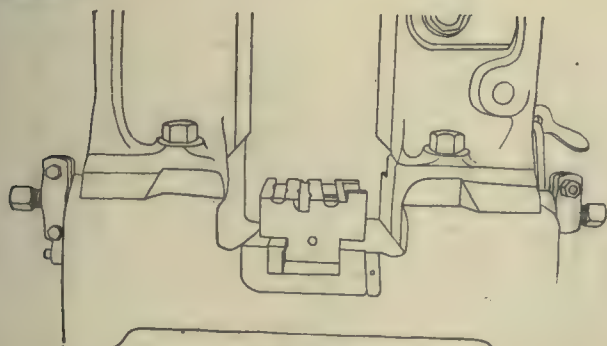


FIG. 566

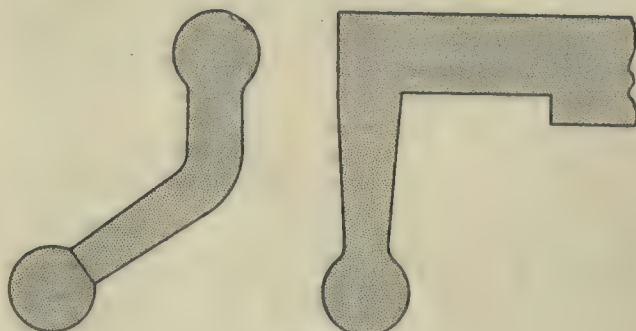


FIG. 569

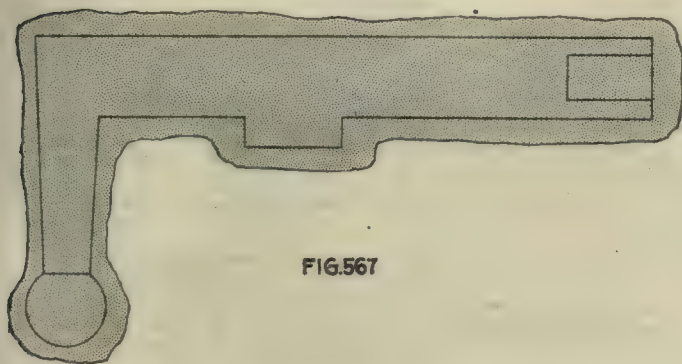


FIG. 567

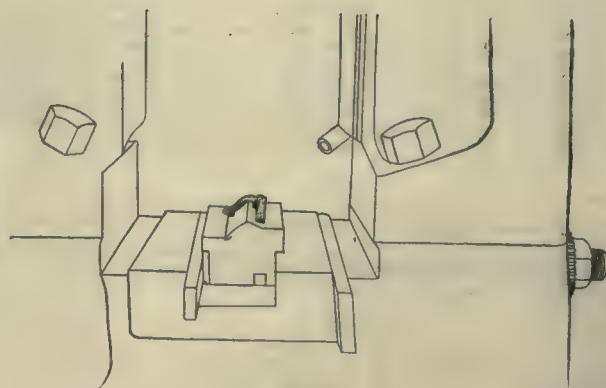


FIG. 570

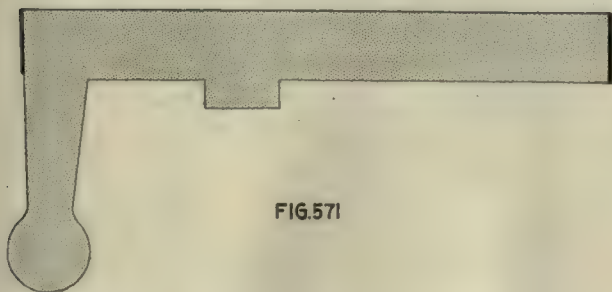


FIG. 571

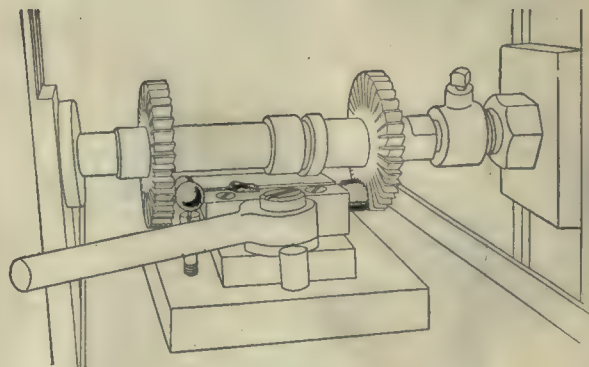


FIG. 572

bright finish; in others the addition of more or less oil gives better results. In all cases the work is flooded for best results.

The diameter of the body is quite important, as it fits the small arcs of the well hole, or bore, of the receiver left by the various milling operations. This guides the bolt in its action, while the lugs slide through their respective slots and lock against their shoulders in the

receiver. These lugs are faced by the same cutters as turn the body, which locates them in proper relation to the handle and the end of the bolt.

The lugs are milled with relation to the body, both in order to serve the proper thickness and to blend with the round body of the bolt itself. This makes it necessary to accurately locate the bolt with relation to the cutter, and even then requires a slight amount of drawfiling.

Profiling the cards on the lugs, and also the sleeve stop at the handle end of the bolt, are interesting operations. In fact, the functions performed by the various portions of the bolt make it a very important piece of mechanism in the operation of the rifle. Its proper action makes the arm extremely effective and its failure renders it useless. In this connection the ease with which the bolt, firing pin and cocking piece can be disassembled and rendered useless is one of the good, even brilliant features of its design.

The drilling of the firing-pin hole as performed in operation 2 is another example of the use of simple fixtures in connection with Pratt & Whitney upright drills. The cutting speed on the work is 600 r.p.m. and that the cut is rather severe is indicated by the fact that fifteen pieces only are averaged to a grinding. The drilling of the striker hole in operation 3½ is not as severe a test as the above on the endurance of the cutting edge of the tool, in spite of the fact that a speed of 900 r.p.m. is used with the same feed as above. This latter operation is

OPERATION 2. DRILLING FIRING-PIN HOLE

Transformation—Fig. 576. Machine Used—Pratt & Whitney upright drill, Fig. 577. Number of Machines per Operator—10. Work-Holding Devices—Drilling fixture, Fig. 578. Tool-Holding Devices—Drill held in collet by setscrew in carriage of machine. Cutting Tools—Barrel drill, Fig. 579. Cut Data—Speed, 600 r.p.m.; $\frac{1}{8}$ -in. feed. Coolant—Cutting oil, $\frac{1}{4}$ -in. stream. Average Life of Tool Between Grindings—15 pieces. Gages—Fig. 580. Production—3 per hr. per machine;

OPERATION 3½. DRILLING STRIKER HOLE

Transformation—Fig. 581. Machine Used—Pratt & Whitney barrel driller. Number of Machines per Operator—Three. Work-Holding Devices—Revolving fixture, Fig. 582. Tool-Holding Devices—Setscrew in carriage of machine. Cutting Tools—Barrel drill, Fig. 583. Number of Cuts—One. Cut Data—Speed, 900 r.p.m.; $\frac{1}{8}$ -in. min. feed. Coolant—Cutting oil. Average Life of Tool Between Grindings—35 pieces. Gages—Fig. 584. Production—12 per hr. per machine.

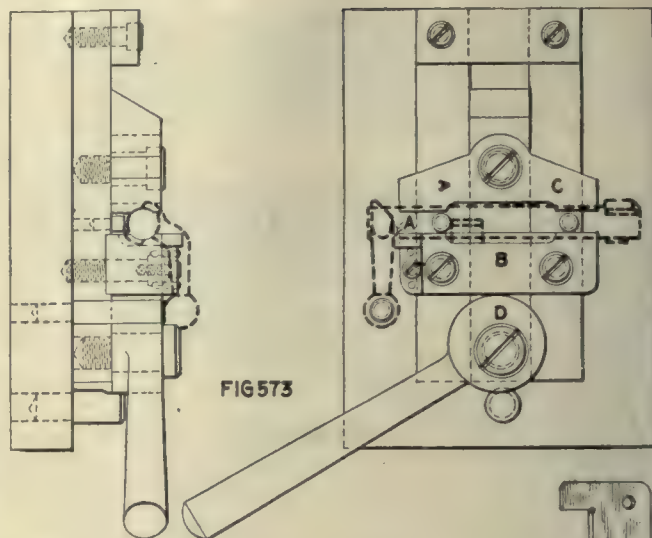
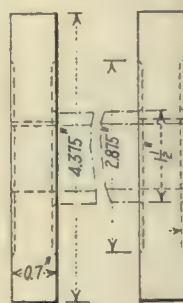


FIG 573



Cut Teeth on Sides and Face, 36 Teeth

FIG 574

OPERATION 1



FIG 575

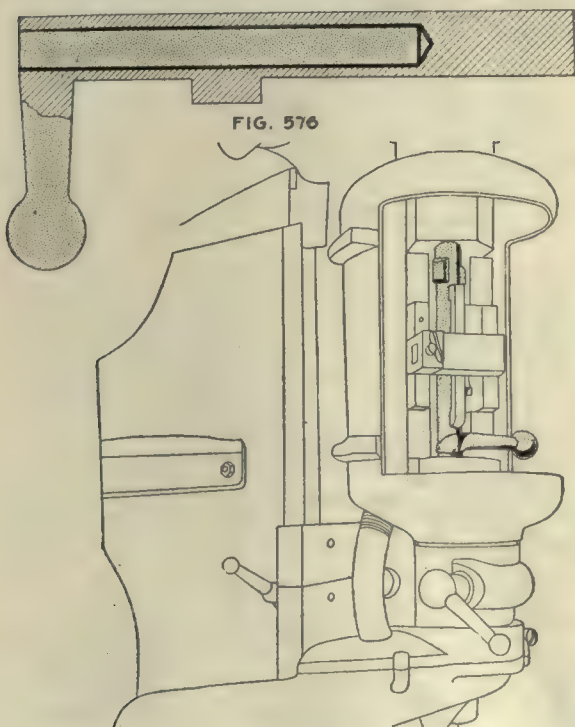


FIG. 576

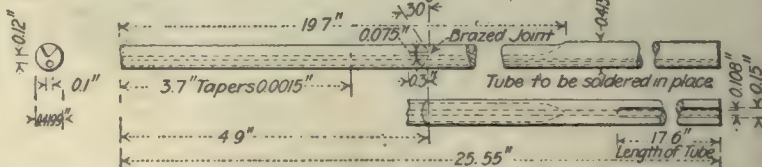
FIG. 577
OPERATION 2

FIG. 579 OPERATION 2

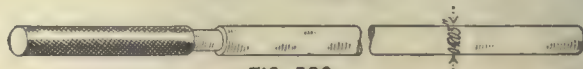


FIG. 580

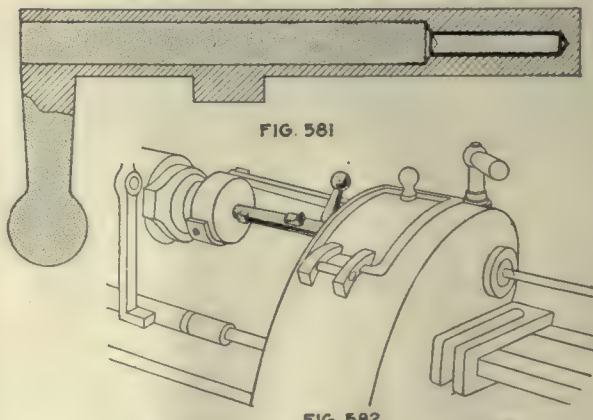


FIG. 581

FIG. 582
OPERATION 3½

an adaptation of the barrel-drilling machine for comparatively short-hole drilling. Apparently it is capable of rather a high rate of production on this class of work and may be said to do this job efficiently although pos-

sibly not from the viewpoint of floor-space efficiency, considering that the larger part of the bed of the machine is not utilized. It is, however, a very good example of the adaptation of work to machines intended primarily for

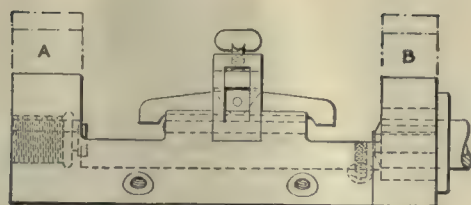


FIG. 578

OPERATION 2

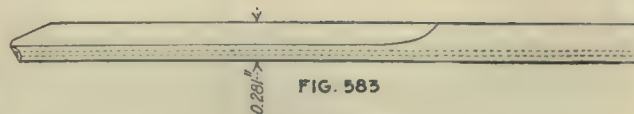
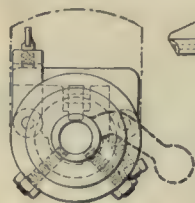


FIG. 583

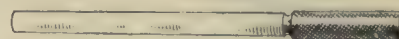


FIG. 584

OPERATION $3\frac{1}{2}$

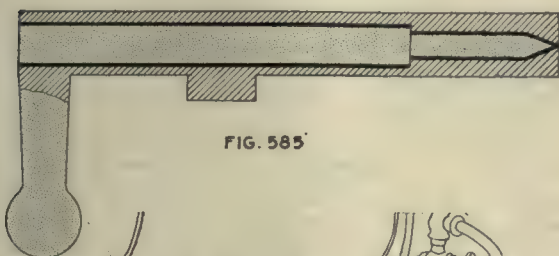


FIG. 585.

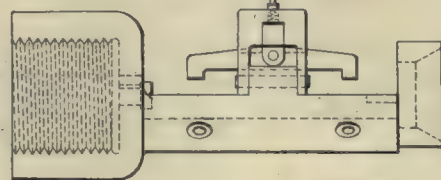
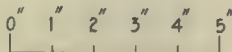
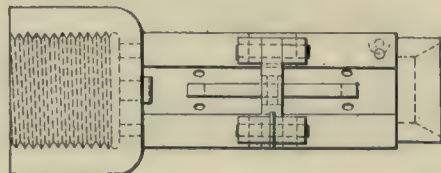


FIG. 587

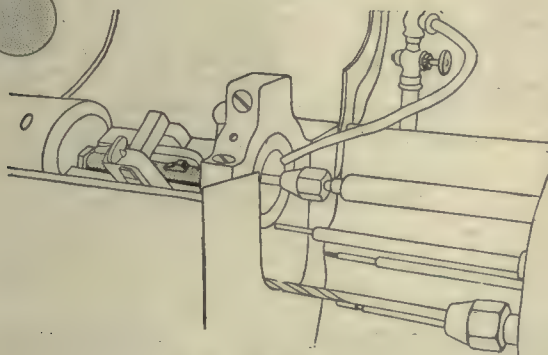
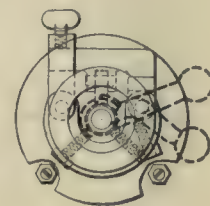
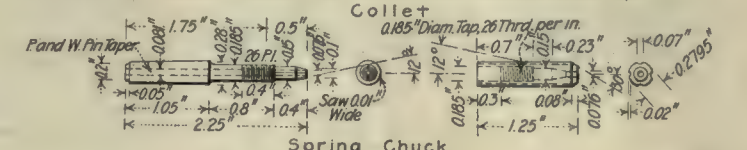
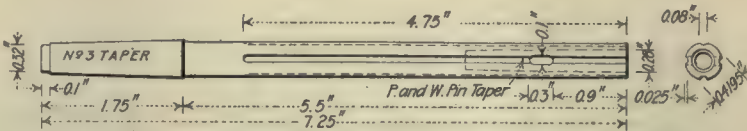
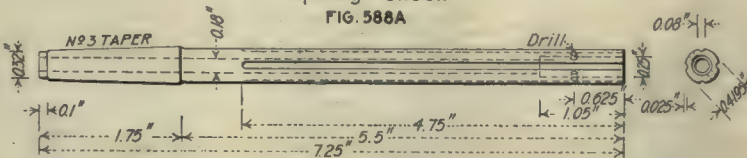


FIG. 586

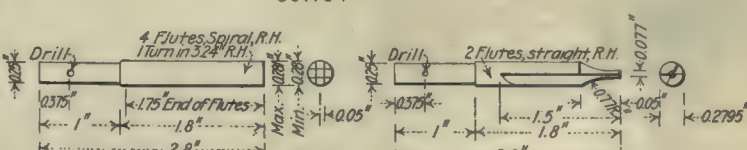


Spring Chuck

FIG. 588A

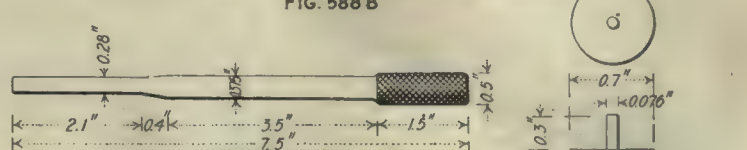


Collet



Striker Body Range

FIG. 1000



STEEL, (Har

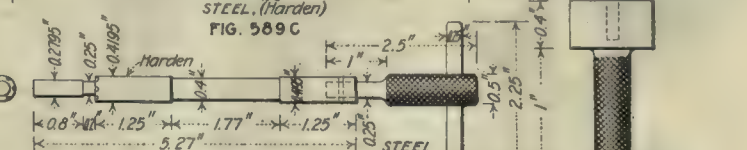
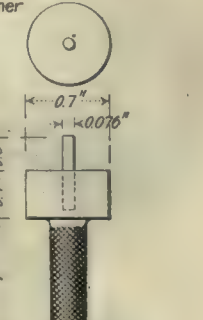


FIG. 589 E



---X 0.3 X---

STEEL (Hard)

OPERATION 43

OPERATION 43. DRILLING AND SHAPING STRIKER SEAT
Transformation—Fig. 585. Machine Used—Pratt & Whitney hand screw machine, 16-in., Fig. 586; machining diagram, Fig. 586-A. Number of Operators per Machine—One.
Work-Holding Devices—Revolving fixture, Fig. 587. Tool-Holding Devices—Drills in turret of machine. Cutting Tools—Two drills, one countersink, one bottoming drill.

and two small drills, Fig. 588; A, drill holder for striker point hole; B, reaming striker point hole. Cut Data—Speed, 640 r.p.m. and 320 r.p.m.; hand feed. Coolant—Cutting oil, $\frac{1}{4}$ -in. stream. Average Life of Tool Between Grindings—300 pieces. Gages—Fig. 589; A, depth of straight part; B, depth on curve; C, size and direction; D, position of striker point hole; E, diameters and depth. Production—75 per hr.

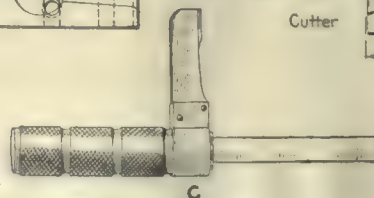
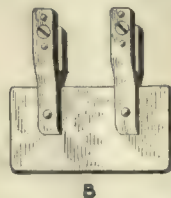
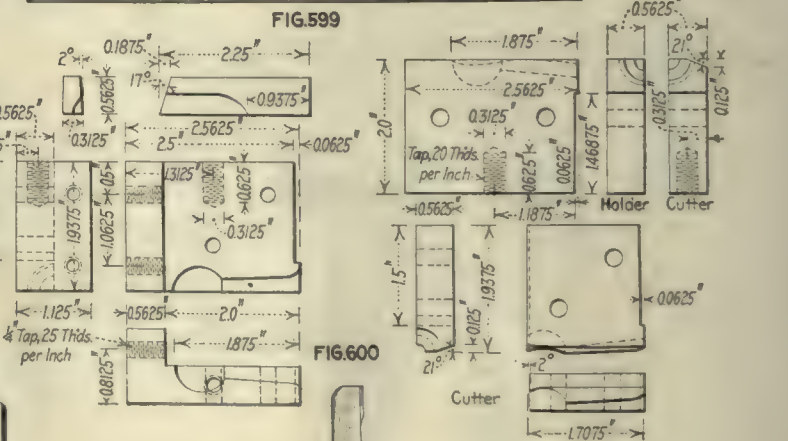
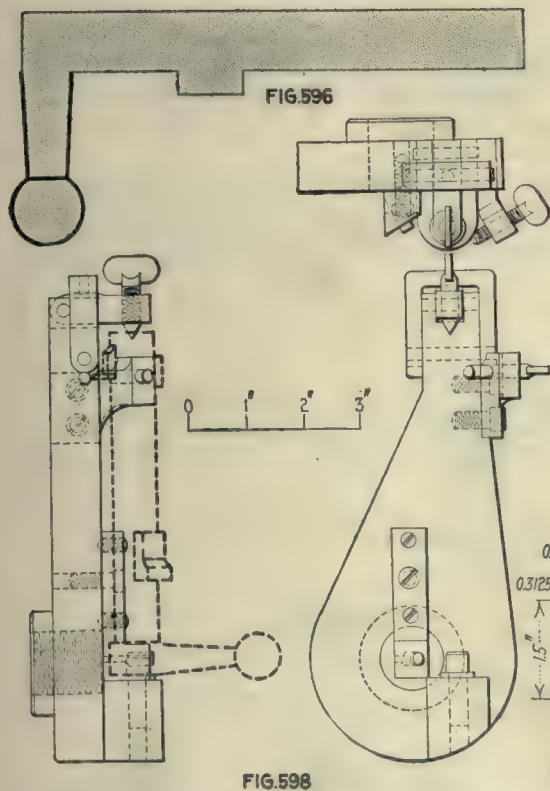
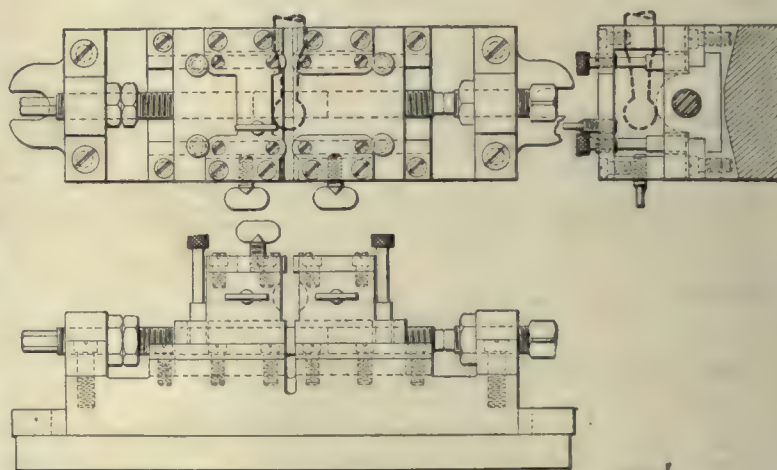
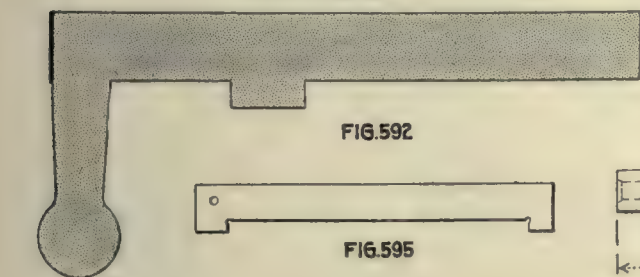
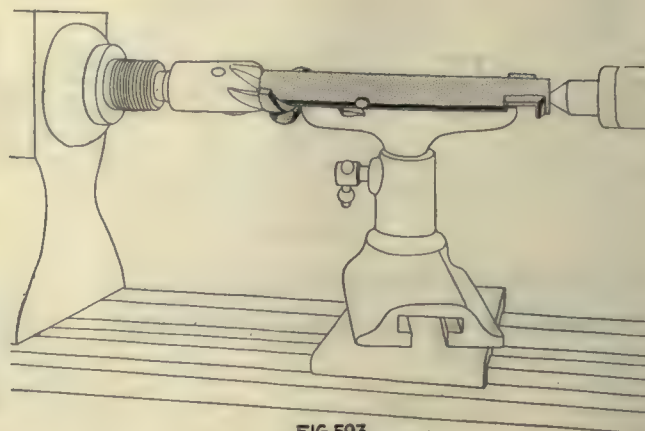
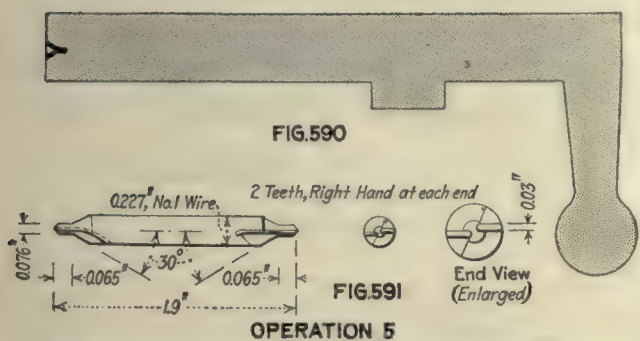


FIG. 601 OPERATION 7

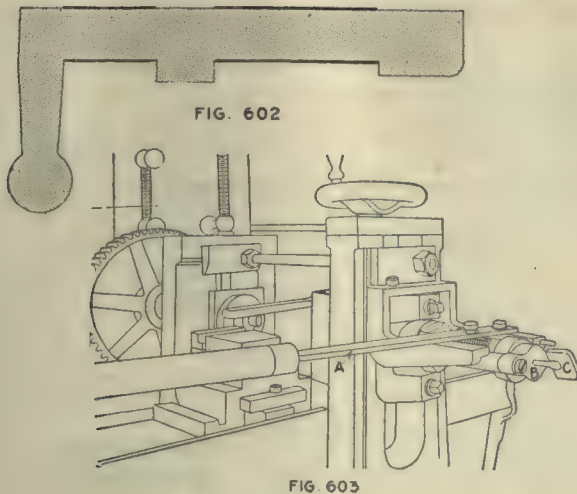
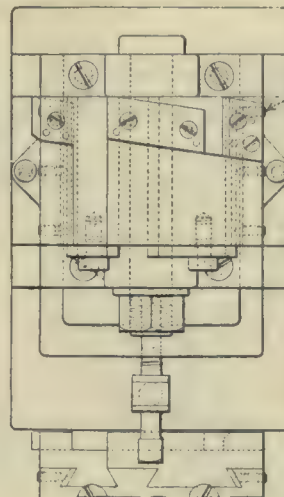


FIG. 602

FIG. 603



Cutter for Roughing Only

FIG. 605

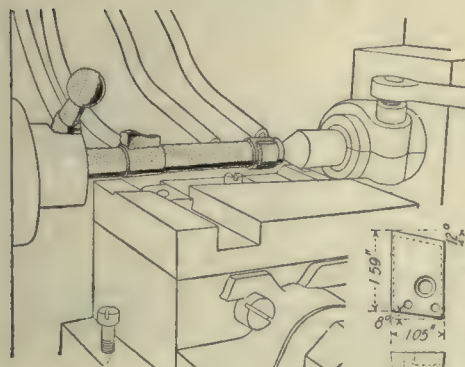
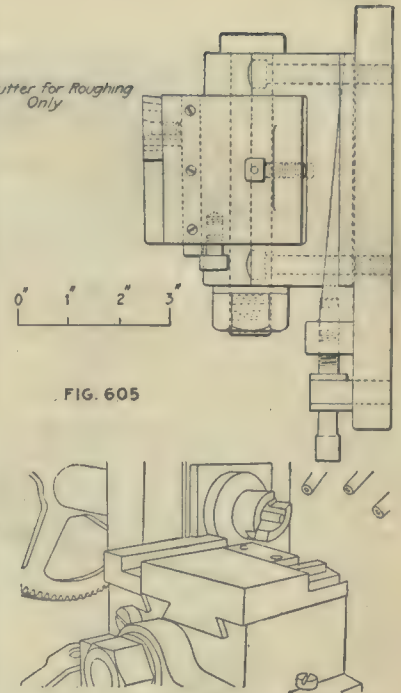


FIG. 604

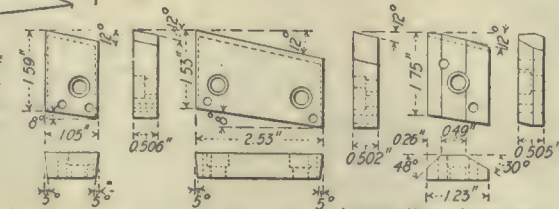
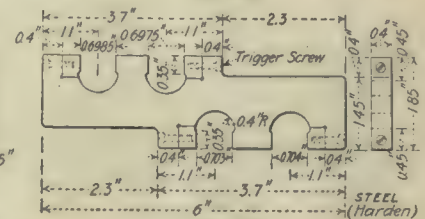
FIG. 606
OPERATION 8

FIG. 607

OPERATION AA. REAMING STRIKER POINT HOLE TO FINISH (HAND)

Number of Operators—One. Description of Operation—Reaming striker point hole to finish, by hand. Apparatus and Equipment Used—Hand reamer. Production—350 per hr. Note—Striker body is 0.28-in. diameter and striker point is 0.075-in. diameter.

OPERATION 5. COUNTERSINKING FRONT END IN LATHE

Transformation—Fig. 590. Machine Used—Prentice speed lathe. Number of Operators per Machine—One. Cutting Tools—Countersink, Fig. 591. Coolant—Cutting oil applied with brush. Gages—None. Production—175 per hr. Note—Same as operation 6, except tool used.

OPERATION 6. FACING REAR END IN LATHE

Transformation—Fig. 592. Machine Used—Prentice speed lathe, 14-in., Fig. 593. Number of Operators per Machine—One. Work-Holding Devices—Held on pilot and center in tailstock, Fig. 593. Tool-Holding Devices—Taper shank. Cutting Tools—End mill, Fig. 594. Cut Data—Speed, 70 r.p.m.; hand feed. Coolant—Cutting oil, 1/4-in. stream. Average Life of Tool Between Grindings—200 pieces. Gages—Fig. 595. Production—100 per hr.

OPERATION 7. CLAMP MILLING HANDLE

Transformation—Fig. 596. Machine Used—Machine built at the Hill shop. Number of Operators per Machine—One. Work-Holding Devices—Clamped to driver, Fig. 598, which screws on spindle nose. Tool-Holding Devices—Special holder, Fig. 599. Cutting Tools—Form cutters, Fig. 600. Number of Cuts—One. Cut Data—Speed, 70 r.p.m.; hand feed.

other purposes. When this can be done as effectively as is done in this case, it reduces the number of idle machines in the plant, thus actually increases the per square foot floor-space operating efficiency of the plant as a whole.

The drilling and shaping of the striker seat is an interesting job, partly on account of the difficulty of supporting the tools which must have considerable overhang in order to reach the portion of the work which is to be machined. The use of a pilot on the spotting drill shown in Fig. 586A tends to reduce this overhang materially and insures at least that the center is spotted in correct relation to the bore of the bolt. The same principle of

Coolant—Cutting oil, 1/4-in. stream. Average Life of Tool Between Grindings—50 pieces. Gages—Fig. 601; A, diameter of ball; B, double snap gage for taper handle; C, squaring handle with body. Production—45 per hr.

OPERATION 8. TURNING BODY, ROUGHING

Transformation—Fig. 602. Machine Used—Pratt & Whitney No. 2 Lincoln miller, Fig. 603; the dead center is controlled by lever A and held in place by strap B, which is swung in and out of place easily; the center is tightened by screw C. Number of Machines per Operator—Two. Work-Holding Devices—Held on centers, Fig. 604, driven by handle. Tool-Holding Devices—In holder on carriage of machine, Fig. 605. Cutting Tools—Form cutter, Fig. 606. Number of Cuts—One. Cut Data—Speed, 60 r.p.m.; 1/4-in. feed. Coolant—Cutting oil, 1/4-in. stream. Average Life of Tool Between Grindings—200 pieces. Gages—Fig. 607. Production—25 per hr.

OPERATION 10. TURNING LUGS, FRONT AND REAR, AND FRONT OF HANDLE

Transformation—Fig. 608. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Machines per Operator—One. Work-Holding Devices—Held on centers, Fig. 609. Tool-Holding Devices—Holder on carriage of machine, Fig. 610. Cutting Tools—Facing cutters, Fig. 611. Number of Cuts—One. Cut Data—Speed, 70 r.p.m.; 1/4-in. feed. Coolant—Compound, flooded with five 1/4-in. streams. Average Life of Tool Between Grindings—200 pieces. Gages—Fig. 612; A, rear of front lugs from rear end; B, rear of rear lug from rear end; C, front of rear lug from rear end; D, front of handle from rear end; E, squaring lugs. Production—25 per hr.

piloting the tool by the bolt bore is followed with the pin-hole drill and the reamer shown in the same illustration. It will be noticed that chip clearance is provided by means of grooves on the sides of the pilots on these tools.

Operation 10 is a good example of how the miller can be induced to turn out lathe work to advantage. The miller characteristic of a rotating tool is dispensed with, and the cutting tools are held in the block shown in Fig. 610, this being mounted upon the miller table and advanced with its multiple tools into the rotating work. This arrangement gives a powerful drive combined with great rigidity, turning out 25 pieces per hour.

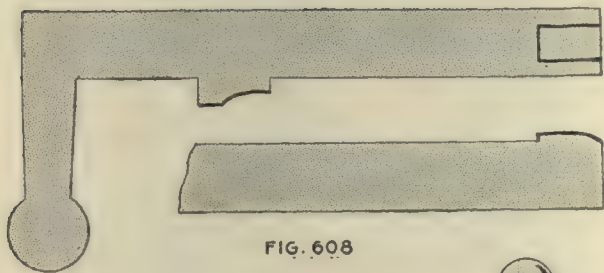


FIG. 608

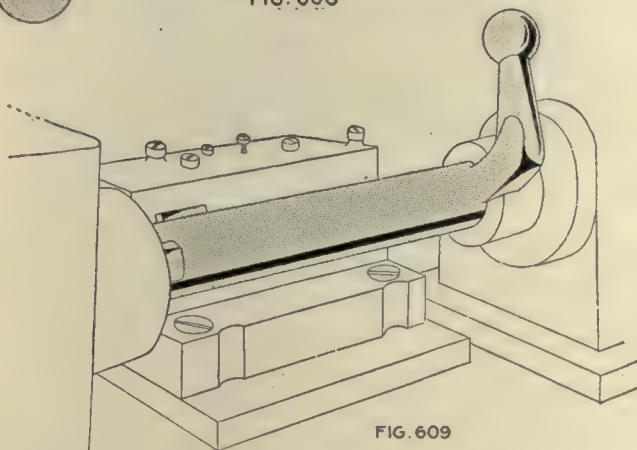


FIG. 609

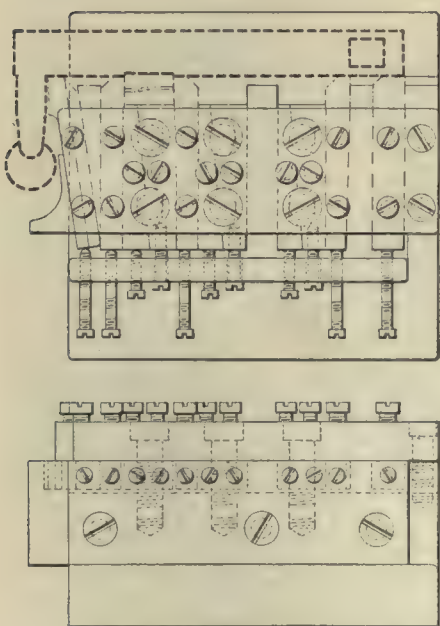


FIG. 610

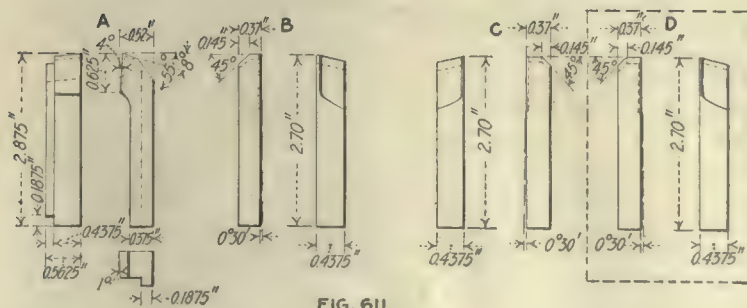


FIG. 611

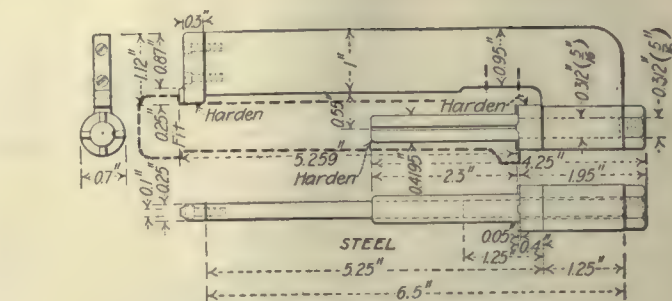


FIG. 612A

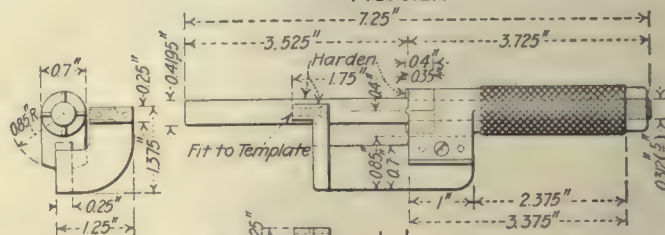


FIG. 612 B

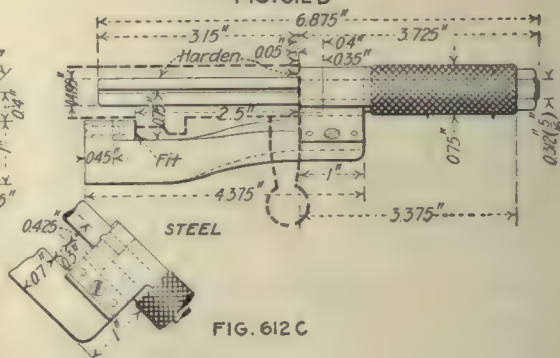


FIG. 612C

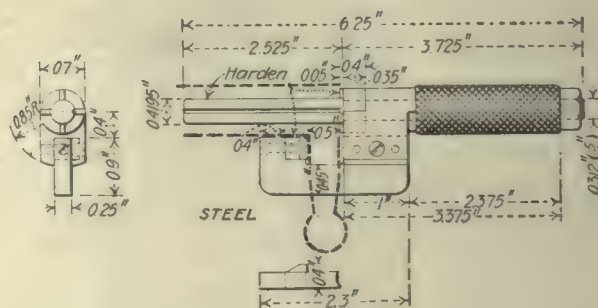


FIG. 612D

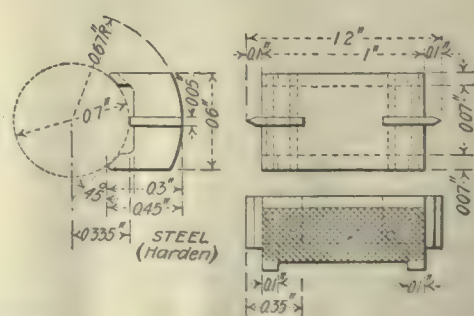


FIG. 612E

OPERATION 10

Letters from Practical Men

Reaming Tapered Holes

The munition manufacturers of the United States and Canada have run into all kinds of trouble in the filling of their contracts, as anyone familiar with this industry can attest. There have been annoyances with over-exacting inspection, absurdly close limits, overlapping limits, and a thousand and one troubles which developed after much valuable material had been scrapped. All these phases of ammunition manufacture have been touched upon in articles and editorials in the *American*

Tapered holes can be produced by boring with a single-pointed tool, but this is a slow operation. In some steels they can also be produced by boring a straight hole and afterward forcing a highly polished hardened-steel mandrel into the hole. There will of course be some "come back" to the steel after the mandrel is withdrawn, but the hole can be made to a fairly definite taper if the steel is of uniform analysis—uniform in temper and of uniform thickness as regards the walls. For this method the taper of the mandrel can be ascertained only by experiment. Calculation in our case gave us no satis-

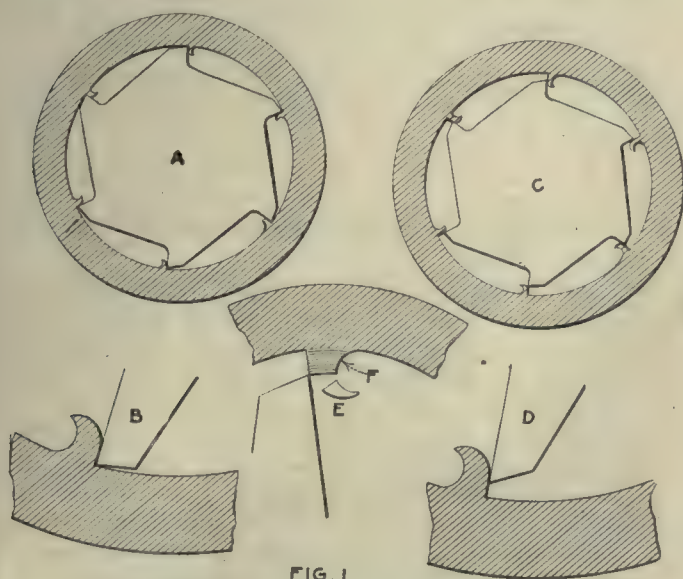
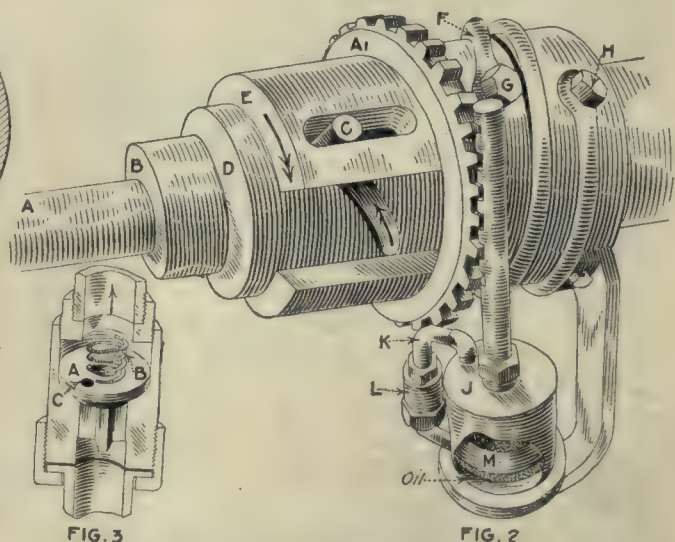


FIG. 1. ANALYSIS OF TAPER REAMER ACTION

Machinist, by men who have cited instances of troubles which they have overcome. There is one shell that has perhaps caused more sleepless nights than all the others together. I refer to the Russian shell with the tapered bore.

A firm with which I formerly was connected had taken a subcontract for a large number of these shells, and it was up to me to devise means for getting this shell out at a profit.

It was at first thought that the shell could be taper reamed in the ordinary manner, and several hundreds of them found their way to the scrap pile before the master mechanic was convinced that he did not know all there was to know about taper reaming. So discouraging was the outlook that the directors of the company had almost decided to throw up the contract and pocket their loss, when I was called into the meeting and asked if I could offer a solution of the trouble or advise them in any way. I asked for a week's vacation from my regular work, and a free hand to experiment and investigate the trouble, all of which was granted. But it seemed to me that if I did not make good, the chances of my being fired at the end of the week were excellent. The story of my investigations may be of interest and profit to others.



FIGS. 2 AND 3. THE REAMING ATTACHMENT

factory results, although the figures looked good on paper and calculations checked up with one another to within a close margin of error. The principal trouble with the mandrel method was the difficulty of withdrawing the mandrel without distorting the shell body. The lack of uniformity of temper also gave us trouble, but to a less degree.

The solution of the problem seemed as far off as ever, when one day, about the middle of my week's grace, I chanced to pass through the toolroom. One of the tool makers was reaming a hole with a taper pin reamer in one of the lathes, and was pulling the work around by hand. The pulling of the belt by hand was unusual enough to arrest my attention, so I stopped to see what he was doing. He would pull the belt around by hand and at the same time feed the taper reamer—which was held in a chuck in the tail spindle—very carefully with the other hand. Then he would stop the lathe and draw the reamer back a little way, and while thus withdrawn, he would pull the belt around slightly. The reamer would then be advanced again and the whole proceeding repeated.

This set me thinking, and I went to the drawing office to do what I should have done at first, analyze the process

of taper reaming in its crudest form, by hand, and try to apply an automatic relief for the reamer when it seizes in the work.

The taper reamer is a much more difficult tool to operate than the straight reamer, for the reason that there is a much greater length of the taper reamer in contact with the work than is the case with a straight reamer. For no matter how parallel a parallel reamer may be, or how carefully it may be operated, it will always—except in rare cases in cast iron—cut larger than itself. For this reason the only part of the reamer which is in contact with the work is the tapered end. As soon as this taper part is past a given point the teeth to the rear of the taper do not cut. They cannot cut because the hole made by the parallel reamer is larger than itself.

The wear on a parallel reamer is on the tapered part, and it is here that the most breakage takes place. In hand reaming, when the parallel reamer seizes, the reamer is withdrawn partly and then turned to break the chip made by the tapered end. In taper reaming by hand the same thing occurs, the reamer being partly withdrawn and the reamer turned to break the chip.

All this is simple with a hand-operated reamer, but it takes a lot of time; and the production of the tapered holes in the Russian shell had to be done by power, and in the least possible time.

In reaming tapered holes in the lathe by power, the elapsed time between the seizing of the reamer and its breaking, if the lathe is powerful enough to break it, is so brief that the operator has not time to withdraw it before breakage takes place. This line of argument suggested some sort of friction drive for the work or the reamer, but the varying hardness of the shells precluded the use of a friction even if a satisfactory one could be devised. Besides, for work as large as this, the friction would contain quite a mass of metal; and the inertia of such a mass would impose further stresses on the reamer.

The friction drive was therefore abandoned, and I set about devising a drive for the reamer which would possess the following attributes: The drive for the reamer should be light in weight. It should be practically a positive drive. It should relieve itself at the moment it seized in the work. In other words, the moment the reamer caught it should telegraph this fact to its holder, which would allow it to turn with the work so as not to break and at the same time withdraw far enough so that the section of the chips presented to it in its withdrawn position would be weak enough to allow shearing off without fear of injury to the reamer blades.

The conditions seemed a rather large order, but they were embodied in a reamer holder which has proved itself competent to handle this difficult work with ease.

To better understand the conditions, it would perhaps be well for the reader to refer to Fig. 1, which shows a section of the tapered reamer in the act of taking its cut, each blade throwing up a chip at *A*, the shape of the chip being shown enlarged at *B*. It will be noted that the root of the chip is broad and strong. Suppose there are six of these chips, and they are each 8 or 9 in. long. One can readily see that it will take quite a lot of power to turn the reamer, and that it will take a very strong reamer to stand up without breaking. Now withdraw the reamer slightly, as shown at *C*. The points or cutting edges of the reamer have receded from the

broad, strong root of the chip, and they are opposite a thin section which will not take much power to sever. This section is shown enlarged at *D*. After it has been severed, as shown at *E*, the succeeding teeth of the tapered reamer as it is fed forward each bite off a little slice, as shown at *F*.

This then is the problem and these the conditions that the reamer holder or the work holder has to fulfill.

I decided to apply the mechanism to the reamer holder in preference to the work holder, because the weight could more readily be kept down without sacrificing strength.

The result is shown in Fig. 2. The reamer *A* is held in the holder *B*, which is a snug sliding and turning fit in *D*. The sleeve *D* has a helical slot running a certain distance around it at an angle of about 45 deg. Outside the sleeve *D*, and a snug turning fit on it, is the sleeve *E*. Sleeve *E* has a longitudinal slot in it the same size as the slot in the sleeve *D*. The length of the slot in *E* is the same as the projected length of the helical slot in *D*, and its width is the same. A pin *C*, which is strong enough to drive the reamer to its full capacity, is passed through the slots and screwed into the reamer holder *B*. One end of a heavy helical spring *F* is secured to the sleeve *E* by a cap screw *G*, and the other end by a cap screw *H* to the body of the device. The rear end of the device is held in the turret or tailstock of the lathe where the reaming is done.

The action of reaming is as follows: The spring action and slot in *E* keep the pin *C* pressed in the direction of the single-pointed arrow against the top and forward end of the helical slot in the sleeve *D*. The reamer thus held is fed into the work, which has previously been bored. As soon as the reamer seizes, the burrs in the work turn it against the spring action and in the direction of the double-pointed arrow. The moment it starts to turn in this direction the pin *C* encounters the wall of the helical slot in the sleeve *D* and is forced to follow the direction of the helix. This withdraws the reamer from the hole, the edges of the blades come in contact with the light section of the burrs left by the reamer, and they are sheared off. The spring acting through the slotted sleeve *E* tends to return the pin *C* to the top and forward end of the helical slot in the sleeve *D*. This, of course, advances the reamer to its work. In advancing, it performs the work indicated diagrammatically in Fig. 1 at *F*.

In action the reamer seems to vibrate constantly till the hole is completed. It was soon discovered, however, that the return action of the spring was too quick and the reamer was returned too rapidly, resulting in broken blades. To overcome this a simple dashpot arrangement was devised. It had a hydraulic cylinder *J* the ends of which were connected by a bypass *K*. A valve of the check type, as shown in Fig. 3 at *A*, was located in the bypass at *L*. It had a $\frac{1}{8}$ -in. hole through it, connecting the top and bottom of the cylinder.

The action of the device was as follows: When the reamer caught in the shell it was turned around against the pull of the spring and caused the piston *M* in the hydraulic cylinder to force the oil in the bypass in the direction of the single-pointed arrow, Fig. 2. With the oil traveling in this direction the valve *A* opens readily, as it is merely held to its seat by the light spring *B*. The moment the reamer shears the burrs off and stops

turning with the work, both of which actions take place simultaneously, the valve *A* seats in its seat in the bypass. The oil in the top of the cylinder holds the piston, which in turn holds the reamer and spring from rapid return. The small hole *C* in the valve *A* permits the gradual return of the oil to the bottom of the cylinder, and with the return of the piston the reamer is advanced up the helical groove to its cut in the shell. The action of this device was highly satisfactory and resulted in perfect work without any broken reamers. It was also remarked that the reamers seemed to remain sharp longer than they did before the dashpot was rigged up.

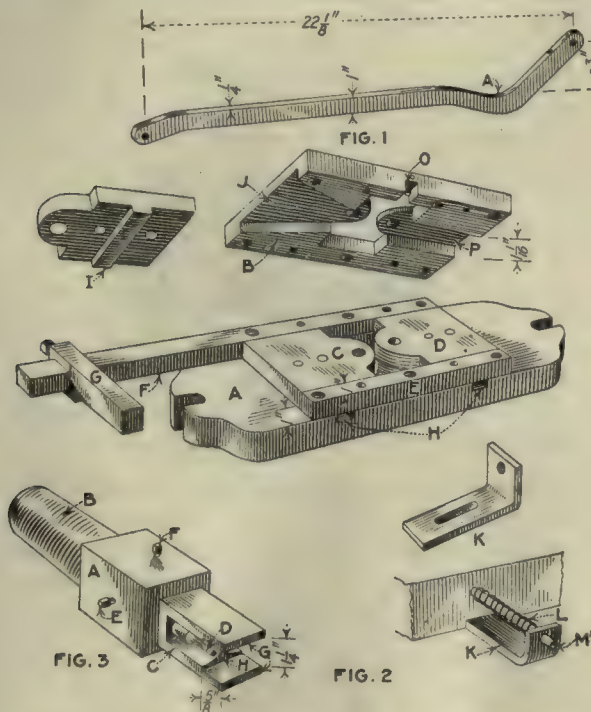
The gear ring *A1* is secured to the sleeve *E*, Fig. 2. The upper end of the hydraulic piston rod has rack teeth cut in it, as shown. The cylinder was light in weight, being made of steel tubing, and was hung from the reamer holder so that it could travel with it and thus keep the rack in mesh with the gear at all times. The piston was packed on both ends, as shown, with hydraulic packing. Care was taken to entirely fill the cylinder and bypass with machine oil, so as to avoid the spring-cushion effect of having air trapped in the device. If there had been any air, the dashpot effect would have been nullified.

W. B. DAVIS.

Chattanooga, Tenn.

An Edgewise Bending Die

When die products are needed in a large shop it is the custom in most cases to put the proposition up to the tool-designing department for solution. In the small shop, however, the procedure is entirely different. Nine times



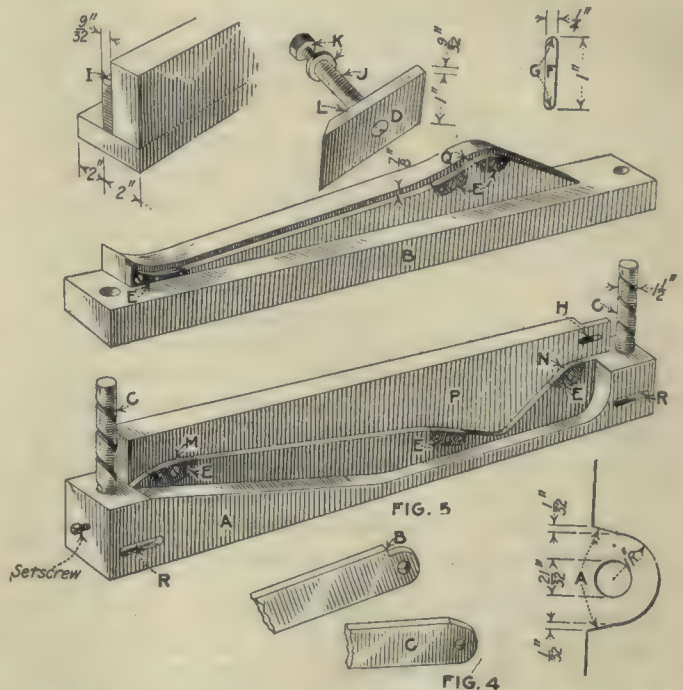
FIGS. 1 TO 3. DETAILS OF WORK AND FIRST PIERCING DIE

out of ten it is the tool maker who has to design his own dies.

In a certain plant a large number of the pieces shown in Fig. 1 were to be made, but the shop having only two punch presses big enough to tackle the job and it being imperative not to tie those presses up for any considerable

period at a time, the problem was to design dies for rapid production. The material was soft commercial bar steel $\frac{1}{4} \times 1$ in., and was bought in 18-ft. lengths.

The first die made was for piercing, rounding the ends and cutting off. While dies of this kind are used quite extensively, there are some features in this particular die which may be of interest. The stripper *B*, Fig. 2, is removed to show the construction of the die to better advantage.



FIGS. 4 AND 5. IMPROVED FORM OF PIERCING DIE AND FINAL EDGEWISE BENDING DIE

age. The shoe *A* is of cast iron. The two halves of the die are shown at *C* and *D*. The cold-rolled steel front side piece *E* is 1×1 in. The other side piece *F* at the back is of the same material and is on the adjustable stop *G*, having a setscrew at the back to secure it when set. Two parallel grooves *H* are milled across the die shoe to receive tongues on the bottom of each half of the die. One of these is shown at *I*. Six cap screws and four dowels hold the side pieces in place. The dies are secured to the shoe by four fillister-headed screws. The side pieces and tongues make the shifting of dies under heavy stresses out of the question.

This method of building up a die of this kind is a good one, saving quite a lot of tool steel, simplifying machining to shape, and facilitating repair if broken. The stripper is of the solid bridge type, making the guiding of stock and the stripping of punches positive. Clearance is machined at *J* in the stripper to allow the operator to pull the stock toward him, after the punch has done its work, sufficiently to clear the stop *G*, thereby making the removal of the finished strip easy.

At *K* is a temporary stop used for locating the end of each new bar of stock, after which the regular stop *G* takes care of the work. The spring *L*, in conjunction with the pins *M* and *O*, keeps the temporary stop always clear of the punches as soon as released. The punch is shown in Fig. 3. The holder *A* is of mild steel, with a round shank *B* fitting the press ram. The end-rounding and cutting-off punch *C* and the piercing punches *D* have round shanks and are held in place by the setscrews *E*

and *F*. The middle portion of the punch *C* is cut away, as shown, to form the pilots *G*, which help greatly in lining up the die in the press, preventing damage by shearing.

The cutting face *H* of the punch *C* is about $\frac{3}{32}$ in. higher than the ends of the punches *D* in order to grip the job securely before the piercing punches come in contact with it. This arrangement prolongs the life of slender piercing punches considerably, more especially if the stock is thick. As the stock in different bars varied a little in width the groove *P*, Fig. 2, was made $1\frac{1}{16}$ in. wide so as to accommodate the largest variations. With this end in view the die was laid out as shown in Fig. 4. The angles *A* insure against objectionable corners like *B*; and even when the stock was slightly undersize, the sheared ends appeared as at *C* and passed inspection.

The next die to be made was the edge-bending die, Fig. 5. The die *A* is made of one piece of machine steel, as also is the punch *B* which, for the sake of clearness, is shown upside down. The only hardened tool steel used in the construction of this die was in the guide posts *CC* and the reinforcing pieces *E*. It was found necessary to reinforce the impression in the soft die with these hardened steel pieces at places where the bending stresses were greatest. Each of the reinforcing pieces is held by a flat-headed screw and two dowels. A glance at the cross-section of stock at *F* shows the rounded edges *G*. A corresponding curve is worked on the bending impression of both the punch and die, as shown in the right-hand projection at *I*. The stop *D* is made of cold-rolled steel cyanided, and is held in place by a $\frac{3}{8}$ -in. stud *J* extending through the slot *H* and secured by a nut and washer *K*. The elongated holes *R*, of which there are four, two in each side, are for clamping the die to the bolster, while the punch is secured to the press ram by two $\frac{7}{8}$ -in. cap-screws, not shown.

When the two dies just described were ready, a strip was cut off by guess in the die, Fig. 2, formed up in the bending die, and the center distances of the hole were measured. It was found to vary, so the stop *G*, Fig. 2, was adjusted till the finished piece measured exactly $22\frac{1}{8}$ in. from center to center, as specified. In operation the stock was placed in the bending die against the beveled end *L* of the adjustable stop *D*, Fig. 5, resting on the points *M* and *N*. When the punch descended, it held the stock securely against side motion between the $\frac{7}{8}$ -in. pilot projection *Q* in the punch and the face *P* of the die. This bending die proved successful; so much so, that another die of the same kind, but longer, was immediately ordered.

In laying out dies of this sort it is well to take into consideration the tendency of stock to spring back at acute bends such as at *A* in Fig. 1. It is good practice wherever bends like these occur to make the angle in the die just slightly more acute and regulate the finished form by the travel of the press ram. It might be said in conclusion that a 40-ton Niagara single-crank press running at 80 r.p.m. was used for the forming operation.

Dayton, Ohio. HUGO F. PUSEP.

Centering Stop and Pin Spanner

In Fig. 1 is shown a collar for making all centers on work exactly the same depth. The value of the collar is apparent when machining duplicate work to a stop, espe-

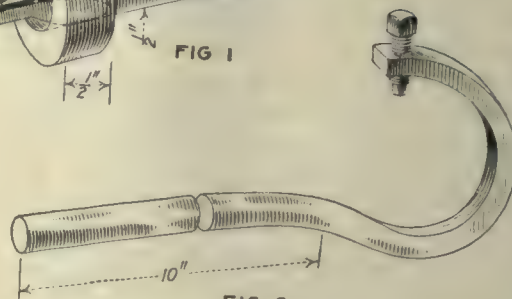
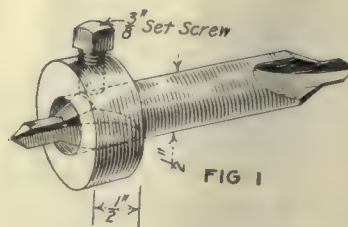


FIG. 2
CENTERING STOP AND PIN SPANNER

cially on a miller that requires work squared or keyways to a certain length. In Fig. 2 is shown an easy way to repair or make a spanner wrench.

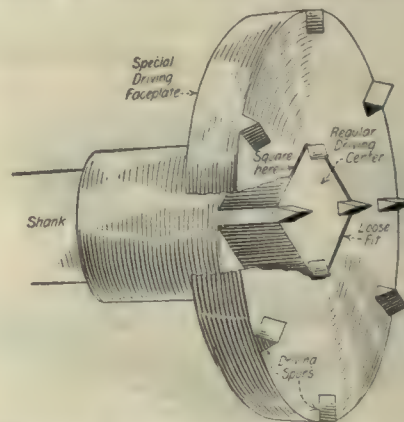
Sharon, Penn.

C. E. APPLEGATE.

Driving Center for Pattern Makers' Lathe

Very often the pattern maker, when he is rigging up the drive on the end of a long piece that is to be turned in the wood lathe, will do it in the way that is the least trouble, because he is in a hurry. He knows that he is defying "safety first," but he is in a hurry.

In the illustration is shown a combination drive for pattern makers' wood-turning lathes—my own idea. It is simple, yet practical, and is inexpensive to make. It also insures safety when turning. It consists of a face-



COMBINATION DRIVING CENTER FOR PATTERN MAKER'S LATHE

plate 4 in. diameter, $\frac{1}{2}$ in. thick, having on one or both faces driving spurs, which are shown on one face only. In the center is a square hole that fits loosely over a corresponding square on the end of the regular driving center. Holes are drilled and countersunk in the plate to receive wood screws for the operation of turning a split pattern.

Instead of crushing the grain of the wood by driving the dull spurs into it, the locations of the spurs are first made on the end of the piece; then a sharp chisel is driven in. This insures a powerful grip of the spurs. No dressing of the wood is required in attaching this to the wobbly end of the piece that is to be turned.

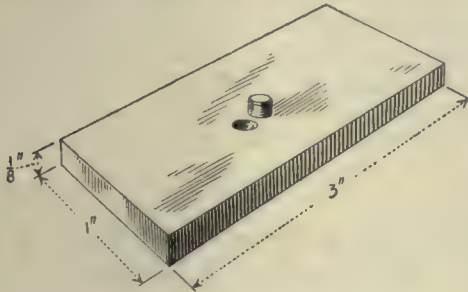
Kenosha, Wis.

M. E. DUGGAN.

Discussion of Previous Question

Device for Making Springs

Jan Spaander's article on a "Hand-Operated Spring Winder," page 536, reminds me of a device I employed in winding springs that had to be wound close and of an even tension. These springs were for telegraph typewriters. The music wire used ranged from 0.010



SIMPLE SPRING WINDER

to 0.040 in. in diameter and was wound on drill rod 0.625 to 0.125 in. in diameter, about 8 in. long.

I took a piece of machine steel $\frac{1}{8}$ in. thick, 1 in. wide, 3 in. long, and drilled a hole in the center the size of the drill rod. I then drilled a hole and drove in a pin of the same thickness as the drill rod, allowing it to protrude about $\frac{1}{16}$ in. The space between the pin and the hole is the thickness of the spring wire.

I put the drill rod in an Almond chuck in a speed lathe and unwound enough wire to feed the whole length. I bent about 1 in. of it at a right angle with the pliers, so as to catch it in the chuck, started a few turns by hand, pushed the jig up against it and held it there while I let the lathe run at about 500 r.p.m. Before cutting off the wire and loosening the jig, I turned the lathe backward a few turns so as to get the pull out.

Brooklyn, N. Y.

OTTO WEBER.

Apprentice Question from the Apprentice's Viewpoint

Almost all the articles published in the *American Machinist* concerning "Does it pay to serve an apprenticeship?" have been written by those who either are or have been in charge of apprentices.

I am still an apprentice and will try to state briefly facts and average estimates, using my own case as an example, as it is quite different from most others and yet deserves consideration, as it can be used as a basis for computation.

Boys look at apprenticeship from a financial point of view. For the year and a half previous to starting to serve my apprenticeship I earned a piecework minimum wage of \$12 per week. As an apprentice, beginning when I was 17½ yr. of age, I earned \$4.90 weekly the first six months, \$5.60 the next six months, \$6.60 the second year, \$7.84 the third year and \$9.24 the last year. This

makes an average for the four years of about \$7 per week. If my wage before serving time stood stationary for four years at \$12 per week, I should sacrifice \$5 per week, \$250 per year or \$1,000 for four years. How many boys are willing to sacrifice \$1,000 in four years? Then again, how long will it take a fellow who has served time to catch up and regain the money he has sacrificed?

If I had stayed in the shop at piecework by the time I was 22 years of age I might have been able to earn about \$15 per week. When I finish serving my apprenticeship I will earn a minimum wage of \$20 weekly. I therefore gain \$5 per week, or \$1,000 in four years. After that the difference is clear profit.

After serving time as an apprentice I can earn a steady, substantial living. I shall have acquired skill and the fundamentals of higher mathematics. By judicious work I can advance, while those who have a common piecework job cannot, for they lack the rigid foundation.

Schenectady, N. Y.

JOHN SILVERMAN.

A Plea for Signed Help Wanted Advertisements

On page 602, R. A. Charles raises the question as to when manufacturers are going to advertise for help over their own names.

This is something I also have often pondered over, as it seems to me that if a manufacturer were in need of a man, and wanted him to apply by letter, he could so state in his advertisement.

A feature Mr. Charles failed to mention is that as an applicant for work does not know the name of the concern advertising, he cannot send a second letter if the first fail to bring an answer.

I have answered a number of advertisements in the *American Machinist*, and also in newspapers, and inclosed a stamped and addressed envelope. In the majority of cases I failed to receive an answer.

I would like to hear what manufacturers have to say about this matter.

EMIL G. J. BEER.

Sheboygan Falls, Wis.

Lubricating the Screw

If Mr. Remacle had been kept out of his bed night after night to remedy the damage caused by screws vibrating loose in the carpenter shop of Winchester Arms, New Haven, where we installed some apparatus, he certainly would not have advised on page 340 to lubricate screws.

Excluding the "moving" variety, the screw is meant to fasten two objects. Its modern thread has been chosen to make its strength equal to that of its area and also to provide as much friction as possible under practical conditions. The scores of auxiliaries to hold screws in place—special fine threads also—indicate that in many cases there is not enough friction. If the screw had been

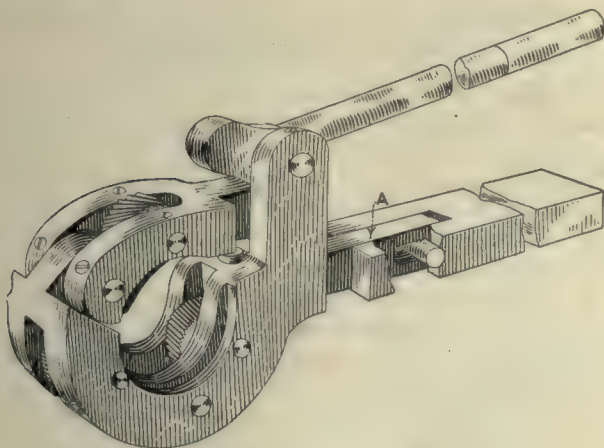
meant to be driven "home" easily, its original designers would have provided a multiple thread, giving the same amount of strength against shearing.

Mr. Remacle and I also seem to have a different understanding as to driving the screw home. A screw is home when the head is down on its seat, and there is no sense in turning it farther by force. This is in many cases even forbidden. Bridge builders warn against unnecessary secondary stresses, and aboard ship it is regarded as bad practice to tighten the screws of the cylinder-head covers more than just home. A well-cut screw goes home without oil. The only screw to be greased is the woodscrew, as that has to do its own cutting. Where oil is used for rust prevention, one might as well select some noncorrosive material for the nut, or even for the screw, when small. JAN SPAANDER.

Brooklyn, N. Y.

Adjustable and Self-Centering Knurling Tool

In the *American Machinist*, page 414, Jan Spaander submits a self-centering knurling tool. Along this line allow me to submit a self-centering and self-contained knurling fixture. It may be noted from the details that it consists of five parts—shank, lever, one fixed and



THE KNURLING TOOL

one movable jaw, and the knurls in place. The pin hole in A is slightly oblong. By pressure exerted on the lever the movable jaw is made to approach the fixed jaw. A stop limits the movement and prevents crushing of the knurls. The tool does its work rapidly and accurately. The fixed jaw has a slot machined which allows of a slight variation in the set up. All parts except the knurls, which are made of Novo steel, are steel forgings.

Philadelphia, Penn.

HERMAN F. ANDERS.

Exact Angles for Lathe Centers

The article on the subject of angles for lathe centers on page 559 interests me. I have had the job of making work similar to the 60-deg. angle gage shown by Mr. Stein. I do not think Mr. Stein recognizes the great difficulty of making a gage like this. The number of possible errors is great, and there would be considerable trouble in using it as a gage, as the members do not meet each

other at the angles; in other words, there is a space between the male and female members. Mr. Green, page 298, got his centers "within 2 min." in $1\frac{1}{4}$ in. It would take a highly skilled tool maker with good equipment to make the gage shown on page 559 as close as that. I have waited in vain for someone to give a simple method of working out the answer to Mr. Green's question—"Would centers within 2 min. be considered good?" I have had several of my mathematical friends work out the problem on the assumption that the error was plus. Their answers were to 7 decimal places and varied by as much as 1,000 per cent., so it occurred to me that a simple arithmetical method of solving the problem might be of interest.

This method is not absolutely correct, but will in this instance be correct to about the fifth decimal place. The 60-deg. centers were $1\frac{1}{4}$ in. on a side; that means that the circle was $2\frac{1}{2}$ in. in diameter. Then $2 \text{ min.} = \frac{2}{100} \times \frac{1}{314} \times 2\frac{1}{2} \times 3.14159$.

New York City.

E. A. DIXIE.

What Is a Gage, a Die, a Jig, a Tool, a Fixture?

On page 649 W. B. Greenleaf writes, "The names jig and fixture are synonymous." I do not think this will be generally accepted, for the usual distinction is that a jig is a device for holding and controlling the work, while a fixture is a device for holding and controlling the tool. Of course there are frequently combinations, and occasionally the two are even interchangeable or identical, but ordinarily the distinction is decided.

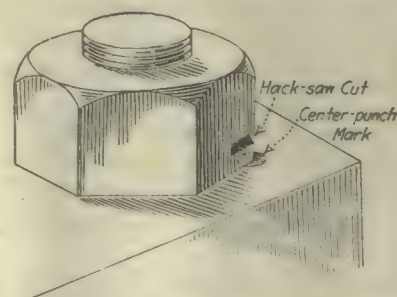
For example: Centers, chucks, vises, mandrels, frames and plates are jigs, while toolposts, turrets, brackets, sockets, arbors and bars are fixtures. These forms just cited are, to be sure, of the most elementary type, but the distinctions are just as clear among the more complicated mechanisms which represent the usual jigs and fixtures.

J. WALLACE TAYLOR.

Toronto, Canada.

One More Locknut

After looking over Mr. Van Deventer's locknuts on pages 180 and 181, I show one he probably overlooked. This locknut is quite popular with millwrights and indeed



A LOCKNUT

is hardly suitable for any other kind of work. A plain nut is slotted with a saw, as shown, and the small part is driven down into a previously made center-punch mark.

Plainfield, N. J.

J. B. MURPHY.

The Making of the Annular Type of Ball Bearings

EDITORIAL CORRESPONDENCE

SYNOPSIS—An outline of the process of manufacturing annular ball bearings is here given, from the rough bar through the various machining, heat-treating and grinding operations up to the point of assembling. While standard machines are used principally, their special applications will be of considerable interest to every mechanic.

The average tool builder or user ordinarily thinks of the function of a ball bearing as merely to save power by the reduction of friction. The true function, however, of a scientifically made ball bearing does not stop with the saving in driving power required. When correctly made, it is so free from the small but destructive internal friction that shortened the life of the early types that, if used according to its rating, protected from external grit and properly lubricated, it is almost wearless and indestructible. Being so nearly wearless, it does not require the periodic adjustment common to all plain bearings, and it lasts for a long time with the same snugness and accuracy of fit as when new.

Ball bearings, so called, are not new to the machine-tool builders. Ever since early bicycle days attempts have been made to substitute them for plain bearings. These attempts, however, were for the most part made without any real knowledge of the most suitable steels, the best design or the refinements necessary to produce durable anti-friction bearings. Even the proper size and number of balls for a given load were for a long time unknown. One of the earliest applications of ball bearings to machine tools was for drilling machine thrust

About twelve years ago there developed an urgent demand for a genuinely durable type of heavy-duty anti-friction bearing. Recognizing this demand, the German Small Arms and Ammunition Works, Berlin, in 1898 commissioned Professor Stribeck, at that time head of the Neubabelsberg Technical Laboratories, to investigate all types of ball bearings then known and to develop, if possible, a new and reliable type. The researches that followed took years and cost a large sum of money. The result was the discarding of all adjustable types and the evolution of the so-called annular type for radial loads.



FIG. 1. TESTING ROUGH-TURNED BARS FOR BRINELL HARDNESS



FIG. 2. AJAX FORGING MACHINE AND TYPE OF FURNACE USED



FIG. 3. FORGING DIES WITH STOCK STOP IN PLACE

collars. The first attempts were along the line of the cup-and-cone type, which naturally failed; but the use of flat, shallow grooved rings filled with balls succeeded, and today a large number of machines are so equipped. Though the fact was not at first recognized, the grooved rings succeeded in spite of inferior steels and workmanship, because they more nearly approached the fundamental principles of sound practice as recognized today.

It is from the data furnished by these researches that Conrad designed the type of ball bearing known as the HB or DWF, manufactured in this country by the Hess-Bright Manufacturing Co., Philadelphia, Penn.

A distinguishing feature of the Conrad design of annular bearing is that where a single set of balls is used, no filling slot or groove is necessary, the outer and inner rings being assembled by placing one ring inside the

sary to give a good understanding of the machining processes. Extreme accuracy in workmanship is very necessary and will be emphasized as the description proceeds.

Naturally, the steel used is of prime importance in a bearing of this kind, and the company's specifications call for chrome-carbon steel made by either the electric or the crucible process. It must be of uniform quality,

at random from several bars or billets of the same lot and must show an analysis within the following limits:

	Per Cent.		Per Cent.
Carbon.....	0.95 to 1.10	Silicon.....	0.20 to 0.35
Chromium.....	1.30 to 1.50	Phosphorus.....	Under 0.025
Manganese.....	0.25 to 0.45	Sulphur.....	Under 0.025

The rough-turned bars must be thoroughly annealed, and the fracture must be close grained. The Brinell

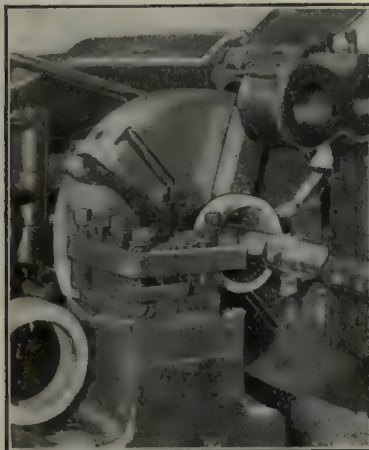


FIG. 12. FIRST OPERATION ON FORGED OUTER RINGS

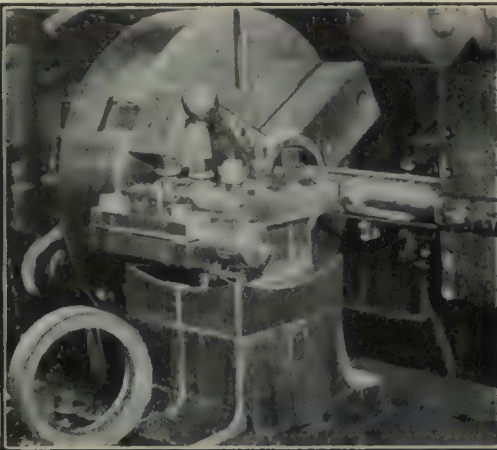


FIG. 13. SECOND OPERATION ON OUTER RING

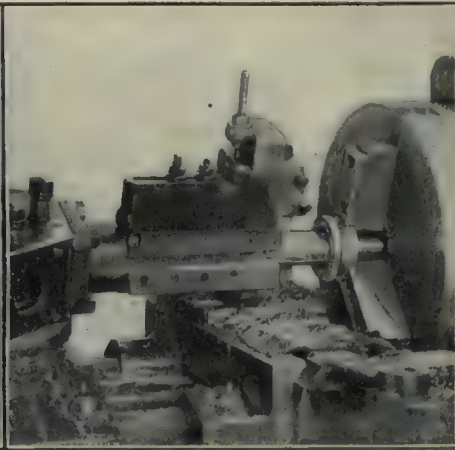


FIG. 14. SECOND OPERATION ON FORGED INNER RING



FIG. 15. FIRST AND SECOND OPERATIONS ON FORGED THRUST BEARINGS

hardness (10-mm. ball under 3,000-kg. pressure) must not exceed 180 or be less than 160 at any point in the length or at any point in the cross-section of the bar tested. The manufacturer's name or trade-mark is also stamped on the surface of the bar or billet near the end, except on sizes under 1½ in. in diameter, which may be boxed; but the required information must be attached to the box or bundle for identification purposes. The

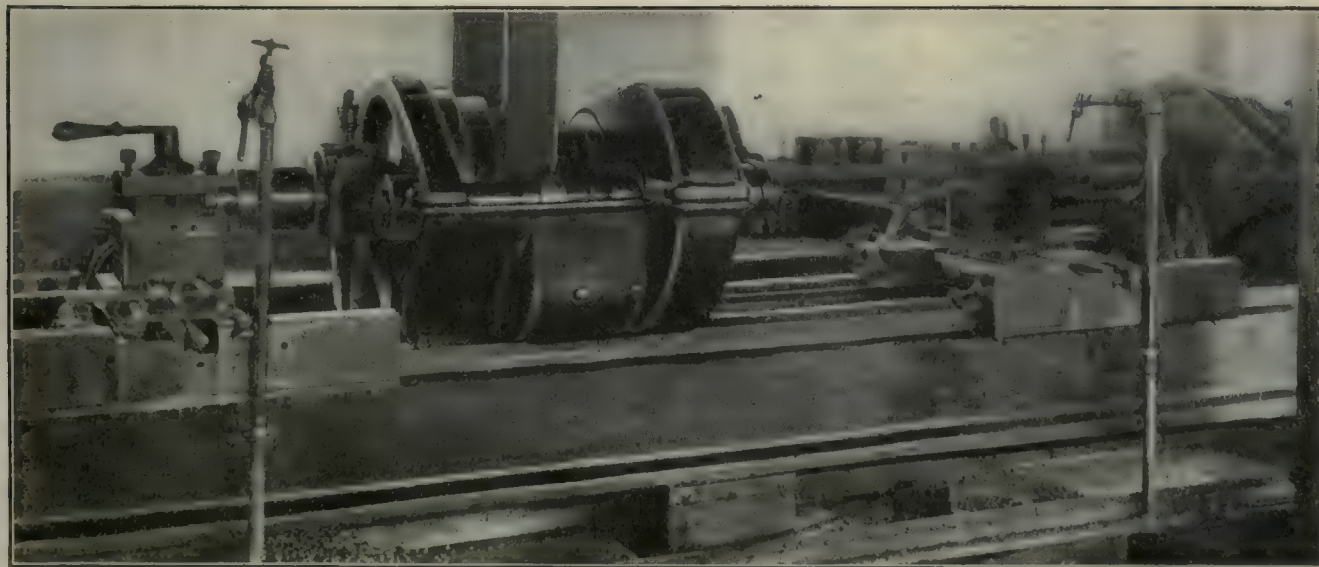


FIG. 16. SPECIAL DOUBLE-HEAD LATHES FOR RING WORK

free from slag or other segregation. The bars and billets must be free from imperfections such as pipes, seams, checks or laminations, either on the surface or in section. Rough-turned bars are specified to be within limits of 0.015 plus or 0.010 minus. Different diameters measured on the same bar must not show a variation of more than 0.015 in. throughout the entire length, the length being not over 9 nor less than 4 ft. Drillings are taken

method of testing in the shop for Brinell hardness is illustrated in Fig. 1.

The blanks for the bearings may be made in several ways—cut from tubing, forged separately, forged from bar or cut from bar. The forging from bar stock and the cutting from the bar in machines are the two more common methods and will be the only ones described to any extent here. Ajax machines are used for forging

both outer and inner rings from bar stock, and rings of this type up to $1\frac{1}{2}$ in. in diameter from a $5\frac{1}{2}$ -in. bar are made at present on these machines. One of the 4-in. Ajax machines and a heating furnace are shown in Fig. 2.

A close-up view of a set of punches and dies in this machine is given in Figs. 3 and 4. Fig. 3 shows the stock stop in working position. The bar, heated to between 1,800 and 1,900 deg. F., is placed in the lower die and shoved in against the stop. The machine is then tripped, the stop wings out of the way, and the upsetting punch comes forward and upsets the end of the bar the proper amount. As the two parts of the die open, the bar is placed in the upper die and the machine again tripped, the stop swings out of the way, and the upsetting pierces the upset blank or, in other words, forces the bar out of the blank. In this way practically no stock is wasted. As the piercing punch draws back, the ring thus formed is knocked downward below the dies and is taken out at the side by a helper who stamps the maker's mark on it.

A set of forging punches and dies may be seen in Fig. 5. The piercing punch is shown at the extreme left and the upsetting punch next. If the die at the right were turned over onto these, the parts would be in relative working positions. Some of the rings made by these dies are illustrated in Fig. 6. Both inner and outer rings are made in the same manner. Details of a set of punches and dies for both are given in Fig. 7. On some sizes of bar only one or two blanks can be forged at a heat, while on others sometimes as many as five can be forged at a heat.

CUTTING BLANKS FROM THE BAR

There are two methods employed in cutting blanks from bar stock. One is to cut them singly and the other two at a time, the size of the ring to be produced being the ruling consideration in most cases. Inner rings may

The production of two rings at once, an inner and an outer, is shown in Fig. 9. Here the hole in the inner ring is drilled out and reamed, the outside turned, and then a trepanning tool is run in as shown in the cut. This forms two complete rings, which are then cut off from the bar. On this particular operation the two rings



FIG. 17. PART OF THE HARDENING ROOM

are 3.166 and 1.799 in. in diameter respectively and are cut from bar $3\frac{7}{8}$ in. in diameter. One operator runs five machines, and each machine will produce about 38 of this size ring per day. A large battery of machines, all Cleveland automatics, are employed on this work alone. The trepanning operation, of course, produces rings similar to the forged ones without ball grooves.

Both the forged and the machined rings are carefully annealed before the subsequent machining operations, the annealing being done in special Quigley furnaces, Fig. 10. The rings are packed in charcoal in pots, luted with clay and handled in and out of the furnaces as shown.

In order to give a flat side to locate from in the chucking operation the forged rings are ground on an Ajax grinder, as illustrated in Fig. 11. The ring to be ground

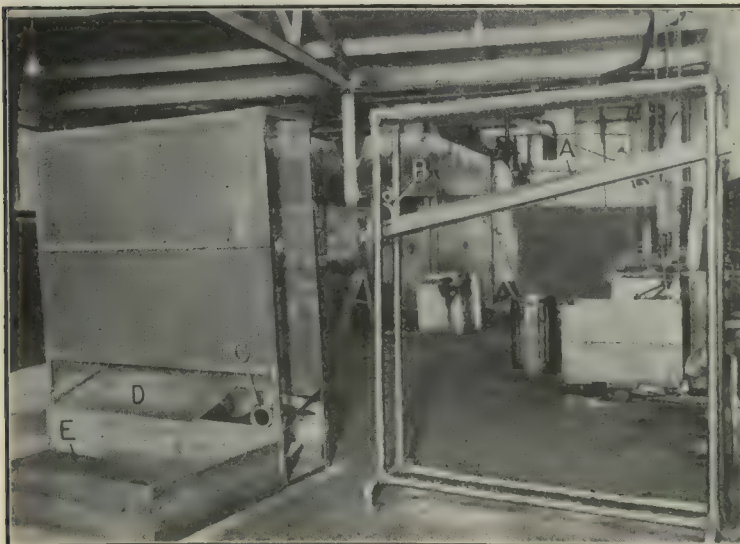


FIG. 18. DROP TESTING AFTER HARDENING

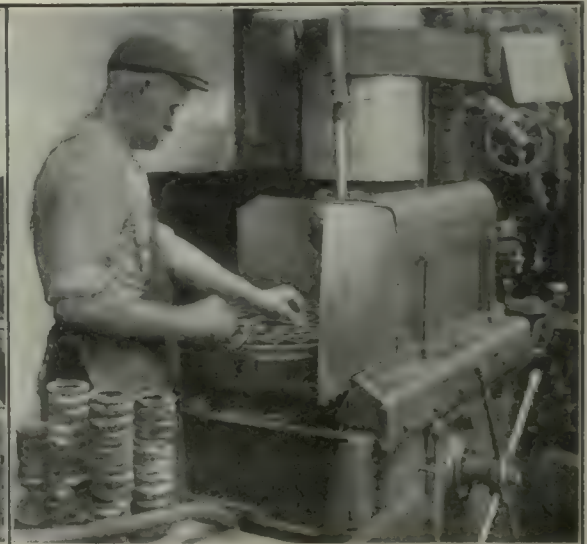


FIG. 19. GRINDING TO FINISH THICKNESS

be cut as shown in Fig. 8. Here the ring is roughed out all over, including the ball groove. One man runs three machines; and while the production varies considerably according to the size of ring being made, the average on a $2\frac{3}{16}$ -in. bar is close to 125 per day total output for the three machines.

is placed on the chuck jaws, the fixture is swung into place and the work revolved against the wheel by means of the handwheel shown.

The first operation on forged rings is done on either Gisholt or Warner & Swasey turret lathes. One of the latter set for machining outer rings may be seen in Fig.

12. The ring next to the machine is a forging, and the one at the left shows the machining done. The ring is chucked internally, then turned and bored about halfway across and faced. After being inspected, the rings go to

lathes. One of these lathes set up for work on inner rings is shown in Fig. 16. The inner rings are held by means of expanding plug mandrels, but the outer rings are chucked. After being rough machined all over the rings

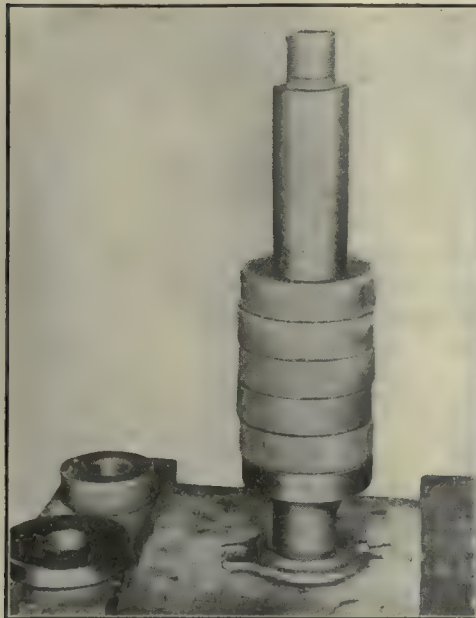


FIG. 20. TYPE OF MANDREL USED FOR FIRST CYLINDRICAL GRIND

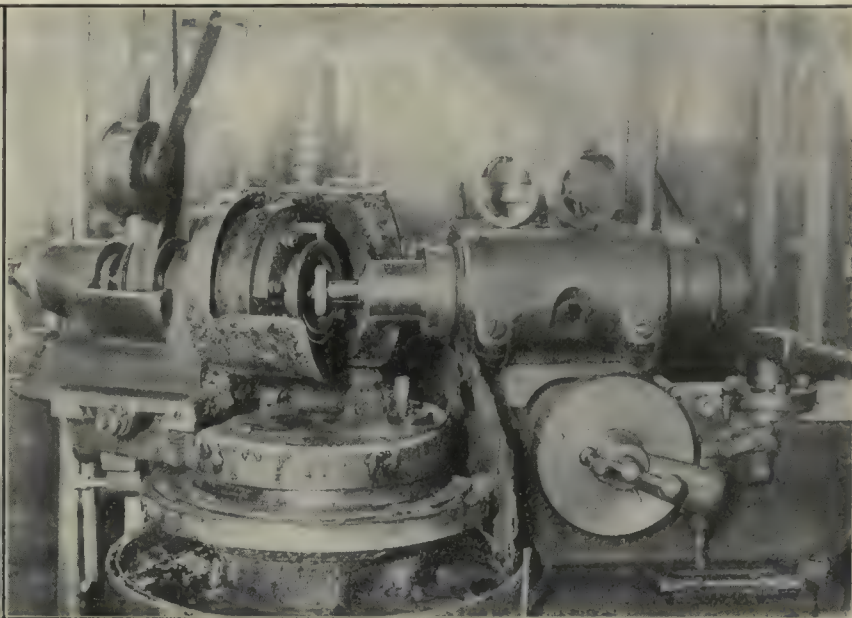


FIG. 21. GRINDING GROOVE IN OUTER RING ON OSCILLATING GRINDER

another machine and are chucked on the turned surface, as shown in Fig. 13. The rest of the outside is turned, the bore cut all the way through, faced, and the ball groove cut in, as shown by the ring at the left.

Forged inner rings are handled in substantially the same manner. A Gisholt lathe on a second operation is illustrated in Fig. 14, the principal difference in this case being that the ball groove is on the outside of the ring instead of inside. Thrust bearings are also handled in the same way, as shown in Fig. 15. The first operation, as indicated by the rings at the right, consists of boring, facing, grooving and turning about halfway

are stamped in a small press with the firm trade-mark, symbol for size and type, etc.

It must be kept in mind that after each machining operation the rings are inspected, and all that do not come up to the rigid requirements are thrown out. The inspection methods and gages will be described in a separate article.

HARDENING AND GRINDING

The hardening temperature, as well as that of the drawing, varies somewhat according to the size and use of the bearings in hand. As a general rule those larger than 3 in. are hardened in water, and those smaller are hardened in Houghton's quenching oil. The hardening heats range from 1,400 to 1,600 deg. F. and the drawing from 250 to 360 deg. F., as specified. Special Quigley hardening furnaces are used. Part of one of these furnaces and a corner of the hardening room are shown in Fig. 17.

After hardening, each ring is tested for fractures by placing it in the inclined trough *A*, Fig. 18, and letting it run off at *B* and drop upon a cast-iron block at *C*. From there it usually bounces to the inclined board *D* and drops into the box *E*. The trough is 6 ft. long with a 16-in. drop to it. The lower end of the trough is about 4 ft. vertically above the cast-iron block, though the ring travels farther than this to reach the block. The frame holding the trough can be easily shifted to or from the block to accommodate various rings being tested. If after this test the ring is tapped with a small hammer, the sound will tell instantly whether a crack has developed or not. The rings are next file tested for hardness, and then one side is smoothed slightly on a disk grinder, to form a good seating surface on the magnetic chuck on which the sides are ground. They are next placed on a Blanchard machine, as shown in Fig. 19, and ground to finish thickness. Now they are demag-

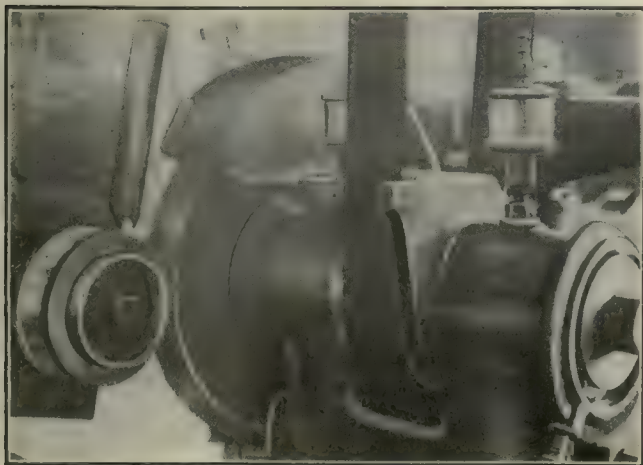


FIG. 22. GRINDING GROOVE IN INNER RING

across. The second, in this case, consists of turning the rest of the outer diameter and facing.

The first operation on trepanned rings is of course on the automatics previously shown. The second consists mainly of grooving. This grooving on both outer and inner rings is done on special double-head American

netized and placed on the type of mandrel seen in Fig. 20, and the outside is trued up in a Landis grinder.

The ball groove in outer rings is ground on either Landis or Van Norman oscillating radial grinders, one of the latter being shown in Fig. 21. Standard-radius diamond-wheel dressers are used to keep the wheels in good shape. The grooves in inner rings are ground on Brown & Sharpe machines, as shown in Fig. 22.

It should be borne in mind that inspection has come after each step in the progress of the rings. They now go to the assembling and polishing department, the operations in which will be described later.

✱

Mistake To Discount the Other Fellow's Brains

BY JOHN R. GODFREY

The one great weakness of self-made men is not so much that they worship their maker, but that they seem to get the idea that both the pattern was lost and the material exhausted when they finished their particular job. I presume it is a natural weakness. Not having arrived at that stage myself, I can not say from personal experience. And the perhaps natural, but very disagreeable, result is that they are apt to put everyone else in the dam-phool class without stopping to inquire as to the reason the others are not training in the successful group.

It may very well happen that the self-made ones are right in most cases—there is a heap more of us than many like to admit—but it does jar the inner conscience a bit to be classed with the idiots and otherwise undesirables when we happen, quite accidentally of course, to be doing something that is perfectly right, if the S. M. M. only looked below the surface, as he used to do before he "arrived."

In one particular case I remember, a perfectly good and harmless workman, who had the best interests of the shop at heart, so far as he knew them, got a terrific call-down from the boss for burning an electric light while the curtain at his window was drawn down: "Any man with a spoonful of brains would put up the curtain," sputtered the S. M. M. as he stormed into his office, decrying the degeneracy of mechanics since the day he was in the shop himself. No wonder they did not succeed.

But there happened to be a reason for the seeming foolishness. Over on the other side of the toolroom, close by a window, was a man at work on a delicate jig that the boss wanted in a hurry. And the man "minus the brains" had pulled his curtain down to keep the setting sun from striking the other man square in the eye. On this account he needed light, but a few cents' worth of juice was of no consequence compared to the work on the jig. This was what the S. M. M. did not stop to find out. Not because he meant to be unfair, but because he had all unconsciously nursed the idea that he had a monopoly of the kind of brains that counted, or else the other men would not have been working for him. It is a bad habit of thought, and the sooner the S. M. M. gets it out of his system the more really and truly great he will be. Discounting the other fellow is not always a safe game to play.

It was this particular case that really started my old friend Jimmy Johnson away from the old shop and into

a new line of work, where, strange to say, he succeeded remarkably well. He had been working for the S. M. M. until the S. M. M. was convinced Jimmy did not know enough to go in out of the rain. That means that Jimmy had not been able to talk the S. M. M. into adopting any of the devices Jimmy had worked out. After the curtain episode Jimmy got busy with a vengeance and did what he ought to have done long before.

Then after he had made a very favorable deal with a "ready-made" shop owner (which means his dad had left the money ready to start him in business), Jimmy paid the S. M. M. a visit to give notice and spake unto him something after this fashion:

"Being as I have it from your own lips that the full quota of brains in my cranium would not crowd an after-dinner coffee spoon, I just naturally concluded you would not be heart broken at losing such a worthless incumbrance from your payroll. So I have hornswaggled young Billson down here not only to give me a job, but to build some of those presses I have been trying to interest you in. And while I am duly sorry for Billson, I just could not bear to burn any more of your juice, even if Bronson was saving ten times its cost over on the Rivett lathe, and I guess I will be quitting about Saturday night."

It was a long speech for Jimmy, but he had been getting madder every minute since the call-down. And then what do you suppose the inconsistent S. M. M. went and did? Told Jimmy he was not fair to the man who had made him what he was. Pulled all the loyalty stuff you read about in speeches at banquets, but seldom see practiced toward the fellow with the dinner pail. And threatened to prevent Billson from making Jimmy's press, because he saw it first, no matter if he had turned it down. The idea was due to working in his shop, and it was his even though it was not worth two hoots in Halifax. But, of course, as a matter of fact, he did not interfere at all.

Fortunately, there are other brands of self-made men. But this tendency is one to be guarded against the minute you begin to feel that you are really going to be successful, because if you wait until you really are, nothing short of an earthquake can make you believe that even the whole solar system is not tied up close to you in some mysterious way.

I do not expect to need to practice preparedness of this kind for some time to come.

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Circle Punch Provided with a Disappearing Pilot

BY JAN SPAANDER

We often had to mark slate and copper to be drilled and punched. As the material was not to be otherwise defaced, we made circles with compasses. Their points



CIRCLE PUNCH WITH DISAPPEARING PILOT

often slipped and scratched the work. We made up a set of circle punches, and to make sure that the circle had its center at the right spot we provided the punches with a disappearing pilot, as shown in the illustration.

Editorials

Productive Capacity

In 1886 Henry R. Towne presented a paper to the American Society of Mechanical Engineers entitled "The Engineer as an Economist." Since that time engineers have been paying more and more attention to economics, for their work is essentially that of effective economy. So far has this movement progressed, that the keynote session of the annual meeting of the American Society of Mechanical Engineers, held during the first week in December, is devoted entirely to economic subjects. The broad topic is "The Valuation of Industrial Property."

One of the papers written by Henry L. Gantt discusses productive capacity as a measure of value of an industrial property.

At the outset, two leading theories are outlined as to what the cost of production in an industrial plant consists of. These are stated to be:

A. That the cost of an article must include all the expense incurred to produce it, whether such expense actually contributed to the desired end or not.

B. That the cost of an article should include only those expenses actually needed for its production, and any other expense incurred by the producer for any reason whatever must be charged to some other account.

When a plant is operated at its full capacity, both theories give the same cost. At less than full capacity the expense of carrying idle machinery, according to the first theory, is added to the cost of the product. This makes the cost greater than during a period of full production. According to the second theory, the expense of idle machinery due to incompletely utilized capacity is carried in a separate account and is deducted from the profits. Thus, if all other factors are the same, the cost remains constant, whether the plant is working full or at partial capacity.

Mr. Gantt then builds upon the second theory and says that in determining the value of an industrial property the consideration of prime importance is "the ability of that plant to accomplish the object for which it was constructed." This is equivalent to saying that the value of an industrial plant must be measured according to its value to produce.

This is a far different measure from those commonly employed. The usual methods have been either to value according to what the plant cost, or according to the amount that it would take to replace it at the date of valuation. Both of these are now brushed aside by Mr. Gantt. He refuses to consider the amount of money originally spent in producing the plant, likewise he argues that the cost of reproducing it is not its measure of value, for it is possible that under no conditions could it be made efficient as a producing unit. But going back to the fundamental idea that an industrial plant is made to produce some commercial article, he states that the measure of its value is its capacity to so produce.

Once we accept this standard, other things come into consideration besides the brick and mortar, machinery and tools that constitute an industrial plant. A part of the producing capacity is the organization and management. These now become factors in measuring its value.

Social Responsibility of Employers

Every employer has a feeling of satisfaction in knowing that human waste is being prevented through a minimizing of industrial accidents. Manufacturers' associations have been the leaders in the great safety-first movement that has contributed so much to the welfare of society. The proper question now is, Have employers any further responsibility with regard to the well-being of the community?

Some have already answered "Yes" by establishing employees' service work, with a purpose of adding to the health and happiness of their working people.

Public health officers in our better managed communities have done about all that can be done to stamp out epidemics and preserve general health, but their work deals with persons in the mass; it is curative rather than preventive.

From what source, then, can come the initiative that will make possible for the individual all the preventive means that can and should safeguard his health? Not only is the employee vitally interested in his own health, but his employer is likewise. From this standpoint of mutual interest health coöperation in industrial plants can become so operative that it will lighten society and lead on to social betterment. This course seems to be one that is promising.

The extent to which this work is now being done is indicated by the fact that not long ago at one of the conventions of the American Medical Society some two hundred and fifty physicians in industrial practice banded together in an organization of their own. Figures are not available to indicate how many plants are served by these men, nor the number of employees whose health they are caring for. The total number must be very large.

These two hundred and fifty men and their employers have seen a social responsibility, else their work would not have been started.

In discussion of the newer methods of shop management a few years ago emphasis was placed upon the application of the principle of "transference of skill." This was directed toward the operations of manufacturing.

When it is realized that a majority of the employees in industry never had an adequate physical examination in their lives, and that many never had dental work of any kind done, it must also be believed that the common habits of good bodily care are not practiced as they should be.

So employees' service is but an extension of the principle of transference of skill. Through the trained directors of service departments some employers are transferring from the great fund of human knowledge the best of skill in the care of the body to those who are unacquainted with many of the commonest facts of hygiene and sanitation.

From this viewpoint the social responsibility of the employer is to help in the great task of teaching men how to live.

Professor Sweet's Book

For nearly sixty years Professor Sweet wrote for the technical press, and many of his articles and letters appeared in this journal. But only one book written by him has ever been published. This is a small volume, knitting together truths on machine design that had previously appeared in the *American Machinist*. The title did not reveal its contents, nor even hint at its worth, for it was unfortunately called "Things That Are Usually Wrong."

After Professor Sweet's death there was found among his effects the manuscript of a book upon which he had evidently worked for a number of years. His own title is "A Book on the Looks and Details of Machines." This matter is now to be published in the *American Machinist*, the first installment appearing in this issue on page 979. The purpose behind its preparation seems in a way to be revealed in a letter written by Professor Sweet and published toward the latter part of last year, Vol. 43, page 936. Its title is "The Best Way To Do Certain Things." The greater part of it is:

"The thought came to me: Would it not be a good thing to collect a lot of plain statements of the best way of doing certain things—things that mechanical engineers and draftsmen and machinists ought to know, nothing for the class in engineering to learn from textbooks or to be found only in handbooks, but things that can be grasped in reading the *American Machinist*? For example, the best way to put a wheel or lever on the end of a shaft, particularly if it is one that has to be removed and replaced, is to put it on a fairly steep taper and fasten it by screwing a nut on the end of the shaft, and if it is something that must occupy a fixed position, a key will serve to locate it.

"Another thing is to secure a rocker arm on a shaft. The best way is to put in a feather on a line with the arm, put on a boss for a grip bolt opposite, split the hub, put a bolt through the boss and screw it up.

"The best way to put in an oil hole where the end of a shaft runs in the box is to drill a good-sized hole in the end of the shaft half as deep as the boss is wide. Drill a small hole from the outside, plug the big hole with a brass plug, with a hole in its center for the nozzle of a squirt can, and stamp it 'Oil.'

"I believe the readers of the *American Machinist* can add to this list innumerable examples of this kind."

His hitherto unpublished book manuscript is a collection of details and devices that in Professor Sweet's experience were "the best way to do certain things."



Selecting Cutting Lubricants for Different Conditions

The question of cutting lubricants or coolants in connection with many kinds of machine work seems to be still open to discussion. It seems to depend very largely on the particular stock that is being worked and not so much on the grade or class to which the stock normally belongs as to the particular lot that is being machined, whether supplied by the same or different makers.

There is in most shops, unfortunately, no provision made for accurately recording the changes of coolant in connection with each kind or lot of stock. The main object is production; and a little more of this or a little

less of that has always been the rule, just as the best cooks use a "pinch" of salt, a "dash" of pepper and other ingredients "according as," as one noted queen of the kitchen said when asked for her recipes. So, to a great extent, it seems to be with the mixing of cutting compounds.

Nor is this necessarily an evidence of poor management, because there are no fundamental data on which to base the proper mixing of compounds. Many shops have run tests of various mixtures and have arrived at what seems to be definite conclusions. And then a new kind of stock comes along, and the mixture has to be changed to do the trick.

It is very much like the cook previously referred to; the compound must be "seasoned" to meet the conditions of the particular case, and to carry the simile still farther, we have no more means of determining the proportion in advance than the cook has in seasoning the Thanksgiving turkey. It seems to be a cut-and-try proposition in both cases, guided of course by previous experience with similar steels or foods, as the case may be.

Just as an example, we may cite a case that happened on shell work. The steel was tough and came off in long curling chips that were not only a nuisance, but dangerous to the operator. A chip breaker was demanded; but before one could be made, the production man, who was fortunate in having a wide experience, tried a change in the cutting compound, which cured the trouble. He added enough oil to the compound to make the body heavier, and the chips broke off in short pieces that gave no trouble.

The theory is that it cooled the chips more quickly and made them brittle enough to break, instead of leaving them tough enough to curl, as before. At any rate, it worked. But it shows the difficulty in deriving absolute formulas to fit all conditions.



Safety Devices as Handicap to Production

The contention that safeguards to machinery are a hindrance to output is being unwisely made; but if a factory safeguard is inconvenient to use, this fact alone is sufficient reason for a workman to disregard it. There has always been some difficulty in keeping safety devices on machines and in good working condition. It is the employer's duty to supply such guards; it is the workman's duty to use them in the proper way.

If guards are persistently removed, or not used as they should be by the workman, perhaps the only course for an employer to pursue is to post a notice that if a workman receives an injury because a safeguard was not in proper working condition the man, after receiving the medical or surgical treatment that is his due, is automatically discharged or suspended.

On the other hand, if a safety device handicaps production, it is but fair that an allowance should be made when setting the piece price or time limit for the job. In this latter connection it must be remembered that safety devices are largely a matter of evolution. Any earnest start in developing them, applying and using them, is better than nothing. Thus whatever can be done to bring about their proper use is well worth while. The need of education in safety is ever with us, for there is a limit to the accidents that can be prevented by safeguarding.

Shop Equipment News

Screw Machine Provided with Bar-Handling Equipment

In Fig. 1 is shown a screw machine with all-gear head equipped for work from the bar. This machine is built by the Foster Machine Co., Elkhart, Ind., and with the exception of the bar-handling equipment is the same

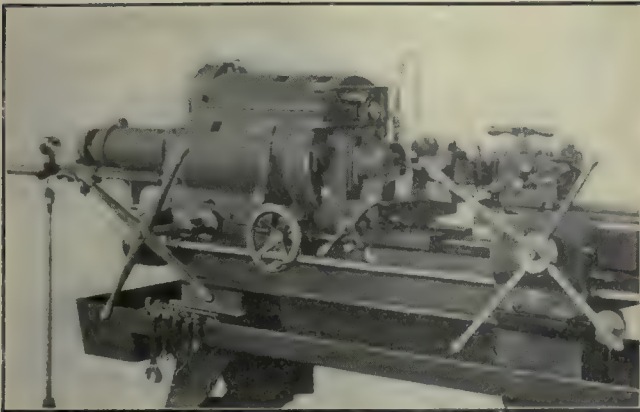


FIG. 1. SCREW MACHINE EQUIPPED FOR BAR STOCK

as the machine described on page 567. The equipment manufactured by the maker of this machine covers all requirements.

In Fig. 2 are shown a few of the tools used on bar work. It will be observed that, although of heavy construction, they can be conveniently manipulated. At the left in Fig. 2 is the single cutter roller turner. This type of turning tool is well known. The tool shown is provided with a slide operated by the vertically disposed lever. This controls the position of the cutter relative to the rolls. On the completion of a turning cut the operator throws the lever actuating the slide, the tool is withdrawn from the cut, and the roller turner can be run back over the finished surface of the work without marring it. The next tool is the multiple-cutter turner. This tool is built with as many as six tools and will handle work in which the shoulders are only $\frac{1}{4}$ in. apart. Next is shown the boring and recessing tool holder, and at the right is shown the adjustable hollow mill.

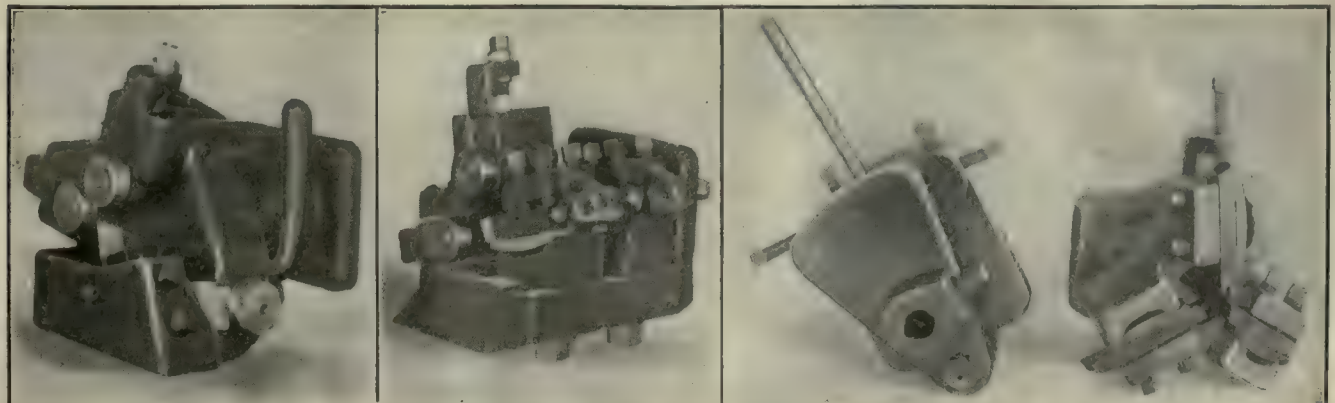
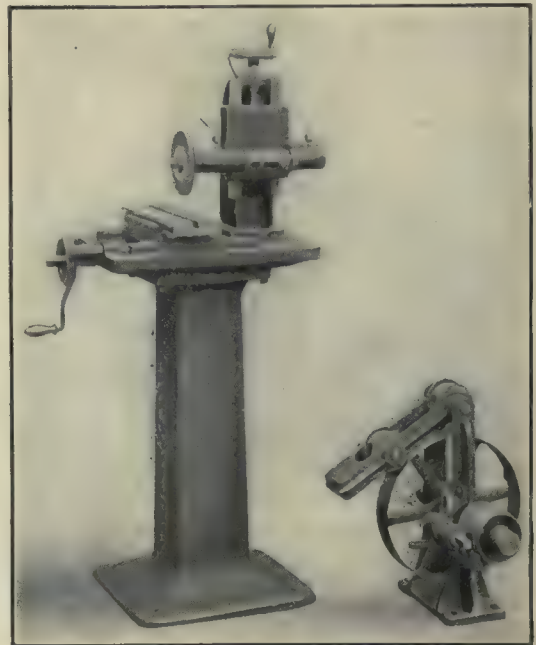


FIG. 2. TOOLS FOR HANDLING BAR STOCK IN ALL-GEARED HEAD SCREW MACHINE

Hand Surface Grinder

The general design and construction of the hand surface grinder shown are apparent from the illustration.

All sliding surfaces are provided with adjustable gibs. Handwheels on the traverse feed and raising screw, each having an indicator graduated to thousandths, give fine adjustments in all directions. The platen is moved end-



HAND SURFACE GRINDER

Capacity for surfaces, 9x6x5 in.; traverse movement of platen, $9\frac{1}{2}$ in.; size of emery wheel, 6x $\frac{3}{4}$ in.; $\frac{1}{2}$ -in. hole; surface of platen, 15x5 in.; adjustment in line with spindle, 6 in.; spindle adjustment above platen, 1 to $7\frac{1}{2}$ in.; width of driving belt required, $1\frac{1}{2}$ in.; floor space required, 27x23 in.; height from floor to top of platen, 36 $\frac{1}{2}$ in.; weight, domestic shipment, 500 lb.

wise by a crank fitted to the square end of a shaft operating a pinion, which in turn meshes with a rack on the bottom side of the platen. The crank can be easily removed and used on the square shaft in front of the handwheel on the traverse feed, if faster movement is desired than that provided by the rack and pinion.

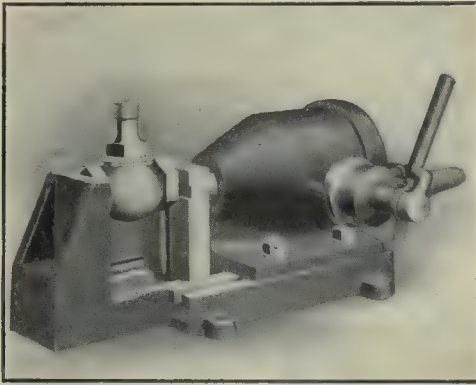
The spindle slide works on a rigid upright provided with scraped ways. The spindle is of crucible steel ground and fitted to reamed and scraped bearings. Both bearings are cast solid, the front bearing being tapered to fit the spindle, the rear one solid but split on one side to permit a take-up. The spindle has take-up nuts for adjusting end play and wear.

The machine shown is a recent product of the American Machine Tool Co., Hackettstown, N. J.

Air-Operated Vise

The form of air-operated vise shown requires little explanation. It is a recent product of the Hannifin Manufacturing Co., Chicago, Ill., and was designed to be especially adapted for assembling work as well as application to the drilling machine and miller.

The closing of the vise is instantaneous with the application of air. The design is such as to permit the



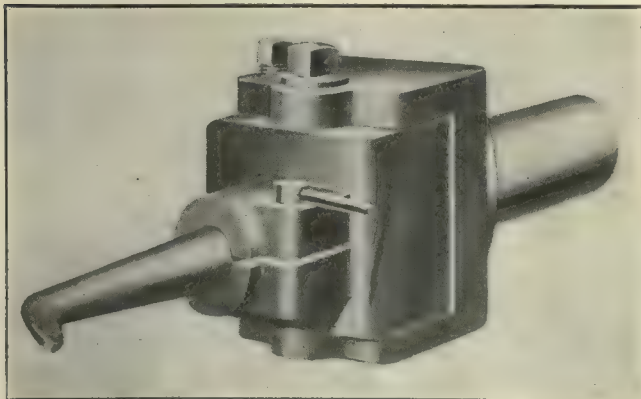
AIR-OPERATED VISE

Capacity without jaws, 7 in.; height of jaw, 5 in.; length over all, 19 in.; stroke of piston, 2 in.; bore of piston, 6 1/2 in.; weight, 80 lb.

use of false jaws, similar to those used in a chuck, or the use of plain hardened-steel jaws. The controlling valve can be attached to the side of the vise or located at any other convenient position.

Adjustable Boring Tool

The illustration shows an adjustable boring tool manufactured by the Pierce Machine Tool Co., Chicago, Ill. The tool is intended for boring holes up to 1 1/4 in. in



ADJUSTABLE BORING TOOL

diameter, but holes larger than this can be readily bored by making the necessary simple adjustments of the tool itself.

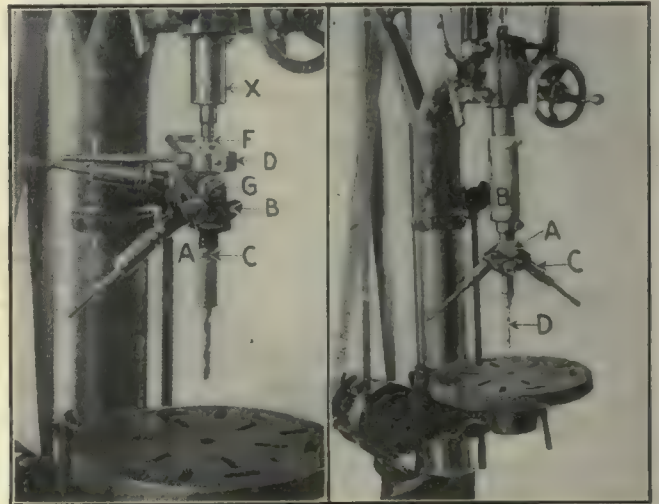
The construction is simple and strong, and adjustments are easily and accurately made by means of a screw. Clamping is by means of a lever, eliminating the use of wrenches for this purpose. The cutting edge of the tool in any position of adjustment coincides with a line drawn through the center of the hole being bored.

Drilling Turret Attachment

The drilling turret attachment shown was designed for manufacturing purposes where a number of operations are to be performed on interchangeable parts.

The illustration at the left shows a plain drilling-machine turret head, which requires little explanation. When the position is changed, the knob *A* is pulled and the plunger locates the drill in the center line automatically in the hole *B*. The shank *C* can be made for special chucks or with taper to fit any standard chuck. *D* is the stop rod that prevents the body from rotating. The turret is driven in the usual manner by the taper shank *F*. The body pivots on the pin *G*. When the spindle *X* is raised, the drill spindle *C* stops immediately.

The illustration at the right shows a similar drill turret with an automatic stop. When the knob *A* is pulled, the drill *D* stops immediately without raising the



DRILLING TURRET ATTACHMENT

spindle. This also shows a sleeve *B* attachment to the spindle, which is desired where the tool is used steadily, and can be made for several sizes of drilling machines. In no case is it necessary to stop the drilling machine when the position of the tool is changed. The turret on this style is made for taper-shank drills. The drift hole is at *C*. The position can be changed in one second while the drilling machine is in motion.

The tool is so designed that the operator can change it without moving from his working position. It is made in several sizes, from two to five spindles and for high-speed drills, by Charles Eisler, 43 Dodd St., Bloomfield, N. J.

Die-Forming Machine

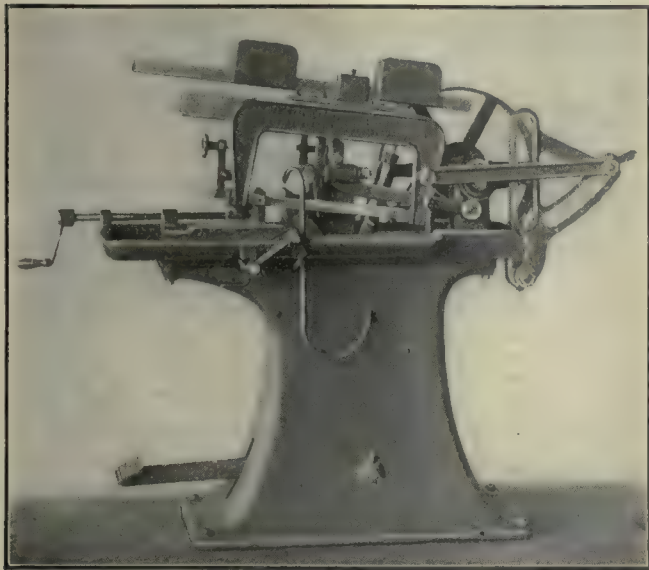
The die-forming machine made by the Anderson Die Machine Co., Bridgeport, Conn., which was illustrated and described in detail on page 611, Vol. 43, and page 612, Vol. 45, is now available with belt-drive equipment.

Hacksaw Machine

The hacksaw machine shown is a recent product of the L. S. Starrett Co., Athol, Mass., and represents its first departure from its tool-manufacturing line.

The form of stroke adjustment incorporated makes possible a stroke of practically the full length of the blade, no matter what size of stock. The foot treadle for raising the saw frames eliminates all exertion on the part of the operator, at the same time making possible greater speed.

An oil dashpot controls the descent of the saw. This dashpot allows the machine to be started when the frame



HACKSAW MACHINE

Capacity, for 14-in. saws; height over all, 48 in.; height to top of table, 28 in.; floor space, 14x32 in.

is up and prevents it from dropping and breaking the saw. It further eases the blade onto the work, so that the teeth do not bite in so rapidly as to strip them or break the saw. An automatic locking device prevents the saw from dragging on the return stroke and holds the saw frames at any height when the machine is stopped for setting work.

The saw frame is mounted on a rectangular slide with a bearing 11 $\frac{1}{4}$ in. long, provided with an adjustment for wear. A quick-acting saw tightener to hold the blades square is also provided. The stroke of the saw is adjustable for stock from 1 to 6 in. in diameter.

A pump and lubricant tank are located inside the base and may be quickly removed for cleaning.

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Bullard Production-Bonus Plan of Wage Payment

An extension of the "Maxi-Pay Wage Plan" described on page 922, Vol. 44, has been made by the Bullard Machine Tool Co. It is a method of establishing efficiency and paying bonus. The announcement of the company reads:

Standard Time—A standard time for production will be established, whenever possible, for each operation. This standard will in all cases be the time in which the operation can be performed on a given piece or number of pieces with the tools and equipment available when time is set. Standard time will remain unchanged for one

year from date, provided no change is made in designs of piece, material, number of pieces, method or equipment. Such changes, if made, will be equitable in every sense both to the operator and to the company.

Trial Time—On new work, or old work done in new ways or with different equipment, it is not always possible to establish an equitable standard time without actual experience as a guide. In such instances a trial time will be set, and the operation performed thereunder will be subject to such future change, either increase or decrease, as may be indicated by the experience gained. Trial time will be considered as standard time in bonus calculations and payments. Standard-time conditions will thereafter prevail.

Efficiency—Skill plus energy and well-directed effort result in efficiency. Efficiency records will be expressed as a percentage obtained by dividing standard time by actual time, thus:

$$\begin{array}{l} \text{Standard time} \dots\dots\dots 200 \text{ hr.} \\ \text{Actual time} \dots\dots\dots 200 \text{ hr.} \end{array} \left\{ \begin{array}{l} \text{Standard time} \dots\dots\dots 175 \text{ hr} \\ \text{Actual time} \dots\dots\dots 200 \text{ hr} \end{array} \right. \text{ or } \left\{ \begin{array}{l} \text{Efficiency} = \frac{200(\text{standard hr.})}{200(\text{actual hr.})} = 100\% \\ \text{Efficiency} = \frac{175(\text{standard hr.})}{200(\text{actual hr.})} = 87\frac{1}{2}\% \end{array} \right.$$

Production Bonus—A production bonus of 1 per cent. of the wages will be paid for each per cent. of efficiency above 75 per cent. If a man performs his work in standard time, he will have an efficiency of 100 per cent. and will receive a production bonus of 25 per cent. of his wages. A record of each man's contracts will be kept. One column will show standard time on each job, and another column will show actual time. The columns will be added up once every month and the sum of the standard times divided by the sum of the actual times. The result is the man's monthly efficiency, upon which production bonus will be paid.

Payment of Bonus—Efficiency will be computed at the end of monthly periods, all contracts completed during each period being included. Weekly wages, at class rates under the "Bullard Maxi-Pay Wage Plan," will be based on clock time.

Advancement—It is the intention, not only to pay a production bonus in proportion to a man's efficiency, but also to use the efficiency records as a basis for advancement from one class to another. Apprentices upon completing their courses will be rated according to the average efficiency records computed over the last three months of their apprenticeship.

✱

Tempering Round Dies

BY ALFRED J. SHIRLEY

A number of circular dies of carbon tool steel for use in tool holders of turret lathes were required. No proper tempering oven was available, so the following method was adopted and proved quite successful.

After the dies had been hardened dead hard in water, they were cleaned up bright. A pair of ordinary smiths' tongs was made with jaws of heavy material and to fit nicely all around the outside of the die, leaving a $\frac{3}{8}$ -in. space when the jaws were closed around the die. The dies being all ready, the tongs were heated red hot, and the dies were picked up and held by the tongs. This tempered them from the outside in, left the teeth the temper required and the outside slightly softer. The dies held up the work successfully and were better than when tempered in the same bath.

Tables To Assist in Setting Piece Prices on Automatics

By J. BURGESS

To set the piece-work price on work being done on Brown & Sharpe or Gridley automatics, one cannot go very far astray if he confines himself to Table 1.

The prices given are on the basis of \$0.09 per hr. for each machine, allowing 25 per cent. for lost time such as

TABLE 1. GRIDLEY AND BROWN & SHARPE AUTOMATIC MACHINES

Piece Work on Basis of 9c. per Hr. per Machine and 25 Per Cent. Allowed for Lost Time

Time per Piece in Minutes	Seconds	Price per Hundred	Time per Piece in Minutes	Seconds	Price per Hundred
0.05	3	\$0.01	0.8	48	\$0.16
0.1	6	.02	0.85	51	.17
0.15	9	.03	0.9	54	.18
0.2	12	.04	0.95	57	.19
0.25	15	.05	1	60	.20
0.3	18	.06	1	..	.40
0.35	21	.07	3	..	.60
0.4	24	.08	4	..	.80
0.45	27	.09	5	..	1.00
0.5	30	.10	6	..	1.20
0.55	33	.11	7	..	1.40
0.6	36	.12	8	..	1.60
0.65	39	.13	9	..	1.80
0.7	42	.14	10	..	2.00
0.75	45	.15			

stocking up the machine, grinding tools and so forth. The table gives two columns of figures, one headed "Time per piece in minutes." This column gives the minutes, divided, first in hundredths and then in seconds. The other column is headed "Price per hundred." This column gives the price per hundred pieces that one will be expected to pay for work when the time consumed corresponds with the time in the column to the left.

For example, should it require 2.85 min. or 2 min. and 51 sec. to make a piece, the price per hundred will be the total of the price for 2 min., which is \$0.40, and 51 sec., which is \$0.17, making a total of \$0.57. This table is very elastic, and the desired result can be had

by adding or multiplying, as the case may require. For instance, if it should require 16 min. to make one piece, you can either multiply the cost of an 8-min. piece by 2, a 4-min. piece by 4, or you can add the cost of a 6 and a 10-min. piece, and the result will be the same.

Table 1 is being used successfully in one of the largest factories in Buffalo, N. Y., and is giving satisfaction to both employer and employee. You may ask, "How much will an operator make out of it, if by chance he should have one or two of his machines down for repair?"

In this event we allow the man to ring in a machine-repair card and allow him \$0.09 per hr. for full auto-

TABLE 2. POTTER & JOHNSTON SEMI-AUTOMATIC MACHINES
Piece-Work Prices Computed on Basis of 10c. per Hr. per Machine and 25 Per Cent. Allowance for Lost Time

Time per Piece in Minutes	Seconds	Rate per Hundred	Time per Piece in Minutes	Seconds	Rate per Hundred
0.1	6	\$0.022	12	..	\$2.64
0.2	12	.044	13	..	2.86
0.3	18	.066	14	..	3.08
0.4	24	.088	15	..	3.30
0.5	30	.11	16	..	3.52
0.6	36	.132	17	..	3.74
0.7	42	.154	18	..	3.96
0.8	48	.176	19	..	4.18
0.9	54	.198	20	..	4.40
1	60	.22	21	..	4.62
2	..	.44	22	..	4.84
3	..	.66	23	..	5.06
4	..	.88	24	..	5.28
5	..	1.10	25	..	5.50
6	..	1.32	26	..	5.72
7	..	1.54	27	..	5.94
8	..	1.76	28	..	6.16
9	..	1.98	29	..	6.38
10	..	2.20	30	..	6.60
11	..	2.42			

matics and \$0.10 per hr. for semi-automatics, as the case may be.

In Table 2 the price is based on \$0.10 per hr. for each machine and 25 per cent. allowance for lost time, such as adjustments, truing up work in chuck, grinding tools and so forth.

Table 2 is for use in connection with Potter & Johnston semi-automatic machines.

New Publications

Hendricks Commercial Register of the United States—Twenty-fifth annual edition. Seventeen hundred and thirty-eight 7¼x10-in. pages. Published by S. E. Hendricks Co., Inc., New York City. Price, \$10.

The appearance of this commercial register has become an annual event in the industrial world.

The new edition maintains its long established reputation. It represents an extensive revision and the addition of considerable new information, useful to both buyers and sellers.

A conspicuously new feature is the section devoted to a list of trade names, which is calculated to be a useful adjunct to this commercial guide.

Canadian Trade Index. Five hundred and sixty 6¼x10-in. pages. Published by Canadian Manufacturers' Association, Toronto, Canada. Price, \$5.

In the 1916-18 edition of this index, the latest to appear, a dependable list of the articles made in Canada and the names of the manufacturers making them, is provided.

A total list of about seven thousand five hundred firm names is given.

Practical Safety Methods and Devices—By George Alvin Cowee. Four hundred and twenty-seven 6x9-in. pages; 127 illustrations; indexed, clothbound. The Van Nostrand Co., New York City. Price, \$3.

This work is intended as a treatise on safety methods and devices for employers, superintendents, foremen and others who come in direct contact with problems in safeguarding industrial workers. There are 28 chapters covering a wide range of applications of safety devices, including those for boilers, engines, elevators, machine tools, grinding machinery and woodworking machinery.

Many of the devices shown are patented and the product of some manufacturer. Many others are taken from the reports and records of bodies

such as the National Foundrymen's Association. While the information in the book is unquestionably of value, it does not seem to present anything new on the subject of safeguards and safety methods.

Trade Catalogs

Flexible Shafts and Portable Tools. Stow Manufacturing Co., Binghamton, N. Y. Bulletin No. 102. Illustrated. Pocket size.

Pumps. Trahern Pump Co., Rockford, Ill. Catalog No. 42. Pp. 46; 5¼x9 in.; illustrated. This shows circulating, lift and force pumps, etc.

Business Item

The Hydraulic Press Manufacturing Co., Mt. Gilead, Ohio, has completed plans for extensive plant and equipment improvements. The improvements consist of one new building and extensions to the machine shop, power house, stock room, toolroom and erecting-shop buildings. To relieve the crowded condition of the machine shop an addition 100 ft. long by 60 ft. wide will be erected. Considerable new machine-shop equipment will be needed for this addition, including a 20-ton electric traveling crane, a large motor-driven horizontal boring mill and a heavy-duty motor-driven planer.

Graves Machinery Exchange has taken over the business of the recently dissolved Co-Operative Used Machinery Co. The new company will specialize in handling the larger tools and has arranged to keep the former organization intact. The same offices at 50 Church St., New York City, will be occupied.

Forthcoming Meetings

Society of Automobile Engineers. Annual meeting, Jan. 9-11. United Engineers Building, New York City. Colver F. Clarkson, secretary, 29 West 39th St., New York City.

American Society of Mechanical Engineers. Monthly meeting, first Tuesday. Calvin W. Rice, secretary, 29 West 39th St., New York City.

Boston Branch National Metal Trades Association. Monthly meeting on first Wednesday of each month, Young's Hotel. W. W. Poole, secretary, 40 Central St., Boston, Mass.

Providence Association of Mechanical Engineers. Monthly meeting, fourth Wednesday of each month. J. A. Brooks, secretary, Brown University, Providence, R. I.

New England Foundrymen's Association. Regular meeting, second Wednesday of each month. Exchange Club, Boston, Mass. Fred F. Stockwell, 205 Broadway, Cambridgeport, Mass.

Engineers' Society of Western Pennsylvania. Monthly meeting, third Tuesday; section meeting, first Tuesday. Elmer K. Hiles, secretary, Oliver Building, Pittsburgh, Penn.

Rochester Society of Technical Draftsmen. Monthly meeting, last Thursday. O. L. Angevine, Jr., secretary, 857 Genesee St., Rochester, N. Y.

Superintendents' and Foremen's Club of Cleveland. Monthly meeting, third Saturday. Philip Frankel, secretary, 310 New England Building, Cleveland, Ohio.

Western Society of Engineers, Chicago, Ill. Regular meeting, first Wednesday evening of each month, excepting July and August. J. H. Warder, secretary, 1785 Monadnock Block, Chicago, Ill.

Philadelphia Foundrymen's Association. Meetings first Wednesday of each month. Manufacturers' Club, Philadelphia, Penn. Howard Evans, secretary, Pier 45 North, Philadelphia, Penn.

Technical League of America. Regular meeting, second Friday of each month. Oscar S. Teale, secretary, 35 Broadway, New York City.

Making Typewriter Type--I

By FRANK A. STANLEY

SYNOPSIS—The type-making processes in this establishment include the engraving of a die block from a templet made from an original drawing 50 times as large as the type is to be, and from this die block the working type are rolled up in semi-automatic machinery. A number of important milling, grinding and piercing operations are required in the preparation of the type blanks and in finishing them after the type characters have been rolled upon the bodies. All the locating of the type for milling, piercing and other operations subsequent to the rolling up of the characters upon the face is done by means of two crosses, known as locating points, which are formed on the type along with the working characters.

In an earlier issue an article was presented describing the methods of the Noiseless Typewriter Co., Middletown, Conn., in engraving the die blocks for rolling, or kneading, the type for its typewriters. It is the purpose of the present article to illustrate some of the methods and equipment utilized for making the type, including both the forming up of the type characters by means of the dies and the operations that follow in making the type bodies and testing them prior to assembling upon the type bars.

OPERATIONS ON THE BLANKS

The blanks for the type are made in the pressroom by punching out of flat stock, then bending to the desired angle. The press tools for this work, Fig. 1, consist of

The bending die shown at the right in Fig. 1 is one of a series of simple dies for the different type blanks required, each at different angles. The dies for these different angles are easily put into position in the bolster when required.

The type blanks are made in large quantities. Fig. 2, taken in one corner of the type-making department, gives some idea of the extent to which the blanks are put through and into stock, ready for machining into finished typewriter type. This view shows a set of 15

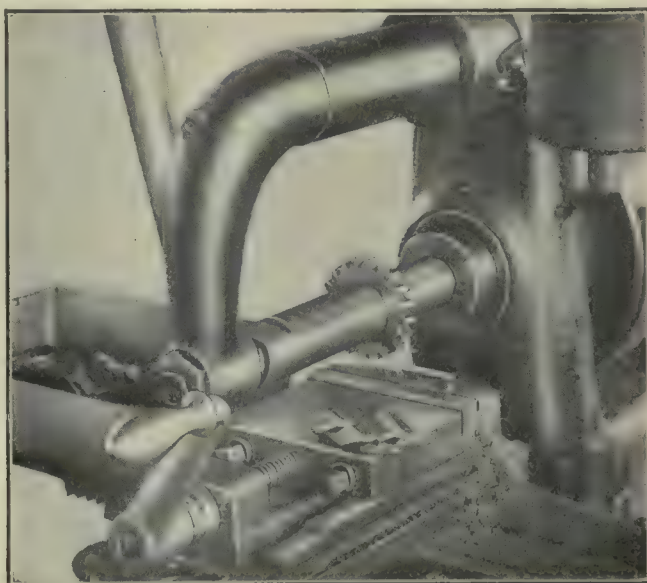


FIG. 3. FORM MILLING THE WORKING ENDS OF THE TYPE BLANKS

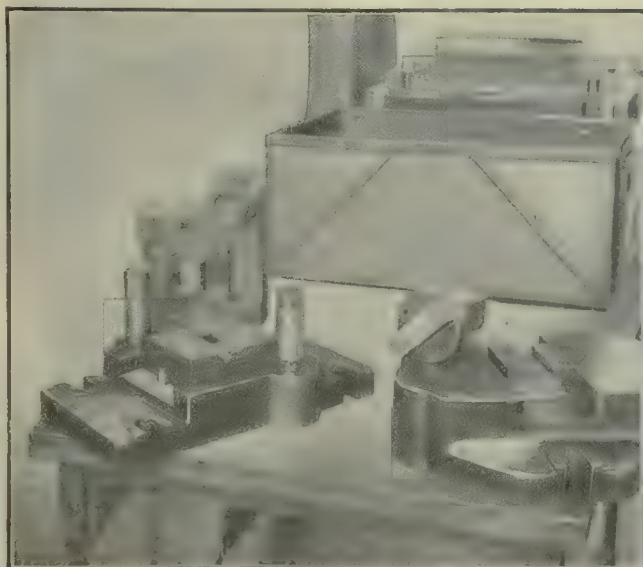


FIG. 1. BLANKING AND FORMING TOOLS FOR TYPE BLANKS



FIG. 2. STORAGE OF TYPE BLANKS IN TYPEMAKING DEPARTMENT

simple blanking and forming dies. The blanking dies are of the corner-post style, to preserve alignment and to prevent wear of cutting edges. The blank thus produced is not rectangular in form, the two end surfaces being at an angle of some 8 or 10 deg. to the edges.

drawers, completely filled with such blanks, and the cabinet forms only a part of the equipment for holding such material in the process of manufacture.

It will be recalled that the type bars in the Noiseless typewriter construction slide in toward a common central

point, each at different angles from the center line, so that the type fastened to the front end of the type bars have to be made at different angles to suit the respective angle at which each bar is carried in the machine. So far as possible, these angles have been grouped, thus making it unnecessary to produce a separate form of blank for each distinct angle. In other words, there are four kinds of type blanks: First, straight, which is used for five different type; second, 0.08-in. offset, used for four different type; third, 0.12-in. offset, used for four different type; fourth, 0.17-in. offset, used for two different type.

Whatever the angle of the blank, the first machining operation following the mere punching out and bending up of the blank is the milling of the edge—that is, the milling of the type end, the front end of the blank, to take off about 0.005 in. or so to give a good solid working space to start with in the rolling up of the type character. This milling operation is done with a form cutter having an angle of about 45 deg. at each side, to take off the corners of the work. This operation is clearly indicated in Fig. 3, and the nature of the various blanks as to angularity is well shown, one of each of the four kinds of blanks having been placed on

the corner of the vise before the photograph was taken. With reference to this point, examination of Fig. 4 will show the dimensions of the flat or plain blank, while details in Fig. 5 illustrate the sequence of operations on one of the bent blanks after the rolling up of the characters in the kneading machines has been accomplished. These drawings are presented at this point in order to give a clear idea of the nature and proportions of the type blanks themselves before entering into a detailed description of all the mechanical processes in the production of the working characters upon their edges. Figs. 6 and 7 illustrate the type-rolling machines designed and built by this company and found eminently satisfactory for the purpose for which they were intended. As will be noticed, they are very heavy machines, weighing probably a little over 3,000 lb. apiece. They are semi-automatic the feeding up of the work to the dies being accomplished by means of a long hand lever acting upon a slightly eccentric head to advance the die, or the work holder, to the cut. In the operation of this machine the die and the type blank are carried in facing heads adapted to operate to and fro in a vertical plane, and the two heads are rocked in unison by means of segmental gear. This keeps them moving in harmony while a pair of rolling plates, corre-

sponding to the pitch diameter of the gear segments, come in contact with one another to assure steadiness of operation. This prevents slipping or overlapping of the die in the work, which would be detrimental in the rolling

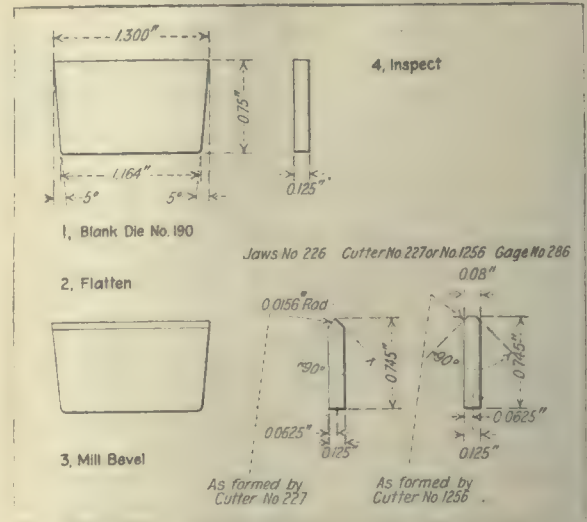


FIG. 4. TYPE-BLANK OPERATION SHEET

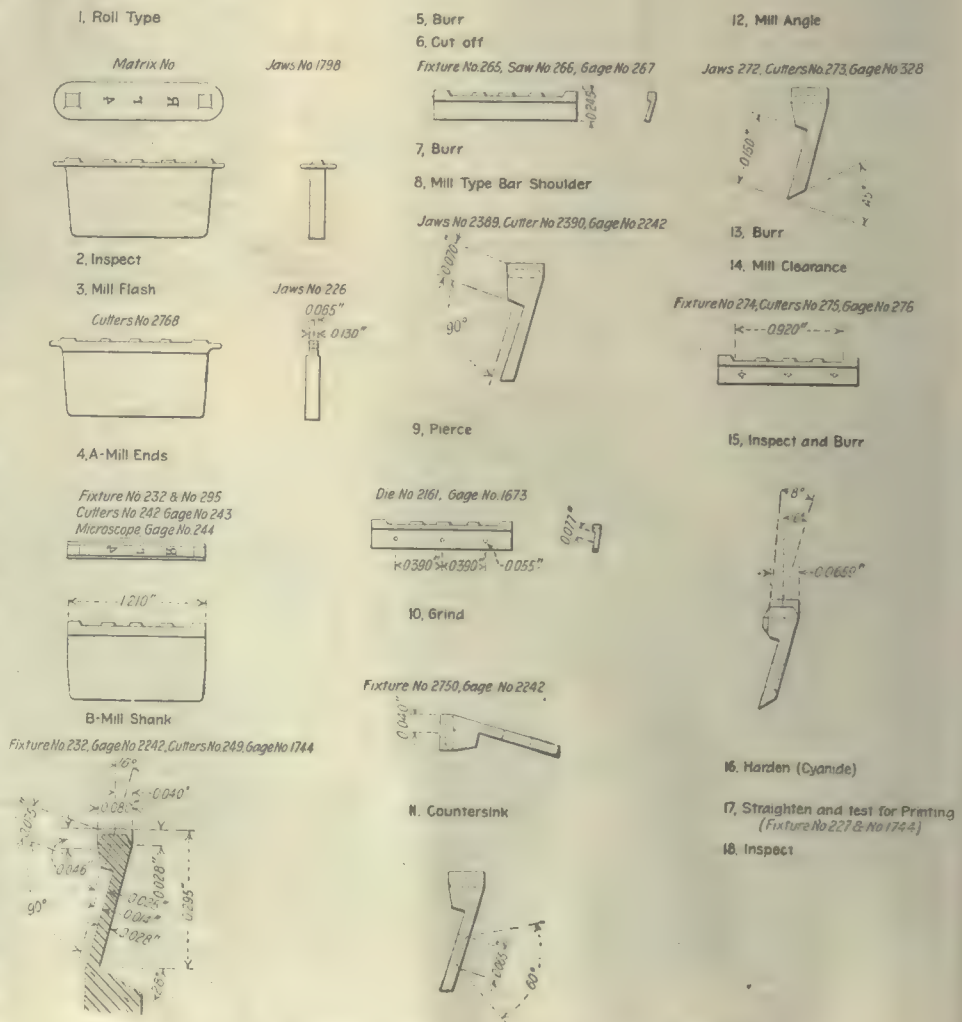
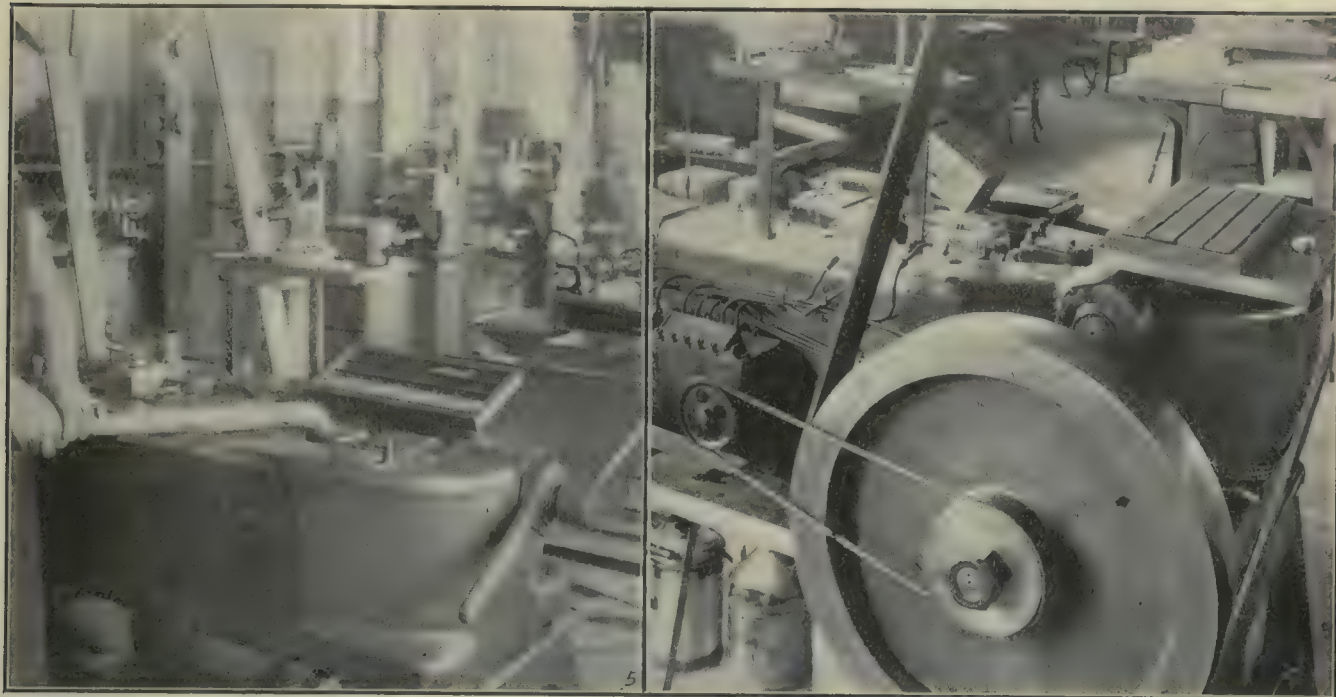


FIG. 5. ROLLING CHARACTERS ON TYPE BLANK

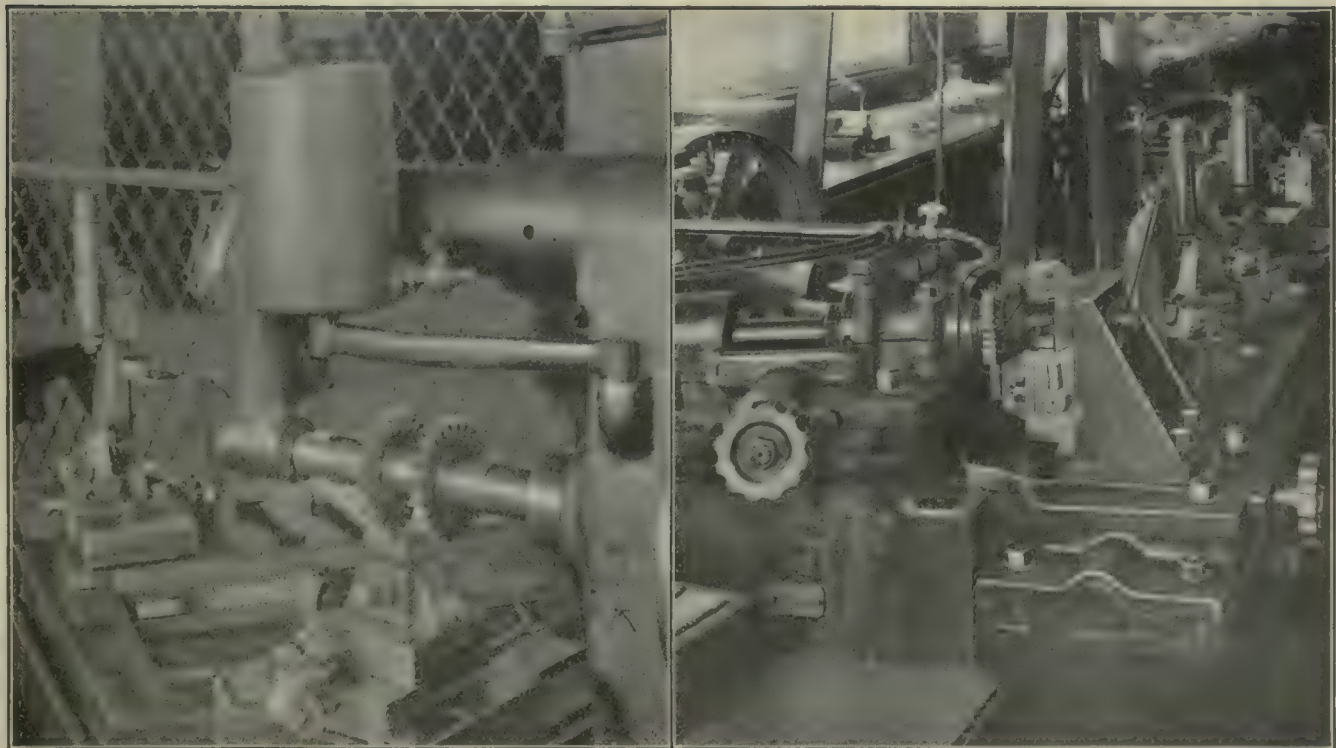
process and would correspondingly affect the accuracy in the finished type. This uniformity of action is further assured by the pressure spring acting against the right-hand head pushing the gear on that head forward. This

holds it always in contact with the gear on the left, so that the two hardened plates, corresponding with the pitch-line circles, are thus always kept in contact so that the teeth of the gears cannot enter into mesh too deeply.

eccentric serves to pull forward the work-holding block, thus crowding the work against the die as rapidly as the rolling operation will take care of the surplus stock presented to its working face. The rate of progress



FIGS. 6 AND 7. ROLLING TYPE IN SEMI-AUTOMATIC MACHINES



FIGS. 8 AND 9. STRADDLE-MILLING ENDS OF TYPE BLANKS

In Fig. 7 the head for carrying the work jaws and the type blank is shown withdrawn from position and set up on top of the machine, where it will come into the range of the observer. In operation, when this work-holding member is put back into place and the long hand lever is pulled around, it brings into action an eccentric portion at the end of the lever. This

forward is of course determined by the operator himself. His facility in the production of the type depends upon judgment and experience, as he must rely entirely upon the "feel" of the job as the metal proceeds and rolls on under the action of the kneading of the rolling die.

The operation of the machine is very rapid; it makes about 300 r.p.m. and a corresponding number of strokes.

The average production in rolling up the type characters on a blank is three per minute for each of the two machines. Ordinarily, it is not necessary to use more than one die for producing the characters on the type, but occasionally, for certain characters, it has been found desirable to use both roughing and finishing dies. Thus, in rolling such characters as the capital letters M and N or other characters where the corners are very sharp, there is more or less trouble in making the metal flow into these corners. In such cases the dies, as they become a little worn, are used later for roughing purposes and new finishers are made to take their place. This saves the finishing dies a lot of wear and tear and makes definite use for the worn dies in roughing. For characters having easier lines to work up in the rolling process, roughing dies are not necessary and they are never used in these machines.

In addition to the general design of these home-made type-rolling machines a feature of interest is the system of oiling applied at the left side, as shown in Fig. 7, this being an adaption of the automobile-lubrication idea.

AFTER THE ROLLING PROCESS

The operation of rolling up the characters on the end of the type blank forms a liberal flash or thin web all around the base of the blank, and the first operation after the blanks leave the rolling machine is to mill off this flash flush with the body of the blanks. The next process is the straddle-milling of the ends of the blanks, Fig. 8.

For holding the work in the vise for this straddle-milling operation the blank is set in a special fixture in the form of a double slide, as illustrated, admitting adjustment longitudinally or crosswise by means of micrometer screws. These adjustments are made use of in the following manner: At the left-hand side of the machine on the table will be seen standing a microscope. This instrument is provided with crosshairs and carries on its base a fixture similar to that shown on the cutters of the miller. These two fixtures are exactly alike in all respects. Once the work is set in place in the fixture, it remains in place for the straddle-milling operation and for the milling of the angular faces of the blanks in succeeding operations to be explained later.

Before the blank is straddle-milled on the ends, it is placed under the microscope with the crosshairs focused on the locating cross formed up by the rolling process at either end of the working face of the type. The micrometer screws are adjusted in both directions to center the type bodies in a certain definite position to which the miller tables have been set. After the type has thus been set up in the fixture, it is put into place in the special holder on the table of the miller cutters and the ends faced off in the manner indicated. The table is then withdrawn. Without taking the work out of the special holding fixture, the latter is placed in the special miller, Fig. 9. Here the sides of the type body are milled with a pair of bevel cutters to the required angle with reference to the working face. In previous milling operations a small amount of material has been left for grinding the top and the exact height from the bottom of the type bar after the type has been riveted in place.

In the double miller with the angular cutter just referred to, the work is fed up between the cutters, then returns to the bottom position automatically. Here it

is stopped by means of the controlling lever at the side, which has a connection with the countershaft and a brake on the counter, which stops the work travel at the lower point. This machine is driven at the bottom by mechanism in front of the knee, which raises the knee and feeds the work between the cutters. The machine answers for all different angles of type blanks, heads or work-carrying brackets, being provided with a swivel. Graduations may thus be set to suit different letters.

Following the milling operations in this double-spindle machine, the blank is removed from the special holder and another one set in place by adjustment by the micrometer, as indicated.

✂

Making Accurate Thread Rolls

BY GEORGE H. HAMILTON

The making of thread rolls for use on the screw machine or turret lathe is a problem that worries many mechanics. Thread rolls for producing threads on brass, bronze or copper parts do not give anywhere near the same amount of trouble as those used on steel. In fact, the difficulties experienced in rolling threads on steel parts has led many manufacturers to give up any attempt to produce them. The greatest difficulties are experienced in getting the roll hard enough and at the same time prevent it from crumbling. A careful analysis will disclose the fact that the action between the roll and the work is constantly changing as the roll is pressed into the work, resulting in a crowding action that tends to change the helical convolutions or threads on the roll into annular convolutions. In other words, the tendency is to straighten the threads. To overcome this action, it is necessary to have the roll much harder and tougher than the work, and at the same time not brittle enough to cause crumbling.

The first question to consider in the making of a thread roll is the selection of a suitable material—chrome-nickel steel, vanadium steel, high-carbon tool steel, etc. Chrome-nickel steel gave fairly good results, but great difficulty was experienced in obtaining uniformity in hardness of different rolls—one giving good results and the next one falling down on the first few pieces.

In the making of one particular screw, which was rough-threaded in a turret lathe, with a self-opening die, and then finished to accurate dimensions by rolling, all grades of material were tried for the thread rolls. Three of these rolls were used in a special thread-rolling machine, and were used to reduce the pitch diameter of the screw about 0.010 in. In addition to producing a smooth thread, this method also had the added advantage of making a screw that could be held to very close manufacturing limits.

The material found to give the best results for these rolls was Ketos nonshrinking steel, made by the Halcomb Steel Co., Syracuse, N. Y. The method followed was to first rough-turn the roll blanks all over to within $\frac{1}{8}$ in. of the finished size. The blanks were then slowly heated in a muffle furnace to a temperature of 1,450 deg. F. and quenched in Houghton's No. 2 quenching oil. After this the roll blanks were again slowly heated in a muffle furnace to 1,350 deg. F. and allowed to cool off in lime.

The next step was to finish-machine the blanks all over, as well as the thread, to dimensions leaving suffi-

cient material for grinding. The threading was done in a tool maker's lathe provided with a corrected lead screw, the blanks being machined to within 0.002 to 0.003 in. of the desired pitch diameter of the thread, and 0.005 in. on the sides of the rolls, for grinding. The roll blanks were again carefully heated in a muffle furnace to between 1,400 and 1,410 deg. F., the temperature being carefully regulated, and under no conditions allowed to go above 1,410 deg. When the correct temperature was reached, the rolls were removed from the furnace and quenched as before in tempering oil.

In order to prevent crumbling or chipping of the threads, the rolls were then tempered in an oil bath, which was heated to 485 deg. F. and in which the rolls were allowed to remain for 40 min. The rolls when cool were ready for the finishing operations, which were performed in the following order:

First, the hole was ground to size in an internal grinding machine. It was then held on a close-fitting plug in a universal grinding machine and both sides ground—one at a time to bring the rolls to the desired thickness. The next step was to grind the thread. This was done in a tool maker's lathe provided with a corrected lead screw and carrying an attachment on the cross-slide on which a diamond-charged lap was mounted. This lap was made from machinery steel carefully machined to the correct angle, and then charged with diamond dust. This was applied to the face of the lap by hand, and then rolled in with hardened and ground rollers set at the correct angle. When rolling in the diamond dust the back gears of the lathe were thrown in so as to give a spindle speed of between 12 and 13 r.p.m. When lapping the threads on the rolls, the diamond-charged lap, which was driven by a separate belt from the overhead countershaft, was rotated at a speed of from 3,000 to 3,500 ft. per min.; whereas the work was rotated at a speed of from 12 to 13 ft. per min. It requires anywhere from 1 to 1½ hr. to grind the threads on one roll down to the finished size.

Magazine Drilling Jig

By GEORGE C. LAWRENCE

The hand-operated fixture illustrated was designed for the rapid drilling of work similar to that shown and is well adapted to this, as no direct handling of the pieces is necessary, except to place them in the magazine. The surfaces are always free from chips, constant changing being avoided.

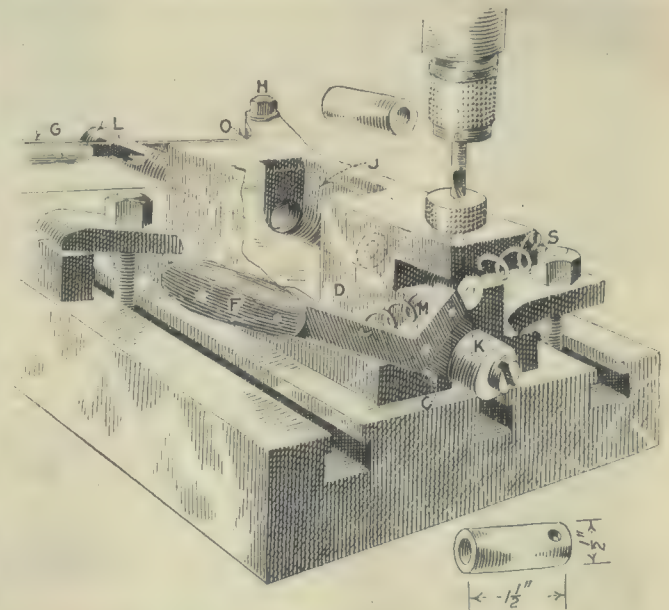
A hole slightly larger than the diameter of the work is bored through the casting *D*. The pieces drop down from a magazine into the opening *J* and are pushed forward to a swing stop *M* and held in position by a plunger *L*, operated by the handle *G*, which has its fulcrum at *O*. *G* works through a slot in the plunger, to which it is pivoted.

When a piece is drilled, the handle *F* is pulled down, and the following piece pushes it out as the plunger is brought forward. As soon as the drilled piece falls out, the stop *M* is returned to position. *G* is pulled as far as it will go, when the second piece is against the stop *M*. *L* is then withdrawn, and the third piece drops into line with it.

Stop pins *C* limit the movement of the handle *F*. An opening *K* allows the chips to fall clear of the fixture

and gives clearance for the drill, the fixture being clamped at the edge of the swinging table. The work falls into a suitably placed receptacle.

As no great accuracy was required for the location of the drilled hole on this job and none of the pieces ran over 0.498 in. in diameter, the hole through the casting



HAND-OPERATED MAGAZINE DRILLING JIG

D was simply bored 0.500 in. full. No difficulty was experienced from the pieces sticking in it. A similar fixture is being laid out with a V to locate the work central under the bushing for accurate results and a simple means provided to wedge the stop *M* against the face of the fixture to insure the correct distance of the drilled hole from the end of the work.

Machine-Tool Building in Japan

By J. MORRIS

Since the war broke out the import of machine tools into Japan from abroad has been very small, and naturally many iron works and small firms began to undertake this kind of work in addition to their regular lines. The specialists in machine-tool manufacture in Japan, however, are but two in number—the Karatsen Iron Works and the Ikejai Iron Works. The Karatsen Iron Works, with a capital of 1,000,000 yen (half of the amount is paid), is on Kiyushu Island. The chief engineer of this plant has served his apprenticeship in the Brown & Sharpe works, and now employs 250 men. When they were making a 72-in. swing and 80-ft. bed shaft lathe and a 90-in. swing by 45-ft. bed crankshaft lathe at one time, the shop was so full that no other work was possible. This gives an idea of the size of the plant.

The Ikejai Works, with a capital of 1,000,000 yen (750,000 yen already paid in), is in Tokyo. This was at first a small concern which commenced business about 26 years ago with an area of only 46 tsubo (1 tsubo equals about 4 sq.yd.), but it now covers 4,300 tsubo, has 47 engineers, about 500 workmen and is well equipped with machines which require a total of 267 horsepower. Last year's output was valued at 1,300,000 yen. At present an extension of 1,300 tsubo is under construction. Machine tools of various kinds are the chief products.

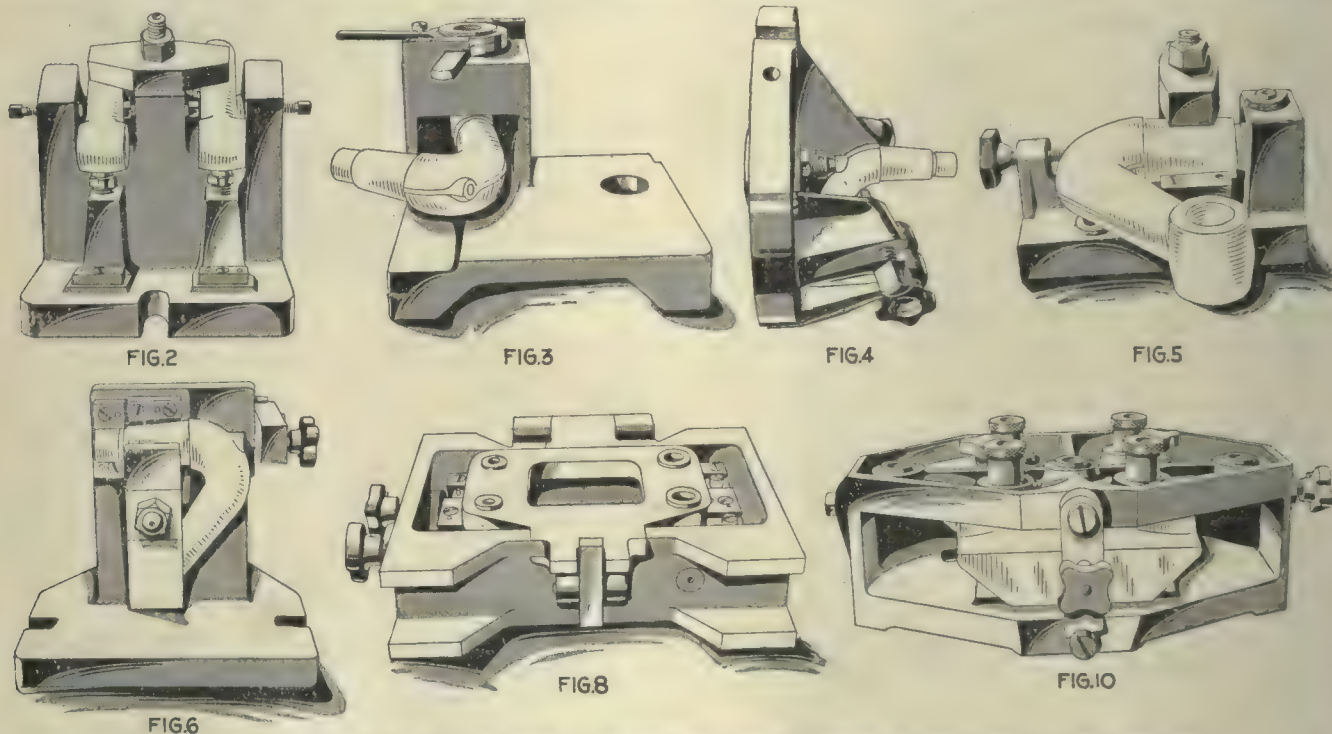
Machining a Steering Lever for an Automobile

BY ROBERT MAWSON

SYNOPSIS—In this illustrated jig and fixture data page are described various tools for machining a steering lever and other elements of a commercial vehicle. These tools comprise drilling jigs, milling fixtures and a lathe fixture.

On pages 936 and 974 were illustrated some of the tools employed by the International Motor Co., Mack

Works, Allentown, Penn., for machining elements for commercial vehicles. In this article are shown other tools, jigs and fixtures seen at the same factory. In machining the steering lever one forging is first milled on both sides of the boss. The hole through the boss is next bored and taper reamed and the taper and straight shank turned. A special fixture serves to hold the part for the operation. A cotter-pin hole is drilled and a keyway is milled to complete the machining operations on the steering lever.



FIGS. 2 AND 2-A

JIGS AND FIXTURES FOR MACHINING A STEERING LEVER, WITH WORK SHOWN IN POSITION

FIGS. 2 AND 2-A

Operation—Milling steering lever, Fig. 1. The forgings, which are placed in a fixture designed to hold two, are located on adjustable screw poppets. The pieces are then forced against stops by setscrews on the sides. A strap fastened down with a nut holds the forging securely. The fixture is located by tongues and held to the machine table by means of bolts in the usual manner.

Surfaces Machined—Sides of bosses, using $6\frac{1}{2}$ -in. side-milling cutters operating at 35 r.p.m. with a feed of 0.06 in. per revolution.

FIGS. 3 AND 3-A

Operation—Boring and reaming steering lever, Fig. 1. The forging is located by a cup bushing that fits on the outside of the boss.

Hole Machined—One $1\frac{1}{8}$ -in. bored and afterward reamed to $1\frac{1}{4}$ in. with a taper of $1\frac{1}{4}$ in. per foot.

FIGS. 4 AND 4-A

Operation—Turning steering lever, Fig. 1. The forging is located by a taper pin that fits into the hole reamed in the previous operation. The piece is then forced back against an adjustable post by a square-headed setscrew. The fixture is located on the lathe with a turned register and held to the faceplate by means of bolts.

Surfaces Machined— $1\frac{1}{4}$ -in., $1\frac{1}{4}$ -in. taper per foot by $2\frac{1}{4}$ -in. long shank, and $1\frac{1}{4} \times 1\frac{1}{8}$ -in. straight part.

FIGS. 5 AND 5-A

Operation—Drilling steering lever, Fig. 1. The forging is located in the jig by resting in a V-block and being forced

against a locating bushing at the end with a knob-headed screw. A strap is then tightened on the part to hold it in position.

Hole Machined—One No. 12 drilled.

FIGS. 6 AND 6-A

Operation—Milling steering lever, Fig. 1. The forging is located in hardened-steel blocks that are made to suit the sizes of the machined shank. The lower end of the piece is located on a pin that fits the reamed hole in the boss. A knot screw forces the piece back against a stop. A strap is then tightened on the forging to hold it securely.

Surface Machined—Keyway, using a $\frac{1}{2}$ -in. end mill operating at 250 r.p.m. with a feed of 0.001 in. per revolution.

FIGS. 8 AND 8-A

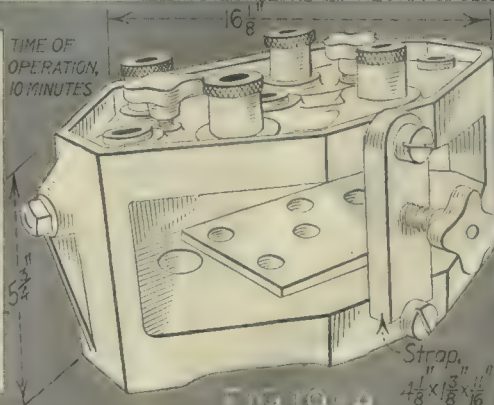
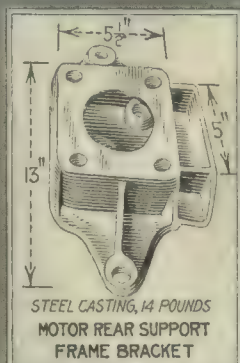
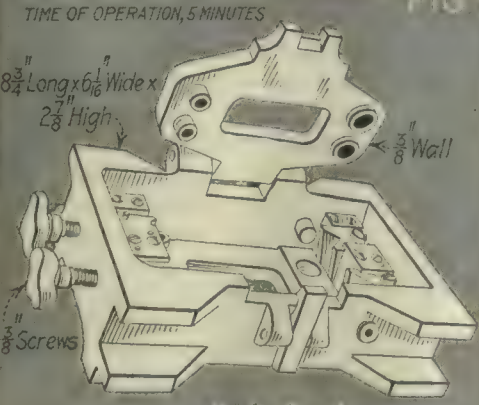
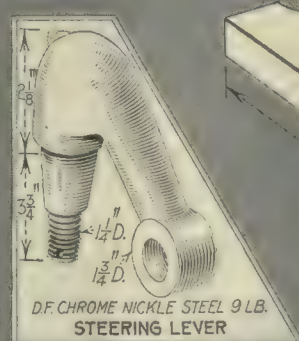
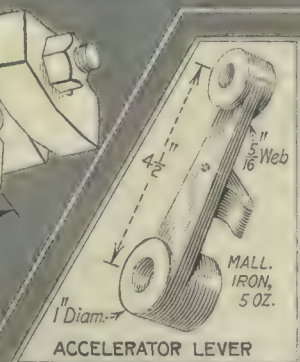
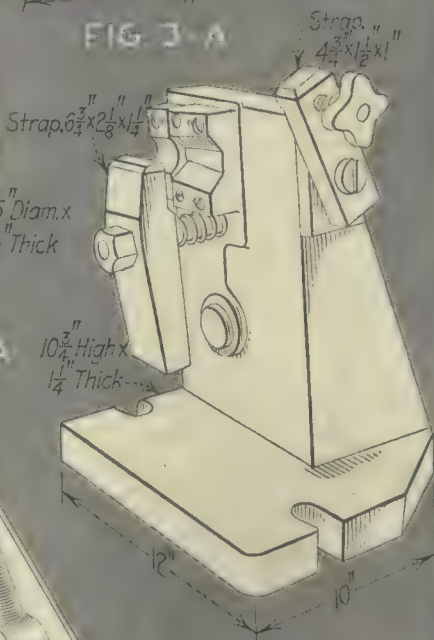
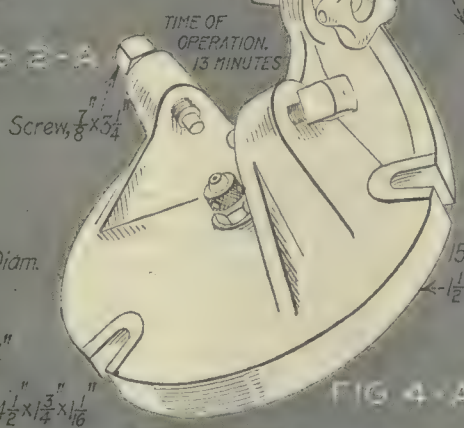
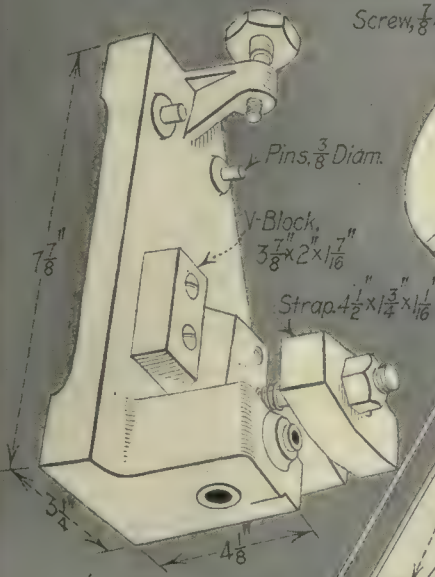
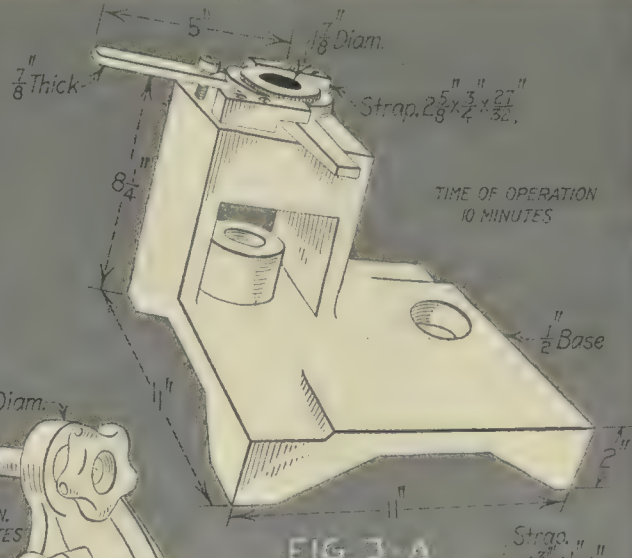
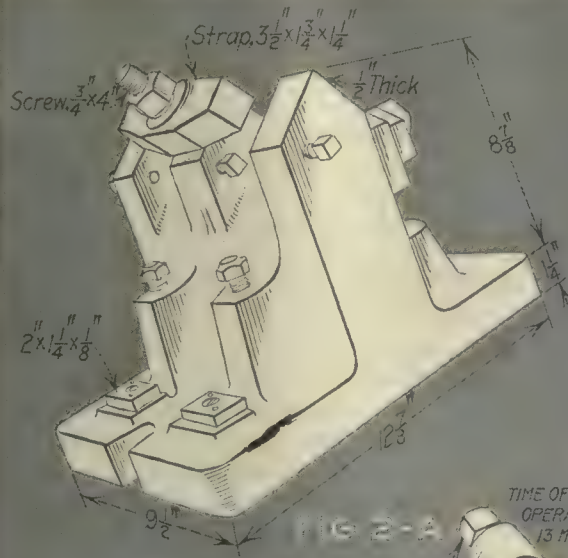
Operation—Drilling accelerator levers, Fig. 7. The castings, the jig for which is designed to hold two, are located in fixed V-blocks at one end and sliding V-blocks at the other. The sliding members are operated with knob-headed screws. The cover is then dropped down, being held by a spring latch.

Holes Machined—One $\frac{1}{4}$ -in. and one $\frac{1}{8}$ -in. drilled in each lever.

FIGS. 10 AND 10-A

Operation—Drilling motor rear-support frame bracket, Fig. 9. The rough casting is located against stop pins at the rear and an adjustable stop at one end. A knob screw at the other end, another knob screw through the strap—after it has been swung into position—and two screws through the upper wall hold the part in position.

Holes Machined—Four $\frac{3}{16}$ -in. and three $\frac{1}{8}$ -in. drilled.



ALL BUSHINGS USED FOR GUIDING TOOLS ARE BLACKENED. ALL JIG AND FIXTURE BODIES ARE CAST IRON. STRAPS AND FASTENINGS, MACHINERY STEEL, GUIDE BUSHINGS ARE TOOL STEEL, HARDENED AND GROUND

The All-Around Mechanic and What Became of Him

By W. F. ABONES

Forty years ago J—— & Co. operated a machine shop. Their line was special machinery, dies and models, and some general jobbing. They employed about thirty hands. Their equipment consisted of lathes, planers, drilling machines, one emery wheel stand, a small forge fitted with the old time bellows, and a power-driven sand stone. This firm was located in the Middle West; to be precise, in Chicago.

On these tools their men were doing a very high class of work, considering the quality of their day. There was not a specialist in the shop, aside from the wood pattern maker and the blacksmith. The others, except the apprentice boy, were all-around men—and good ones. I was the apprentice boy. We did considerable milling and grinding work on the lathe, using special fixtures of our own construction.

As J—— & Co.'s business increased, new equipment was added continuously; namely, millers, a boring mill, a slotter, a universal grinder, a power forge, a special tempering furnace and so forth.

After the firm had been in business about ten years nearly one hundred men were employed. We were under a foreman, and he had an assistant. But that is getting ahead of one very important point.

Mr. J——, who was previously foreman, salesman, timekeeper, paymaster, and in short the entire office force, found his work too heavy and had built up an able office staff. This enabled him to devote much more time to the manufacturing department of the firm, and he began to observe and study conditions. He noticed that Baxter was more successful at tempering than the other men in the plant. His tools stood up better, in drawing he got just the proper hardness and roughness, and his work was seldom fire cracked. He also noticed that Smith was rather clumsy and slow at the vise, but made up his lost time on the lathe. He observed, too, that Hall could keep the big drilling machine going; and always while Hall was operating a drill he whistled to beat the band.

I believe it was Hall's whistling that got him the drilling machine as a permanent occupation. After a long consultation between Mr. J—— and the foreman, it was decided that Hall should do all the drilling; Baxter, all the tempering; and Smith was to get the best lathe and keep at it. It did not require a production expert to tell Mr. J—— he was on the right track. From this time on specializing was the order of the day.

STARTING SPECIALIZATION

About this time the company purchased the patent rights on several wood-working machines, increased its capital stock and built a much larger factory. In this new organization machines were grouped. Vise hands no longer operated machines, while machine men operated continuously one class of machine. There was good sound reason in this method. A man can learn to operate one type of machine much sooner than he could possibly learn to handle a dozen.

The apprentice boy, were he to start today to be a proficient operator on all the toolroom machinery we have now, could get about a week at each in his three years' apprenticeship; and every reader knows that a lathe hand

might work six months on job after job, and every one would be different.

The present system does away with many troubles. The planer hand knows just what bolts and clamps he has; he knows the chuck is a few thousandths out on graduation, he knows just what tools he has and where to find them, and he keeps his stock up and in working condition. This feature applies to all classes of machines and to bench or vise workers as well. It is a vast improvement over the old way—and we all know it.

NEW CONDITIONS REQUIRE NEW METHODS

The cry is quality and quantity. To slow up now is to blow up. The apprentice boy is with us, but not as of old. Thirty years ago a boy could start learning the trade at the tender age of eight years. I am sure of this, because I finished my first year under nine and was the proud receiver of \$2 per. But times have changed. Society demands, the law enforces; boys are expected to go to school until, 14, 16 or 18 years of age.

In every state in the Union and throughout Canada there are child labor laws, and boys are not permitted to work in factories until they are old enough to meet the law's requirements.

No young man who enters the machine shop or toolroom nowadays, and gets proficient on one machine at a small recompense, is going to continue jumping from machine to machine at a small wage. It is not profitable to him, nor is it profitable to the management. Therefore we have specialists. But we have the apprentice boy with us, and also the all-around mechanic is quite in evidence.

How about your foreman and the men higher up? The foreman of a toolroom or machine shop who is not an all-around man is not a howling success. Some who are not all-around mechanics hold positions, but sooner or later the law steps in and you find it is the survival of the fittest.

The apprentice boy who is in earnest and devotes his time to one machine can, by persistent effort on his own part during his spare time, become a good all-around mechanic and secure a better knowledge of modern mechanics than his dad ever had. Periodicals such as the *American Machinist*, *Engineering* and the *Scientific American* are overflowing with knowledge of the craft. Kent's pocket book is always at hand. Technical courses are simple and along special lines. And last but not least, educational opportunities abound, and to the boy or man who observes and absorbs there is every opportunity for advancement. Owing to the present world war even unskilled labor is scarce. When this labor is scarce, skilled labor is more so. This condition calls on the manufacturer for a change of method, or system, in his factory; and the resulting change is progressiveness. The less you have to teach a man the sooner he becomes proficient.

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Molybdenum Is Used in Form of oxides, ammonium salt and metal. Several tons a year are used in the United States in form of ammonium molybdate as laboratory reagent in the determination of phosphorus in iron ores, their products and in fertilizers. The salt finds a further use in fire-proofing fabric. The metal is used in self-hardening steel; from 5 to 10 per cent. is introduced and the resulting steel is raised in elastic limit and tensile strength, and possesses greater toughness in addition to the former property. Wire made from it is said to have greater elongation and high tensile strength.

Deceptive Working Limits on Munitions

By F. H. BOGART

SYNOPSIS—It is well known to those who have taken contracts for munitions that the working limits given by the foreign governments are not only deceptive but in many cases impossible. This article gives an analysis of the working limits on various parts.

The question is being asked on all sides, "Why is it that practically all the American manufacturers of munitions for European governments are having difficulties in meeting the gaging requirements?" For a decade or more, especially since the processes of manufacturing the parts of automobiles passed into the stages where

classified as interchangeable, but which were built up part by part to an assembled whole. It is obvious that such manufacturers, while they might be supreme in their own lines, would be poorly equipped both in the experience of their executives and their general factory organization to undertake work of the character called for in the contracts referred to.

But this answer does not cover the subject by any means. Many of the direct contractors, realizing that they were poorly equipped for such work, or finding on investigation that it was going to be impossible to get together the proper equipment of tools in time for specified deliveries, sublet parts of their contracts to other manufacturers. These in many cases had both the equipment and the personnel, and went into the matter with both eyes open, because by the time the subcontracts were placed the specifications had been handed about sufficiently to familiarize all parties with what was expected. But the subcontractors have had their troubles also, and these troubles have reached such an aggravated stage in numerous instances that manufacturers of very high national repute have become disgusted with the whole business and repudiated their contracts, writing off as a dead loss the sums spent in experimenting and for rejected production. To the trained mechanical mind it would appear that somewhere there was a nigger in the woodpile. It is not reasonable to assume that some at least of the manufacturers who have had difficulties in getting material past inspection cannot manufacture in their factories to limits as fine as those specified on the foreign blueprints. It would be a safe guess, rather, that these same manufacturers are turning out daily a regular product that is more accurate in the essential dimensions than the contract referred to calls for.

The following suggestions, based upon actual experience in plants now engaged in this work, may point to a solution of the problem:

1. The limits or tolerances given on the detail drawings submitted with contracts have proved deceptive and have led master mechanics, production supervisors and inspectors into errors that were difficult to discover until large quantities of material had been spoiled.
2. The limit gages have in most cases been designed and the points of reference selected by the mechanical representatives of the contracting European governments, while the tools and order of operations have been devised by various American mechanics without taking the gaging or natural reference points into consideration in the slightest degree.
3. Commonsense has made it obvious to the American mechanic that about 75 per cent. of the dimensions that on the blueprints are held to fairly close limits are non-

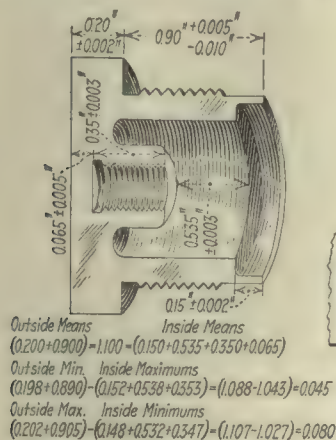


FIG. 1. SHAPE AND DIMENSIONS OF 3-IN. CASE PRIMER BODY

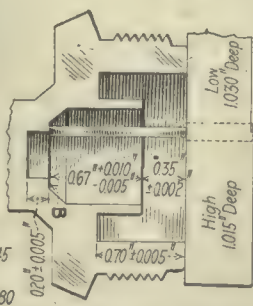


FIG. 2. FORM AND DIMENSIONS OF NO. 85 FUSE BODY

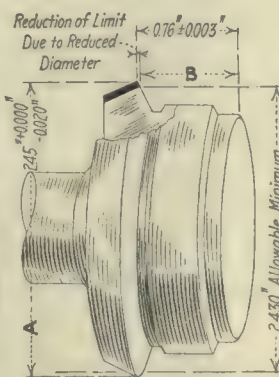


FIG. 3. BASE AND FLAT-FORM OF NO. 85 FUSE BODY

practically all manufacturers claim interchangeability, we have been congratulating ourselves on holding the lead over all other nations, not only in the development of machine tools for accurate duplicate production, but on production itself, to what we considered very close limits of accuracy.

Yet it is a well-recognized fact that few if any of the American manufacturers that took contracts for shells, cartridge cases, fuses or primers ever were able to carry forward these contracts to completion to the drawings and specifications originally furnished with the contracts. Somebody must have been deceived; otherwise, why should iron-clad contracts based on English, French or Russian inspection have been passed upon by the mechanical departments of manufacturers of wide reputation, when these same mechanical departments a few months later were to be found begging the powers above for increased tolerances, asserting in many instances that "the Lord Himself could not manufacture to such close limits."

MANUFACTURERS UNFAMILIAR WITH THE PRODUCT

The answer to the question most commonly given is that a majority of the contracts fell into the hands of very large manufacturers of big work, whose plants were not in many cases manufacturing products that might be

essential; that is, a considerably greater variation from that allowed would in no way affect the function of the component being produced. This knowledge has proved a boomerang, because it has led many to deceive themselves into thinking that such dimensions actually need not be held to the prescribed limits, but that "pretty near" was good enough.

THE TOLERANCES ON THE WORK ARE DECEPTIVE

The matter of the tolerances being deceptive came to the writer as a sort of shock. Soon after becoming associated with the mechanical department of a large firm manufacturing primers for the 3-in. shrapnel case, the manager of the department, who happened to be a mechanic of very wide experience on small, accurate work, asked that a technical analysis be made of the primer body, as shown in the detailed print accompanying the contract specifications. "I contend," said he, "that it is mechanically impossible to manufacture a piece to those dimensions." At first glance such a statement would appear absurd. All the mean dimensions checked up correctly, and the plus and minus limits were certainly all that ordinary production accuracy required. But slight progress had been made on the analysis before it was discovered that there was a whole lot of solid fact in his statement. The truth of the statement rests on the fact that mechanically you must assume any combination of the limits given as possible, if not probable.

Referring to Fig. 1, which represents in general form and dimensions the standard 3-in. case primer body, it is obvious that, taking the minimum limits on the outside, it would be possible to have a body pass on the outside length gages measuring 1.088 in. over all. Let us assume that on this particular body the inside dimensions down to the top of the anvil and the depth of threaded hole to the recessed bottom were at or near the maximum allowance. Subtracting the total inside depth from the overall length leaves only 0.045 in. for the thickness through the head at this point, whereas 0.060 in. is the least allowable thickness. Likewise, a primer having a maximum length of 1.107 in. might gage correctly on the outside, but combine minimums on the inside in such manner as to leave the head 0.080 in. thick, while the greatest allowable thickness is 0.070 in.

In these primer bodies, then, you have manufactured parts that would under ordinary conditions go through nine-tenths of the processes of manufacture, passing every gage perfectly, only to butt up against certain rejection when gaged for the thickness of the head. This is just one example of possible combinations of maximums and minimums that have put both the production and factory inspection departments into a position where they never know when they are safe. There are about five other pitfall combinations that can be figured out on this one part alone, and on paper this would appear to be about the simplest of the smaller parts to be made. These are not imaginary or impractical sources of trouble. The writer has seen tens of thousands of primer bodies land in the scrap pile, the principal cause, though not the only one, being such discrepancies as are illustrated above.

Another source of deception can be traced to the foreign inspectors granting increased tolerances on certain dimensions, but holding to a close limit on some one dimension that goes to make up the combination.

The effect of this will be clear from reference to Fig. 2. The sketch represents roughly the form and dimensions of the No. 85 fuse body. All the internal depths are gaged from the face of the base by pin gages of the general type shown. Originally these depths had all the same tolerance; but subsequently they have in many cases been changed by the chief of the foreign inspectors to something like the figures given, allowing a much greater limit of variation than formerly on every dimension except the distance down to the rim of the wall of the powder chamber, which they continued to hold to plus or minus 0.002 in.

It is common practice to finish these inside dimensions with a stepped reamer usually designed like a two-lip butt mill, the steps being ground to the mean dimension as near as practicable. When the wider tolerances were granted, the gages were changed to the increased limits; and there the trouble started. It is apparent that, with the steps on the finish reamer fixed, there can be no greater variation at any point than the smallest limit allowed—namely, plus or minus 0.002 in. If all four depth gages were always used, the discrepancy would be apparent; but they are not always all used by any means, and the writer has seen hundreds of bodies spoiled because the inspector was gaging down to surface *B* and assumed he was perfectly safe so long as he held them inside the limit for that dimension.

TROUBLE WITH BEVELED SURFACES

Another "death trap" has been the allowance on dimensions represented by the intersection of beveled surfaces. By reference to Fig. 3, intended to represent the base and platform of the No. 85 fuse body, it will be seen that a very wide tolerance is given for the extreme diameter over the platform, while the allowed variation from the bottom of the base to the intersection of the beveled base with the rim is only plus or minus 0.003 in., or a total of 0.006 in. It is obvious that any variation of the diameter *A* between the limits 2.450 in. and 2.430 in. will likewise vary the dimension *B*, as the two beveled surfaces are not in any instance generated with one tool, but are machined in separate operations. The result is that the greatest limit that it is safe to take for dimension *B* is what is left after deducting the mechanical variation possible in machining to the limits of *A*. In the case of the No. 85 body this cuts the available limit on *B* down to approximately plus or minus 0.001 in., depending on the base angle, which varies somewhat in different specifications.

The above are only random illustrations. Every drawing of every part, if carefully analyzed, will be found to be filled with just such traps for the mechanic and inspector.

It may not be entirely clear why, if these things are so easily caught in the final inspection, with resultant rejection, they cannot in every case be caught by the department inspectors if they are sufficiently careful. The trouble is as explained in the case of the primer body, Fig. 1. The manufacture may move steadily and smoothly through operations one, two, three, etc., perhaps up to number eight or nine, every part being held to every gage, and at this advanced point a discrepancy develop that may make it necessary to go back even to the first operation to correct. Obviously, all the production that intervenes is defective. The natural desire of the manu-

facturing department is to save this material if possible, and the saving process is nothing more nor less than pushing work that is known to be defective through the remaining operations to the final inspection, with the hope that by some hook or crook it will get by.

Regarding the lack of coördination between the tools and the gages, it should be understood that on every part to be manufactured it is quite common for the foreign inspectors to explain that all the dimensions are important, but a certain few are "very important," it being easy to infer that no matter what leniency they may show at some future time in passing on work not quite to gage, on those particular dimensions no leniency must be expected.

It should be apparent even to the average mechanic that on such of the dimensions as require the greatest accuracy, any grouping of the tools that would hold in a fixed relationship those tool elements that finished the surfaces requiring special accuracy would be the best gamble as a choice of design. Yet it is not apparent from current practice that this has been given any consideration whatever. The writer has seen instance after instance where surfaces that must be held in relationship within a limit of 0.004 in. have been separately machined at different settings, or machined on poorly constructed turret lathes, one surface with a cross-slide tool, the other with the turret. It would not be practical, of course, to tie all the tools in a bunch, as would be necessary if this principle of grouping were carried to its extreme; but in almost every case in mind an order of operations and a combination of the tools could be devised that would go far toward eliminating a wide variation from piece to piece of the material produced.



A Book on the Looks and Details of Machines--II

BY JOHN E. SWEET

SYNOPSIS—This second installment takes up the strength of machine parts, and Professor Sweet emphasizes the need of often applying Kingsford's formula, "Be sure it is strong enough and then double it." Then follow a reference to friction and a discussion of devices that operate because of this force—clutches, couplings, start and stop motions and brakes. The final portion is devoted to friction-reducing devices—roller bearings and ball bearings.

In the rectangular cored section one is not sure that the core is in the center. To what extent this weakens the piece against crushing may in cases be worthy of consideration. Assume that the offset is in one direction. The two sides would not be weaker than if the core was central, and the other way the thick side will sustain a little more than if no thicker than the thin one. A good way to deal with this is to consider it as a lever.

Assume the load to be applied central and the two points of the lever to rest central on the two webs. It will be seen at once that the thick part will carry the

Regarding the all too prevalent practice of not holding the machine supervisors or factory inspectors strictly to the limit gages, but allowing it to be understood that so long as some dimensions are pretty near they will go all right, the principle involved is not mechanical, but purely one of personal judgment. Everybody knows perfectly well that a great many of the matters regarding which the foreign inspectors seem determined to split hairs are poppy-cock and that the parts would be just as good for the purposes intended if practically unlimited tolerance were allowed on many unimportant dimensions. But who is to say where to draw the line? Certainly with the limited knowledge of munitions in general possessed by the average American manufacturer he would be skating on thin ice to create a new set of tolerances based upon his own judgment as to what was required. And on limit-gage work there exists no basis for a second choice. Either the work must be done inside the gages, or the limit becomes the blue sky and the gages a useless toy for the inspectors to play with.

It would seem, in consequence, that the one safe course would be to maintain from the first to the last operation the fixed purpose to hold to the tolerances allowed and to accept as defective all material produced that is outside those limits. Intelligently handled, a large percentage of such defective material might be repaired and passed. Certainly the chances that such material might eventually be accepted would not be lessened by handling it through the various repair processes in an open and above-board manner, and the spirit of antagonism that is so prevalent between the factory inspectors and the foreign representatives would have fewer causes for existence and conditions thus generally made better.

greater load, as that end of the lever is the shorter of the two. This same application of the lever principle will apply to many problems that seem complicated. Take the strain on a chain hook. Those of correct form are made thicker on the inside than on the outside. The necessity for this will appear when we consider the strains as we would in a lever. The load is applied at one end of the lever, the metal that is represented by the other end is in compression, and the center point must sustain the sum of both, hence needs the most material.

THE BENT-LEVER PLAN

Another application of the lever system is that of a bent lever to determine the strain on a horizontal piece. Suppose it to be desirable to ascertain the additional strain brought upon the lower chord of a truss by the application of an additional load in the center.

Assume it to be sustained by two bent levers, each carrying one-half. Then the strain on the lower chord will be as much greater than one-half the load as the horizontal arm is longer than the vertical one, and this leads to a still more simple rule: The strain will be as much greater than half the load as one-half the span is greater than the depth of the truss; or still shorter—

the strain will exceed the load as much as one-half the span exceeds the depth.

This reasoning out of the different strains is given as an introduction to the reasoning out of the special features more particularly embraced in this work and is what would have to be done if mathematical determinations were to be made; but so far as machine framing in general goes, if there is thought to be so little metal in the plan as to call for mathematical computations to decide whether it is strong enough, Kingsford's formula had better be applied the first thing. It is, "Be sure it is strong enough and then double it."

MACHINES THAT NEED TO BE LIGHT

In traveling cranes, agricultural machinery and things that have to be moved, the question as to how little metal will answer is important; but as to the framing and the stationary parts of fixed machines, no one in competition with other builders will ever put in so much material but that his machine would be better if he put in more.

Woodworking machines and printing presses of recent designs are of rectangular sections, only large enough to look right if solid, and then cored out very thin to save iron. In this the builder cheats his customer and cheats himself. Such machines, of all others, are subject to shakings and vibrations. If, in the author's opinion, the makers should leave out the core by mistake, they would find that the result would justify the belief that every pound of iron put in the place of the core is as valuable as any other pound.

In the early days of machine-tool and engine construction the makers depended largely upon the masonwork to give strength and stability to their constructions. To a sufficient extent to carry the load of the machine this will always be necessary, but to resist pull and push, bending and torsional strains it will be less and less so.

SELF-CONTAINED MACHINES

With the growth of electrically driven independent machines, which permit moving the machines bodily from place to place, this making the masonwork a part of the machine will be largely abandoned. Machines the bed of which can be a single casting will rest either upon one foot or upon three. If a machine when constructed rests in a certain way and is then made true, it will be true wherever set, provided it be rested in the same way. With one or three points of support it will be the same way wherever set.

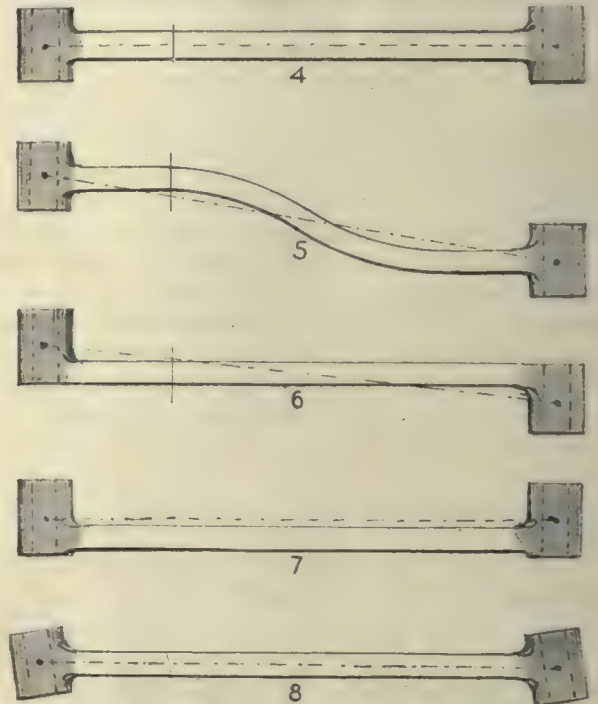
Adopting the box section for all framing, in place of the side-plate and crossgirt form, will enable the makers to ignore the foundation except for support. Only where there are heavy reciprocating parts, it may be necessary to secure the structure to the foundation to help absorb the disturbing action. In this case weight alone is a matter of importance, and simply filling the hollow-box section or deep beds of engines is the best possible place to put it.

STRAINS AND HOW BEST TO RESIST THEM

Strains go in straight lines. If that line passes through the neutral axis (the center of a solid bar, Figs. 4 and 8), then the bar will remain straight and will only yield by stretching or upsetting; but if the line of strain does not pass through the neutral axis because of the bar being crooked (Fig. 5), offset (Fig. 6) or more metal on

one side than the other (Fig. 7), then the bar or member will straighten out if under a pulling strain, or will bend more or less or double up if subjected to pressure. Many times it is not possible so to construct the framing and other parts of a structure that the line of strain can pass through the neutral axis, and many times it is possible where it is not done; but unless in a case where elasticity is desirable, the right form and the right place are a straight member with its neutral axis coinciding with the line of strain.

With the question of straight members for framing comes the question of looks. Whether a structure looks



FIGS. 4 TO 8. FIVE FORMS OF LEVERS

right to the observer is partly a matter of fashion and partly a matter of training. That which is right can be made to look right, if the designer is equal to the task.

The forces tending to spring, bend or break machine members or framing may be actual or accidental. If the former, and known, then their result may be computed with an accuracy dependent upon what is known about the elements that are to resist them. If either of them is unknown, then the mathematical calculation can be only approximate; and the result simply helps to form an opinion. The more nearly the actual strength of resisting material is known the more nearly can the results be predicted.

Boilers are among the most dangerous of all structures, and yet the factor of safety used in practice is less. The reason why that is justifiable is that the strength of the material and the strength of the joints can be more accurately ascertained than in almost any other structure, and the actual strain from any given pressure can be determined. Were it not for unequal strains from heat (not computable), bad workmanship and deterioration, only a small factor of safety would be necessary.

In machine tools and engine frames—in fact, all stationary parts—the strains are mostly accidental and not computable. Besides, no matter what a machine is or for (with perhaps some exceptions to make the rule good).

the more metal that is put into the stationary part the better it will be. Commercial reasons always have prevented such parts being made as good as they ought to be—and always will.

The words strength, or strong enough, have nothing to do with it. A part may be strong enough and spring like a spring-board, but nothing about the framing of a machine tool can be quite as good as it would be if more rigid and more solid.

HOLLOW-BOX SECTION

There is a limit to the amount of material one can afford to use in any structure; hence, it is best to put what one can use in the best form. An I-beam section is as strong in one direction as a square hollow

It is definitely stated that cast iron has no limit of elasticity. If this has been demonstrated by actual test, it is probable that the assumption has been made that one piece of cast iron truly represents all cast iron. As a matter of fact, cast iron covers a wide range of material, being constantly improved. That cast iron will continue to spring almost an indefinite number of times without either taking permanent set or breaking is shown by the fact that a punching press, which sprang to a visible extent at every stroke, cut between twenty-five and thirty million pieces without either taking permanent set or breaking.

HARMONIC VIBRATIONS

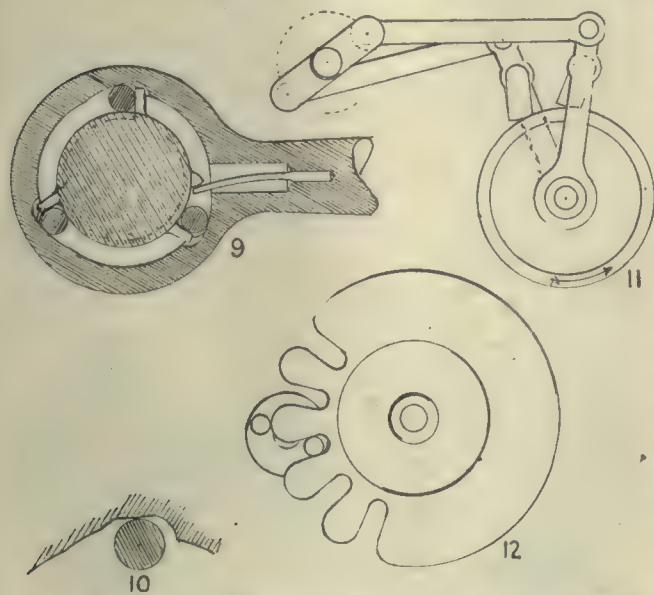
Good cast iron will both spring and bend, and it could do neither were it not compressible and elastic; but as indicated before, the amount of metal should be, in all parts of a machine where cast iron is used, so far in excess of the size the figures would indicate as necessary that the thing becomes a guess or matter of judgment in the end. While the question of rigidity may be dealt with by the formula and table of flexure, that would be no index to the magnitude of harmonic vibration. Besides, one would have to guess, as no one could tell whether he could permit one one-hundredth, one one-thousandth or one ten-thousandth of an inch vibration. The difference between deflection by a given weight and harmonic motion produced by successive application of the same weight is shown by the running of a dog, or the marching of soldiers over a suspension bridge. The difference between the two is unmeasurable and incomprehensible until one sees it or observes the chatter of a piece on the faceplate of an ancient lathe.

It would seem that mathematical calculation would determine positive results, if in anything, in the proportioning of gear wheels. Yet to realize how unsatisfactory it is, one only needs to refer to the various tables on the strength and proportion of gears from standard authors and note the great variation to see that there is a great difference in the strength of material upon which the figures are based or that accurate calculations are simply impossible.

The designer can only find out as best he can the probable strength of the cast iron that is to be used, determine what the tooth, the arm or the rim should stand from the formula, then make everything stronger according to his own judgment, if he has had experience, or profit by the experience of others, using the tables he finds in the books or multiplying by some factor of safety that someone gives him. However accurate he may be in the determination of the strength of his material or in his mathematical calculations, just so much greater as his factor of safety is above it, so is his uncertainty or matter of judgment greater than his matter of fact.

Still without his facts and without experience and without the experience of others he would be all at sea. Only the instinct of a natural designer can save a man from utter failure unless he has the facts and judgment of others.

If the mathematical calculations are from necessity based upon data any one factor of which is uncertain or variable, as is the case with the strength of cast iron, or if the load to be carried is uncertain, as is the case with accidental strains, the graphic method or the slide rule, though not as accurate as the figures, is rather more



FIGS. 9 TO 12. INTERMITTENT AND RATCHET MOTIONS

Fig. 9—Three-roller friction ratchet. Fig. 10—The ring of a friction ratchet wears. Fig. 11—Double-pawl ratchet. Fig. 12—Intermittent motion having two-toothed pinion.

box. It is in only one direction, however, having comparatively little strength sidewise and less against torsional strain, so both as to strength and rigidity and against vibration the square hollow section is the cheapest when considering pattern work. It is so much the better as completely to exclude the I-beam from consideration where the hollow-box section can be used. Up to a certain point the larger and thinner section is better; but that point is soon reached. If too thin, the trouble in casting becomes serious; and besides, the thin sides will set up a tremor within themselves, on the principle of a drum head. This is worse than the tremor in a spring or beam as, in a drumhead or diaphragm, vibration occurs in unison with any tremor.

In the construction of machines, knowledge of the ultimate strength of material is of little use, except as it may be an index to the elastic limit. There are in rolling mills and a few other places certain pieces whose whole business is to break when subject to an undue strain. In the main, however, it is necessary to keep far within the limit of elasticity. As the limit of elasticity is alike whether in tension or compression, there is no occasion for the tension side of a cast-iron beam being larger than the compression side, as would be the case if the beam were to stand the greatest breaking strain for its weight.

accurate than the data one has to work from, hence as much better than the figures as it is quicker.

Many times short-cuts are found that are sufficiently accurate, so that it is unnecessary to resort to either method. The simpler one of considering that the load on a diagonal brace or tension rod is as much greater than the actual load as the diagonal is longer than the vertical height is so simple that one does not need to resort to any figures at all. For instance, a brace may be 17 ft. 7 in. long and the vertical height be 15 ft. Now, $17\frac{1}{2}$ ft. is $\frac{1}{6}$ longer than 15 ft.; hence if there is a 6-ton load, there would be 7 tons' strain on the brace. But the mathematicians will say that 17 ft. 7 in. is an inch more than $17\frac{1}{2}$ ft. Yes, but why bother about the inch when one is going to multiply by 6, 8 or 10 and guess at the 6, 8 or 10? It is simply as $\frac{1}{2}$ is to 600 or 800.

It is possible with a known load to calculate perfectly the amount of strain on the different members that are to support it, however intricate the directions. Moreover, with perfect workmanship it would be safe to rely upon the result; but in work more or less intricate the strains are not sure to fall where anticipated, and this in addition to the unknown quality of the resisting material renders it necessary to add to the figures.

ELONGATION AND FRICTION

So long as the natural soft steel used in structural work will stand an elongation of, say, 15 per cent., it would seem at first sight that, if one piece is a little too short and is thereby subject to an overload, it would stretch so as to throw the load on the other members, where it belongs. This it would do, were it not for the fact that in plate work the rivet holes weaken the piece at the ends, as does cutting a thread on a bolt, and the pieces will break at the weak points before the stretch takes place.

As strains can be figured, so can the motion of simple or complicated gearing, and usually with absolute accuracy; but what work a given force applied to one end of a strain of gearing will do is rendered impossible of determination in most cases by the unknown factor—friction. Friction may vary from a fraction of 1 per cent., as in the case of one surface plate floating upon another with air as a lubricant, to a wedge of 100 per cent. The worst of it is that it is variable, erratic and defies predetermination.

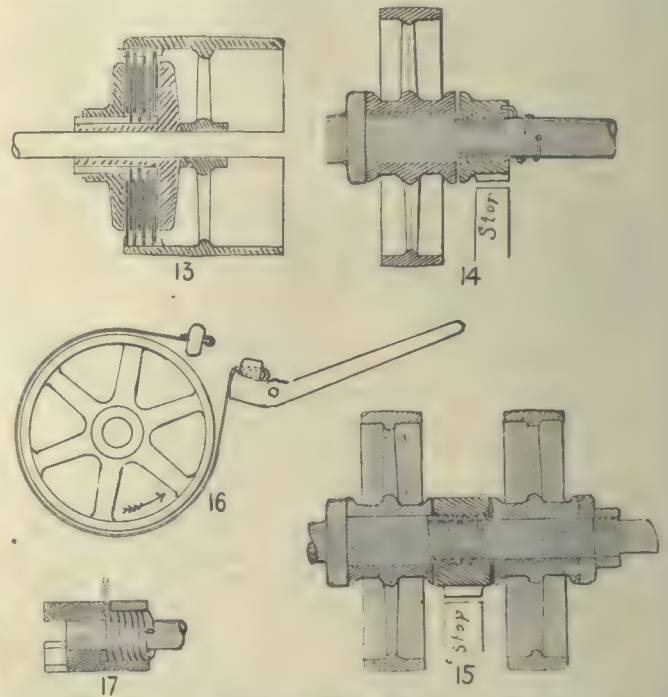
Friction ratchets as a substitute for ratchet and pawl usually fail for the reason that if the angle of contact is such as to insure a positive drive, it is liable to bind when it should let loose.

This is as nearly overcome in the three-roller plan. Fig. 9, as in any (particularly where a ring and a single spring are used rather than a separate spring to keep each roller in contact), as the horns on the ring bring all three rollers in contact uniformly. But even this fails after a while, for if all the surfaces are hardened and ground the angle of the cams must be very slight or they will slip. Then it lets up reluctantly. If soft cams are used, they soon wear so as to leave a shoulder, Fig. 10, and then they will slip.

In a case where it is desirable to give a continuous motion to a shaft by two or more ratchets working alternately, this difficulty does not exist, as the action of one pawl releases the other (see Fig. 11).

This arrangement gives an intermittent motion, the wheel coming to a dead stop at every half-revolution of the driving double crankshaft. The device is not so good in any way as a two-tooth pinion, Fig. 12, which produces the same motion without the possibility of slipping. This may be carried out in spur or bevel form—that is, with the shafts parallel or at right angles.

Friction clutches composed of male and female cones tapered 3 in. to the foot drive very well, but release with difficulty. Friction clutches made by a number of disks rotating with the shaft and sliding between another set of disks within a pulley, Fig. 13, have great driving power



FIGS. 13 TO 17. VARIOUS STOP AND REVERSE MOTIONS
Fig. 13—Disk clutch as part of a pulley. Fig. 14—Start and stop motion. Fig. 15—Reverse motion using two pulleys. Fig. 16—Strap-stop motion. Fig. 17—Coil coupling

by the application of a small force to close them together; but if run at high velocity they become an exhaust fan and the plates are held together by a partial vacuum that makes them hard to release. Or if an opening be provided to admit air at the center they become a fan, tending to blow themselves apart.

An instantaneous start and stop motion, where the work is not excessive, is made by a nut screwing up against a flat surface and grasping the moving part, Fig. 14, a gear wheel or pulley between two flat surfaces—the face of the nut and a collar. When the nut is released, a spring wound around the shaft screws the nut up against the wheel, and the friction causes it to grip tighter and tighter until the shaft revolves with the wheel. To release the drive, it is only necessary to stop the nut by any convenient device, when the motion of the shaft unscrews it, it stops and lets the wheel loose.

FRICTION REVERSES MOTION

For a reverse motion it only requires two pulleys running in opposite directions (see Fig. 15). Whenever the nut is stopped by an elastic abutment it is loosened from one pulley and spins over against the other, and the direction of motion is reversed.

Any automatic or hand device that will bring up a stop to arrest the motion of the nut will reverse the

direction of motion, whichever way it may be turning. With close adjustment the action is nearly instantaneous. Shifting belts are the smoothest sort of a device, so far as starting goes, but operate more slowly than friction clutches, for which reason friction clutches for reversing lathes have been adopted.

For stopping revolving shafts a metal strap around a smooth-face pulley or drum, Fig. 16, is very effective, as in a measure it is partly self-acting or accumulative. The principle is the same as that of the snubbing post, where two or three turns of a rope around a post enable one man at the end of the rope to stop a ship at the other end.

In certain cases clutches or binding devices, such as couplings, Fig. 17, are made, in which a coil of square

To do this, various cages and separating rollers have been devised. They do well when new and fail when worn. Mechanically, the correct method would be a pinion on each end of the rollers engaging with a gear on the shaft and with one or two internal gears in the box, Fig. 18, the pinions and gears all having pitch lines of the same diameter as the contact surfaces.

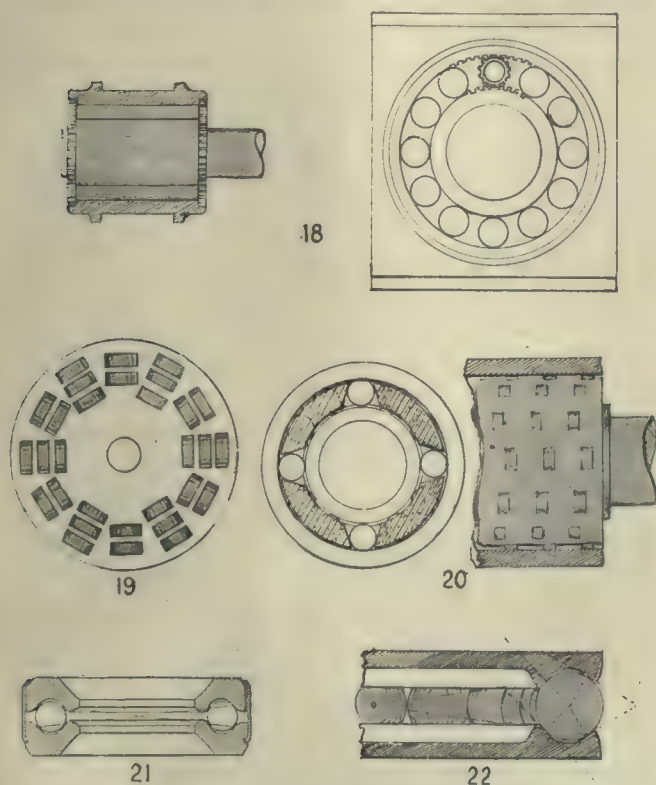
Elastic rollers can be slightly compressed and hence forced into a shell so as to be always tight, unless the load is so great as to compress the loaded rollers still more and so allow the unloaded ones to be loose. If always tight in the case, there should be no chance to skew, unless one end of the shaft bearing or case is larger than the other end; but the necessity of perfect parallelism is of far more moment than would at first appear. If one end of the journal is one ten-thousandth of an inch larger than the other, the shaft will only have to make 100 turns before the rollers will be about one thirty-second of an inch skewed, unless restrained by a cage.

THEORY AND PRACTICE

One of the many things that are theoretically wrong, but said to work well in practice, is the use of short rollers in the place of balls in a thrust bearing, Fig. 19. Very short rollers are used on flat surfaces and held in a cage by their ends to keep them from twisting out of a radial line. They ought to go hard and wear out, as there is a constant sliding action at each end; but it is said they do not. It is quite possible that rollers so short that they would be held parallel by their ends running in a cage, Fig. 20, would do for journals better than long ones or balls. Cages could be made by the Franklin metal process or by double broaching, at reasonable cost. Such things wear out faster than the ordinary journals, and it is only when friction, or its elimination, is of the utmost importance that these mechanical substitutes for oil lubricants are to be recommended. The journal friction of a bicycle on a level smooth road consumes a large percentage of the entire work, and the difference between oil and ball lubrication is very marked; but in the case of a steam hammer the usual friction is a matter of no moment.

The practical perfection reached in the manufacture of balls and ball races, the quality of the material used and the great degree of hardness with strength obtained formed one of the great achievements in mechanical perfection accomplished during the last years of the nineteenth century. It was this perfection that rendered the ball bearing of practical use. Balls running on a flat surface to resist end thrust, or on and in truly cylindrical surfaces, run the freest from friction, but will not carry so heavy a load as if run in a concave raceway.

Whether two, three or four bearing points are best depends on whether the balls have to resist end thrust as well as side thrust. One form of thrust bearing where the four-point contact is used and so proportioned that the ball rolls as a true cone, Figs. 21 and 22, would not do at all were it possible to make them theoretically correct, as then the balls would never change their position and the wear would all come on two bands of only a line in width. But such perfection is not obtainable unless by accident, and this form of ball bearings properly applied—that is, where the service is not too severe—answers admirably.



FIGS. 18 TO 22. BALL AND ROLLER BEARINGS

Fig. 18—Geared roller bearing. Fig. 19—Short-roller thrust bearing. Fig. 20—Short-roller journal bearing. Figs. 21 and 22—Ball thrust where each ball theoretically rolls as a true cone.

wire acts in a manner comparable to the rope around a post. It is a very effective device where the coil is of itself strong enough to do the work. This device slips when reversed.

While friction is useful—in fact, indispensable—in mechanics, the places where it is undesirable are far more numerous. The various devices employed to avoid or overcome it have called up as much ingenuity and experimenting as any other one thing—rollers, balls and rings in innumerable variety of shapes, and lubricants from plumbago and tar to spindle oil and air, with thousands of methods of feeding.

ROLLER BEARINGS

Roller bearings are of two classes—solid and elastic—and of various kinds. Solid rollers must be hard, run in hardened boxes and on hardened shafts or sleeves, be as true as possible and the rollers all of the same size and parallel: the difficulty lies in keeping them parallel.

What Kind of a Man for Foreman?

BY ENTROPY

If a small shop is successful, it is a pretty safe bet that somewhere in the plant there is a good foreman. He may be the proprietor himself, or he may be the man who carries the title of foreman. Whatever his title, he is an all-around good judge of human nature, with a clear head for details that have not been reduced to drawings or writing, and he has something of a financial mind.

Every once in a while a successful small shop comes under the notice of some big concern, and the management of the latter decides that the man responsible for the success of that little shop will prove a valuable acquisition to its big plant, and hires him as foreman. Then the story begins.

UNDER NEW CONDITIONS

Mr. Foreman finds right off that he is neither allowed nor expected to do many of the things he formerly did. He no longer knows just how much cash there is in the bank. To be sure, he doesn't have to worry whether the pay roll will be met if he doesn't get that last machine on the cars before the first of the month, and he doesn't have to order all his castings or keep an eye on the amount of coal on hand for the blacksmith shop. All he has to do is to keep things going straight in one particular room. He finds that materials come in and are placed beside each workman's machine or bench. Each man is handed drawings and tools for the job and instructed just what speeds to use and how often to grind his tools and whom to take them to if they dull. Pretty soon he wonders what he has left to do and what he was hired for anyway.

The successful small-shop foreman is good material for a large-shop superintendent, but not often for a large-shop foreman. As a shop grows, its foremen are assisted by being relieved of the many things that take up their time. The foreman himself does not put it that way. He thinks that these duties are taken away from him, thereby decreasing his authority. There is no place in his armor quite so vulnerable as his power to make arbitrary decisions. The old story of the Irish foreman who fired a man or two every morning to show his authority has its parallel in almost every shop even today, unless some restriction is placed on the power of foremen to make arbitrary decisions.

The modern problem is to find foremen who can do the things that modern system has left in the hands of foremen, not to be all-around executives.

THE MODERN FOREMAN IS A TEACHER

What is left? The employment department has taken over the hiring, has put restrictions on the discharge, and has largely taken over discipline, except that of the minor variety. The efficiency department has taken over the planning of the way the work shall be done and routes it through the hands of one man or machine after another. A trucking department handles all the materials and finished product. As a result of all these things, the foreman finds himself left with just one big job, and that is to teach. The best the employment department can do is to give him men of a moderate degree of intelligence for the jobs for which he formerly secured experienced men. He must teach them to do the work or fall down on the

job. Tell him he is a teacher, and you scare him. He is no professor, and he is glad of it. Tell him that you have picked him because you believe that he can make people understand what he wants them to do, and he is right with you. That is all there is to good teaching, but he doesn't know it.

FUNDAMENTALS OF GOOD TEACHING

The fundamentals of good teaching are to know what one is trying to teach and to know how the other fellow, who is being taught, looks at it. Many mechanics can do good jobs themselves as long as everything runs smoothly, but unless they know the reason why for every move they make do not pick them for foremen. The foreman who has analyzed every job that comes to him and knows why the efficiency department wants two operations performed in the reverse order to what is usual, is much more likely to turn out a large day's work than the man who says, "Well, they want this thing done in this — fool way, so I guess we will have to do it even if it does take twice as long." This second man is one that has had some prerogative taken away, or thought he had. He wants to show the concern that if it would only fire the whole efficiency department and let him run his job the way he used to, it would have some shop. He always gets left, for progress just progresses, it never backs up. If it finds efficiency departments are no good, it invents something else. It never goes back to the abandoned scheme.

SOME THINGS A FOREMAN MUST MASTER

To know how to do a job implies some natural or trained common sense along the line of mechanical principles. Parrot-like ability to remember isolated facts is good only while it is being used by the one who has it. It is no asset to the man who would show others. The specifications so far might include graduates of technical schools, but they do not; because the technical graduate will not stay on a job long enough to pay for breaking him in. He is looking for something that he thinks is bigger, and he hasn't the patience to master the details that this foreman of ours must master. Then our foreman must have an additional quality that is not so common as it should be in college men, and that is an appreciation of how the chap feels who is trying to bring up a family on even present-day wages, with the cost of living jumping every few minutes.

MEN AVAILABLE FOR THE SKILLED JOBS ARE NOT ALL YANKEES

The men who are available for semi-skilled jobs are not all Yankees, and they are not all from the northern races. In fact, they are largely of a type that only a few years ago we would not have hired for anything except the most imitative work. Their viewpoint is altogether different from that of the northern races. They have not the same natural initiative or ambition. They are more content to let well enough alone. They can get quite excited over a race, but it must be a short dash, no six-day race for them. Just so this new foreman must understand the type of man that he must deal with. We may have sympathy for him and wish that the day might return when we can get the kind of workmen that we are accustomed to, but in the meantime we have to do the best that we can with what is available.

Safe and Noiseless Operation of Cut Gears

BY WILLIAM KNIGHT*

SYNOPSIS—An investigation of experimental results and authoritative studies on the design and operation of cast-iron gears. The cause of noise is discussed, and a formula for reduction of tooth height to avoid interference is given. Charts for safe load factors are presented, durability is considered, and formulas for thickness of the side plates and heating effect of rawhide gears are given.

The investigation of the proper shape of gear teeth and the allowable working stresses for the safe and noiseless operation of gears of different materials has for a long

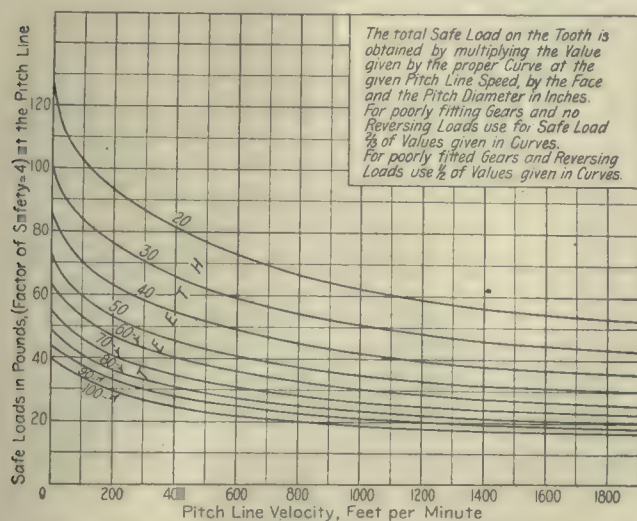


FIG. 1. SAFE NONREVERSING LOADS ON BROWN & SHARPE 14½-DEG. INVOLUTE CAST-IRON GEAR TEETH PROPERLY FITTED, PER INCH OF FACE AND PER INCH OF PITCH DIAMETER

Plotted from the empirical formula given by G. H. Marx and L. E. Cutter (see paper presented at the September, 1915, meeting of the A. S. M. E.), loads assumed to be applied on one tooth only (arc of action coefficient in Marx's formula $a = 1$).

time been the object of laborious efforts of engineers and manufacturers.

According to Willis, the involute form of gear tooth, which is the most commonly used nowadays, was first suggested by Euler.

In the last fifty years a large number of technical papers have been written on the subject of transmission of power by gears, and the *American Machinist* has largely contributed to the technical literature on gearing.

The most important articles published in the *American Machinist* on this subject are: 1901, Vol. 24, page 1140, the proportions and strength of spur gear teeth adopted by the Joseph Adamson Co.; 1902, Vol. 25, page 145, "The Strength of Shrouded Teeth," by Wilfred Lewis; 1903, Vol. 26, page 257, a comparative study on the resistance to crushing of curved surfaces of different radii in contact, by H. D. Williams; 1905, Vol. 28, page 220, Cheddie gives his ideas as to relative loads on cast iron, gun metal, cast steel and forged steel; 1908, Vol. 31, pages 95 and 115

(parts I-II), C. H. Logue on the effect of wear in the calculation of gear teeth; 1914, Vol. 40, page 182, T. V. Converse advocates increasing the angle of obliquity.

The most recent publications on spur gearing are: 1915, a paper on strength of gear teeth by G. H. Marx and L. E. Cutter, presented at the September meeting of the American Society of Mechanical Engineers, 1916, and a paper on spur gearing by D. Adamson, presented at the May meeting of the British Institution of Mechanical Engineers.

The object of the present paper is to review the results of the most recent investigations on the causes of noisy operation of gears, causes of failure, factors of safety, safe loads and proper speeds to be adopted in designing a gear drive, and to give a graphical representation of Marx's empirical formulas which, it is hoped, will allow a comprehensive idea to be obtained of the relative value of the safe load on gears and pinions for different pitch velocities and for different number of teeth.

CAUSES OF NOISE IN GEARS

The noise of gear drives is caused by the vibrations of the material, produced either by a variable compression (owing to the load being taken up by more teeth at some periods than at others), by concussion when a tooth becomes disengaged before the next one takes the load owing to a too small number of teeth in the pinion or to inaccuracy in cutting the teeth), or by a bad alignment of the shafts that allows jamming action between gear and pinion with a resulting grinding noise. To prevent troubles a bearing pressure sufficiently low should be allowed on the bearings, and the bearings should be located as close to the gears as possible.

Another common cause of noisy gear drives is to be found in the "interference" between teeth when a pinion with too few teeth is used. If the 14½-deg. Brown & Sharpe angle of obliquity is used with an addendum equal to 25 per cent. of the pitch and a dedendum of 32 per cent. of the pitch (proportions used by Daniel Adamson for spur wheels on cranes), a 12-tooth pinion and rack would produce "interference" if a straight-sided rack-tooth is used; and to avoid it an angle of 22½ deg. should be employed. If the minimum number of teeth in the pinion is 14, the 20-deg. angle of obliquity will be sufficient to prevent interference.

Interference is prevented by using, for a given reduction, the proper diameters of pinion and gear. The usual problem met with will be: Given the reduction, to find the most suitable number of teeth for the larger gear. An exceedingly good solution of this problem is offered by E. A. Vessey and J. A. Seager in *Machinery* of November, 1911. Applying the method described by them and solving the formulas given, Table 1 was derived.

Having found from the table the minimum number of teeth to be used in the larger gear, and dividing that number by the reduction, the corresponding number of teeth in the pinion can be found.

It will be seen from Table 1 that by increasing the pressure angle from 14½ deg. to 20 deg., the minimum

*Crocker-Wheeler Co., Engineering Department.

number of teeth in the larger gear that would secure the best results for avoiding interference and the consequent noise and wear of the teeth, can be greatly reduced; but an objectionable feature of this method is that being $14\frac{1}{2}$ deg.—the standard angle generally used—interchangea-

TABLE 1. SMALLEST NUMBER OF TEETH IN LARGER GEAR FOR GIVEN REDUCTION AND PRESSURE ANGLE

Gear Reduction	Pressure Angle, Degrees		Gear Reduction	Pressure Angle, Degrees	
	14 $\frac{1}{2}$	20		14 $\frac{1}{2}$	20
1.0	20	12	5.0	140	76
1.5	35	20	5.5	155	84
2.0	50	28	6.0	170	92
2.5	65	36	6.5	185	100
3.0	80	44	7.0	200	108
3.5	95	52	7.5	215	116
4.0	110	60	8.0	230	124
4.5	125	68			

bility would be sacrificed; and besides, because of the increased angle the "back-lash" would increase.

It is also evident from Table 1 that by adopting the $14\frac{1}{2}$ -deg. pressure angle, in many cases, the number of teeth in the larger gear would be so great that it would become necessary to use a fine pitch; and in order to secure the requisite strength in the teeth a large face would have to be adopted, requiring great accuracy in cutting and a careful meshing of gear and pinion in order to prevent the load from being thrown on one corner of the teeth, which being of a fine pitch could easily be broken.

It is suggested by Vessey and Seager that when a gear of a diametral pitch P having a number of teeth T different from the number N of teeth obtained from the table is to be used, to avoid "interference" the overall diameter of the gear should be reduced by an amount

$$A = 2 \times \frac{N - T}{P \cdot N} \text{ inches} \quad (1)$$

In this way, by reducing the height of the tooth, the digging of the gear teeth into the pinion teeth will be prevented. This digging weakens the teeth and is invariably accompanied by noise.

By reducing the addendum, only that portion of the tooth that wears uniformly is retained in use, thus preserving the original shape as long as possible.

The reduction of the addendum has been successfully carried out for years by E. A. Vessey and J. A. Seager, and has been proved to be desirable by the investigations of O. Lasche, of Berlin, published in 1899 (*Zeitschrift des Vereines deutscher Ingenieure*, Vol. 43, page 1417). Mr. Lasche's article is a valuable contribution to the literature on the subject, but unfortunately, as far as I know, has never been translated into English.

From what has been said, we may conclude that a means of greatly improving a noisy gear drive (always objectionable from the point of view of the comfort and the durability of the gear teeth) is to reduce the standard outside diameter of the larger gear the amount given before.

STRENGTH OF GEAR TEETH

The strength of a gear depends on its accurate design and construction and on the proper choice of material for a given service.

Irregularities in pitch, as has been proved by Lasche, at high speeds will give rise to some very severe stresses in the teeth, owing to the variation of angular velocity of the driven wheel (assuming that the velocity of the driving wheel remains constant) when the contact between teeth does not take place at the right point. In this case for a length of time t during the arc of approach the point of the tooth of the driven wheel will have to slide on the

tooth of the driving wheel until it reaches the point of theoretical beginning of contact (near the pitch line of the driving wheel), when sliding ceases and rolling begins. At this point the velocities of both wheels are equal, but before this point is reached the driven wheel must be retarded from the velocity that it had at the actual beginning of contact. If we call r the difference of pitch-line velocity of the driven wheel at the beginning, and at the end of time t , and if we call MK^2 the mass moment of

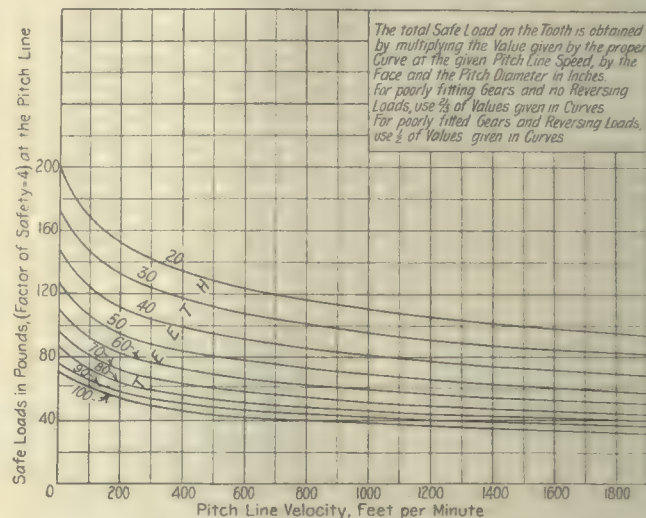


FIG. 2. SAFE NONREVERSING LOADS ON FELLOWS 20-DEG. INVOLUTE CAST-IRON GEAR TEETH PROPERLY FITTED, PER INCH OF FACE AND PER INCH OF PITCH DIAMETER

Plotted from the empirical formula given by G. H. Marx and L. E. Cutter (see paper presented at the September, 1915, meeting of the A. S. M. E.), loads assumed to be applied on one tooth only (arc of action coefficient in Marx's formula: $a = 1$).

inertia of the driven wheel and R the radius at the pitch line, the accelerating pressure on the teeth is:

$$P = \frac{MK^2}{R^2} \frac{2f}{r} \quad (2)$$

In the above formula r could be expressed as a function of the pitch-line velocity V of the two wheels, or:

$$r = AV$$

where A is a constant varying almost directly as the per cent. variation of the pitch due to inaccuracy in cutting the teeth. The time t varies inversely as V and can be expressed:

$$t = \frac{B}{V}$$

where B is another constant. Substituting r and t in (2) we obtain:

$$P = \frac{MK^2}{R^2} \frac{A}{2B} V^2 \quad (3)$$

showing that the accelerating pressure on the teeth varies directly as the square of the pitch-line velocity.

In an example given by Lasche of a 35-tooth pinion meshing with a 136-tooth gear, pitch 1 in. (approx.), pitch diameters $16\frac{1}{2}$ and $64\frac{1}{4}$ in. respectively, error in pitch 0.02 in. power transmitted by pinion 75 hp. at 570 r.p.m., we have that the torque transmitted is only 1,000 lb. at the pitch line, and the accelerating pressure due to 0.02 in. error in pitch, at the pitch-line velocity of 41 ft. per sec., is 28,000 lb., or 28 times the pressure necessary to transmit the power.

This will explain the reason why extreme accuracy is required in properly cutting, assembling and lubricating gears operating at high speed, the necessity of using high-grade steel and large factors of safety for transmitting a given torque and the desirability of having, whenever it is possible, a length of shaft or a flexible coupling which will allow some slight variation of angular velocity of a

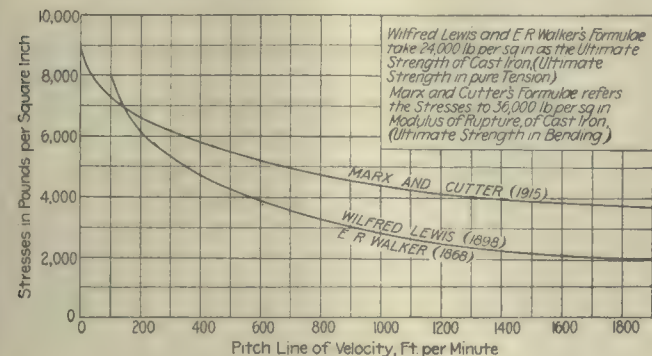


FIG. 3. COMPARISON OF TOOTH STRESS IN 14 1/2-DEG. INVOLUTE CAST-IRON GEARS, FACTOR OF SAFETY EQUALS 4—ACCORDING TO DIFFERENT AUTHORITIES

large gear without imposing excessive loads on the teeth owing to unavoidable errors in gear cutting.

Table 2 gives the allowable inaccuracy expressed in per cent. of the circular pitch for corresponding velocity of

TABLE 2. RATIO OF ALLOWABLE INACCURACY TO VELOCITY

Velocity at pitch 100 line ft. per min. or less	200	300	600	900	1,200	1,500	1,800	2,100	2,400
Inaccuracy in per cent. of circular pitch.....	5	1.76	0.96	0.34	0.185	0.12	0.09	0.065	0.042

the pitch circle in feet per minute, as given by D. Adamson in a paper on spur gearing presented at the May, 1916, meeting of the Institution of Mechanical Engineers, London.

Figs. 1 and 2 give the safe nonreversing loads respectively on properly fitted Brown & Sharpe 14 1/2-deg. and Fellows 20-deg. involute cast-iron gear teeth per inch of pitch diameter and per inch of face. The values plotted in these two diagrams were calculated from the empirical formulas derived from the experiments of G. H. Marx and L. E. Cutter (see paper presented at the September, 1915, meeting of the A. S. M. E.), and are based on the assumption that only one couple of teeth bears the load to be transmitted (arc of action coefficient a in Marx paper taken = 1). This has been done because, while a larger arc of contact is desirable and is probably obtained with new gears properly cut and carefully assembled (as was the case with those tested by Marx and Cutter), wear will take place after running for a certain time under severe conditions, and the load will be borne by only one couple of teeth at the place where less wear is likely to occur (near the pitch line). This is the scheme followed by E. R. Walker (1868) and Wilfred Lewis (1893), whose works on the analysis of stress in gear teeth have been considered for years as the standard works of reference on this subject. (See also discussion of Marx and Cutter's paper on the influence of the arc of contact coefficient.)

For poorly fitted gear teeth and no reversing loads use two-thirds the values given in Figs. 1 and 2, and for poorly fitted gears and reversing loads, use one-half the values given.

To obtain the total safe load at the pitch line multiply the load obtained from the proper curve in Figs. 1 and 2 by the gear (or pinion) face in inches and the pitch

diameter in inches. The product will represent the total safe load in pounds (factor of safety = 4) on one tooth, at the pitch line.

Fig. 3 is a comparison of the stress in pounds per square inch in Brown & Sharpe 14 1/2-deg. involute cast-iron gear teeth for the safe load on the tooth as given by Lewis and Walker, and those given by Marx and plotted in Fig. 1.

The safe stresses as given by Lewis are based on the ultimate strength of cast iron in pure tension of 24,000 lb. per sq.in., using at different speeds the corresponding factors of safety as given by E. R. Walker. The stresses obtained by using Professor Marx's safe loads at different speeds are based on a modulus of rupture of cast iron for transverse stress (or ultimate unit stress in outer fiber due to bending) of 36,000 lb. per sq.in. with a factor of safety of 4. Since the teeth of a gear finally fail in bending and not in tension, this seems to be the most consistent way of analyzing stresses in cast-iron gear teeth.

If we compare the severe stresses produced at high speed by inaccuracy in cutting gear teeth (28 times the stress produced by the transmitted torque, as given in Lasche's paper, for 0.02 in. error in pitch and 41 ft. per sec. pitch-line speed) with the allowable stresses given by Professor Marx for transmitting a given torque, we see that no

TABLE 3. VALUES OF FACTOR K

Total Life in Millions of Revolutions	17,000 Lb. per Sq.In.	14,000 Lb. per Sq.In.	11,400 Lb. per Sq.In.	8,500 Lb. per Sq.In.	5,700 Lb. per Sq.In.	2,850 Lb. per Sq.In.
0	1,350	1,120	898	605	455	228
1	1,292	1,080	870	655	442	228
2	1,238	1,040	840	640	442	214
3	1,180	1,010	812	626	428	214
4	1,138	968	798	612	428	214
5	1,094	940	785	598	413	214
6	1,051	910	770	598	413	214
7	1,023	883	742	584	413	214
8	997	868	726	570	399	214
9	968	840	713	555	399	214
10	940	826	698	555	384	214
12	883	782	670	526	384	200
14	840	740	640	512	370	200
16	797	712	612	498	356	200
18	769	685	598	484	356	200
20	740	655	570	470	342	200
30	612	555	485	442	314	185
40	526	484	428	370	285	172
50	413	384	356	299	242	157
60	342	327	299	270	214	142
100	297	284	256	226	200	134
120	257	242	226	212	171	123
150	228	212	200	185	157	111
200	185	171	157	142	128	97
250	142	142	137	127	111	86
300	128	123	120	109	100	77
400	101	98	94	88	80	64
500	84	81	81	74	69	56

matter how small these are taken, if the inaccuracy in cutting the teeth is not reduced to the very low figures given in Table 3, breakage is liable to occur.

THE DURABILITY OF GEARS

As Mr. Adamson points out in his paper, proper consideration has not as yet been given by designers to the durability of the gear teeth subject to alternating stresses, which in the long run will greatly reduce the ultimate strength of the material if the working stress (owing to the transmitted load or to the error in pitch) is too high.

Dr. Otto Schaefer (*Dingler's Polytechnisches Journal*, 1910) gives a table, reduced to English units by Mr. Adamson, showing the variation in loading according to the number of revolutions. Table 3 gives Dr. Schaefer's values for K (a variable dependent upon the material used) with particular reference to hoisting machinery, in the formula:

$$W = PFK$$

where:

W = Safe working load in pounds;

P = Circular pitch in inches;

F = Width of face in inches.

Dr. Schaefer suggests maximum stresses of 17,000 and 14,000 lb. per sq.in. for forged steel and steel castings respectively, and 5,700 lb. per sq.in. for cast iron.

RAWHIDE PINIONS

Rawhide is a material that is utterly unmechanical, and pinions made of this material must depend absolutely on lateral supports to carry the load. If the side plates of a built-up rawhide pinion are not stiff enough to provide a sufficient axial impression, the teeth will bend over, the drive will become noisy and the pinion will finally be destroyed.

Wilfred L. Spence, in *The Mechanical Engineer*, July 13, 1907, gives an empirical formula that he has used successfully for years for specifying the thickness of side plates t in inches and has checked with a number of pinions giving good service:

$$t = \frac{P}{4} + \frac{\sqrt{D}}{40} + \frac{1}{4} \text{ in.}$$

where:

P = Circular pitch in inches;

D = Pitch diameter of pinion in inches.

Mr. Spence's practice in respect to the smallness of wear has been to load the pinion as if it were of cast iron.

A. Shein, in the *General Electric Review* of April, 1913, page 276, points out that the face of a rawhide pinion is not determined by its strength only, but that the heating of it also has a decided influence in its choice.

TABLE 4. VALUES OF FACTOR C FOR HEATING OF RAWHIDE PINIONS

Diametral pitch. Values of " C "...	1 1,600	1½ 1,400	2 1,200	2½ 1,000	3 900	3½ 800	4 600
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Table 4 gives the maximum allowable values of the heating coefficient C for rawhide pinions in the formula:

$$C = \frac{WV}{FN^2}$$

where:

W = Total load on the tooth at pitch diameter pounds;

V = Velocity in feet per minute at pitch diameter;

N = Number of teeth in pinion;

F = Width of face in inches.

Livingstone, in the *Electrician* of March, 1909, page 892, gives an average of fifty examples of rawhide pinions "in service and giving satisfaction," working at a pressure of 115 lb. per in. of face.

A satisfactory operation of rawhide pinions with milled cast-iron wheels is reported by Lasche at 2,400 ft. per min. and a load of 112 lb. per in. of face.

§

Accurate, Simply Made Sine Bar

BY FRED HENKE

Since so many tools, gages and fixtures have been made in the last year, a thing that has confronted the tool maker is how to get some of the angles given on the drawing. This problem has made the sine bar become more popular and brought it before many tool makers who never saw or heard of it before. Although made in different lengths, the 5-in. size is most commonly used.

There are different ways of locating the studs accurately. Some tool makers drill and ream the holes and,

after the sine bar has been hardened and ground, bush the holes and bore them out, using the button system of getting the correct center distance. Others leave enough for grinding, and grind them out—a very slow way. The most simple method is to lay out the center distance as accurately as possible, with dividers; drill and ream the holes; then, after the bar is hardened, grind on the two sides. Make the studs with a shoulder, the small end to fit the holes. One stud can be concentric, and the other must be eccentric. Drive in the concentric stud first, and the other tight enough, but so that it can be turned.

Turn the eccentric stud until the exact center distance is obtained by measuring over the outside, allowing for the diameters, and drive it in to the shoulder. The small ends of the studs that enter the holes should be made large in the center or crowned a little, in case the bar has sprung and left the holes out of square with the sides, the crown allowing the studs to go in square against the shoulder.

Then set up on the surface grinder, indicating from the studs; grind one edge, turn the work over and grind the other edge. This will give an accurate and quickly made sine bar.

§

Care of the Miller Table

BY HERBERT M. DARLING

If high-class tool work is to be done on a miller, it is imperative that the surface of the table be as nearly perfect as possible. Yet we often see millers with their tables "pock-marked" from end to end, and all through carelessness.

One of the commonest ways of marring a table is by bolting down vises, or index heads, without making sure that their under surface is absolutely clean. Most manufacturers make their tables of a hard grade of iron, but when a vise is tightened down with a chip beneath it, it will surely mar the table. Another source of trouble is in the use of rough blocking. When clamping work down with bolts and straps, it is well to be careful about the blocking used under the outer end of the straps. It is best to use blocking that is smoothly finished on the bottom. I know of one shop that keeps a plentiful supply of hardwood blocking in the toolroom, and the tables of its millers certainly show the good effects of it.

Cleaning up a miller after working steel, with its accompanying mess of chips and oil, is a dirty job and one that, unfortunately, is shirked by some tool makers. While milling few of these mechanics seem to look forward or do anything to make the cleaning job easier. In a shop where wiping rags are provided, it is an easy matter to spread a cloth on the miller table on either side of a vise, or between the index head or the foot stock. If this is done, it is an easy matter to clean up, for the chips are all on the cloth instead of being in the T-slots and table end pockets or plugging up the oil drains. One tool maker of my acquaintance keeps three pieces of ½-in. board handy. One is used to cover the table between index centers, while the other two are cut out to fit on either side of the miller vise. These boards not only protect the table, but catch most of the chips, making the clean-up easier. This man's miller has been in use over three years, and the table is still in perfect condition and without a blemish.

United States Munitions*

The Springfield Model 1903 Service Rifle

Operations on the Bolt--II

SYNOPSIS—A continuation of the detailed description of manufacturing operations on the bolt.

OPERATIONS 16 AND 19½. TURNING BEVEL, FRONT END

Transformation—Fig. 613. Machine Used—Pratt & Whitney No. 2 Lincoln type miller, same as turning body, Fig. 603. Number of Operators per Machine—One. Work-Holding Devices—On centers, Fig. 614. Tool-Holding Devices—In holder on carriage of machine. Cutting Tools—Plain turning tools, similar to Fig. 606. Number of Cuts—One. Cut Data—70 r.p.m.; $\frac{1}{8}$ -in. feed. Coolant—Cutting oil, $\frac{1}{4}$ -in. stream. Average Life of Tool Between Grindings—3,500 pieces. Gages—Fig. 615; A, diameter of extractor collar; B, distance; C, location of bevel from end; the arm is hinged and brought down on the bolt after it is slipped on the stud. Production—25 per hr.

OPERATION 9. TURNING BODY TO FINISH

Transformation—Same as Fig. 602. Machine Used—Pratt & Whitney No. 2 Lincoln miller, same as Fig. 603. Number of Machines per Operator—Two. Work-Holding Devices—Held on centers, same as Fig. 604. Tool-Holding Devices—Held in holder on carriage of machine. Cutting Tools—Form cutter, Fig. 616. Number of Cuts—One. Cut Data—Speed, 70 r.p.m.; Feed, 0.004 in. per rev. of cutter; $\frac{1}{8}$ in. stroke. A vertical Life of Tool Between Grindings—250 pieces. Gages—See Fig. 607. Production—20 per hr. per machine.

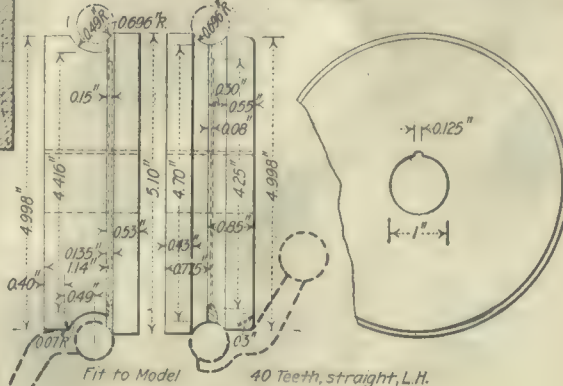
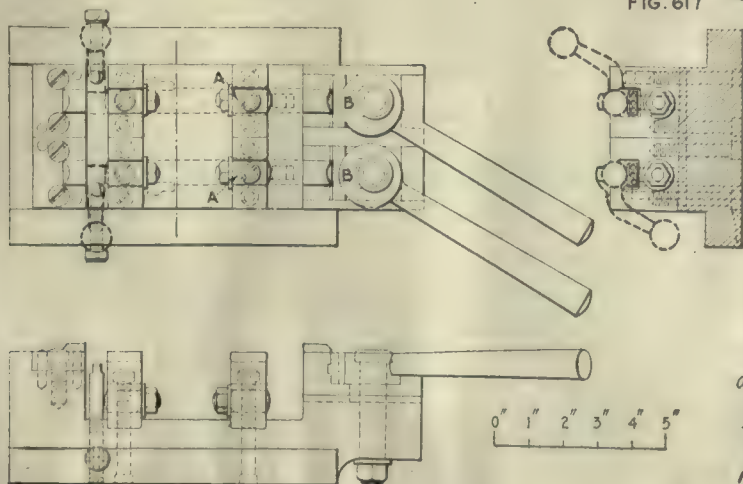
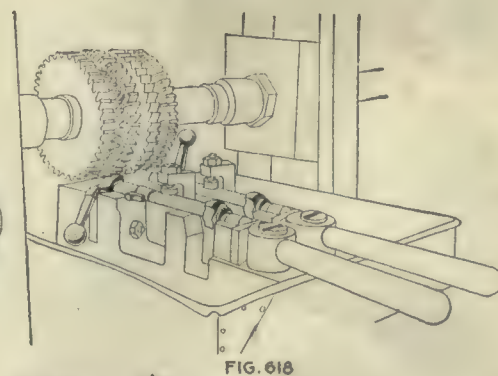
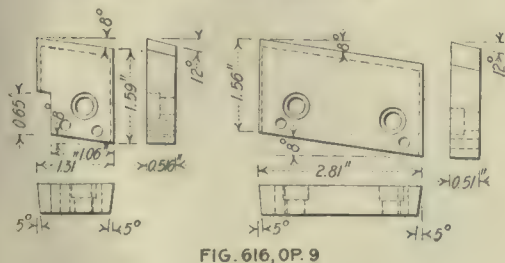
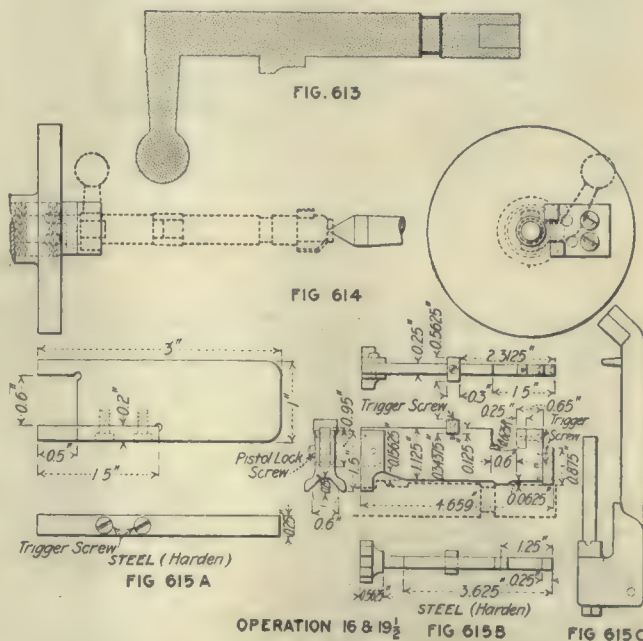
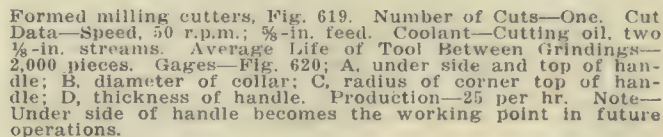
OPERATION 11. BURRING REAR END OF WELL HOLE

Number of Operators—One. Description of Operation—Filing burrs thrown up by turning operation. Apparatus and Equipment Used—File. Production—400 per hr.

OPERATION 12. MILLING BODY, UNDER SIDE AND TOP
OF HANDLE AND EXTRACTING CAM COLLAR

Transformation—Fig. 617. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Machines per Operator—One. Work-Holding Devices—Held on forms by finger A and clamped at ends by cams B, Fig. 618; one bolt is held in each position, so opposite sides of two bolts are milled at one setting. Tool-Holding Devices—Standard arbor. Cutting Tools—

*Copyright, 1916, Hill Publishing Co.



and 671. Here the clamping piece *A* can be swung clear of everything by means of the long link on which it is hung, while the actual locking is accomplished by the cam surface on the inside of the hook.

The odd shape of the bolt, with the handle at right angles to the center line of the body, in addition to the bend in the handle itself, makes it a somewhat difficult piece to hold for some of the operations. These difficulties are, however, overcome in various ways, as can be observed.

Some of the operations are seemingly very trivial from the machining point of view, and yet each must be done

shows clearly how the bolt is held in the fixture with the front end projecting so as to be accessible to the cutter, while at the same time it is substantially supported against the thrust of the cutter, so as to prevent vibration with its attendant chatter. The methods of rotating on the trunnions *CC* by means of the handle *D* can be clearly seen, the amount of movement being governed by adjustable stops, one of which is shown in front of the lever.

The milling of what may be called the back or neutral part of the lugs to conform with the body of the bolt itself involves the use of hand millers and formed milling cutters

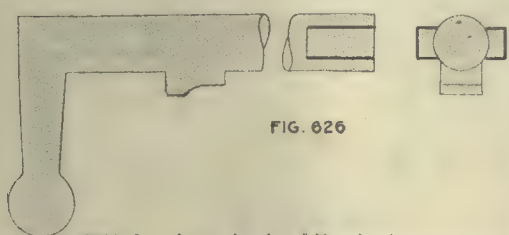


FIG. 626

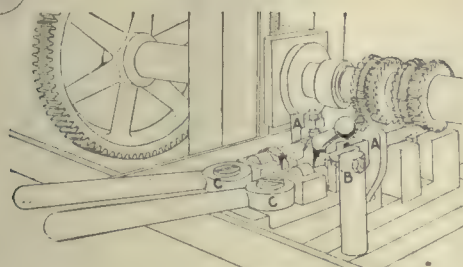


FIG. 627

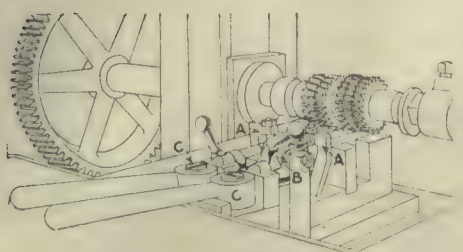


FIG. 628

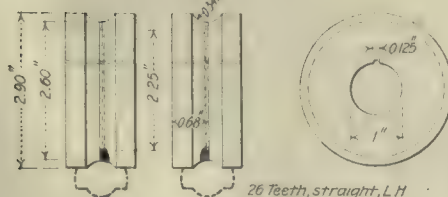


FIG. 630

26 Teeth, straight, L.H.

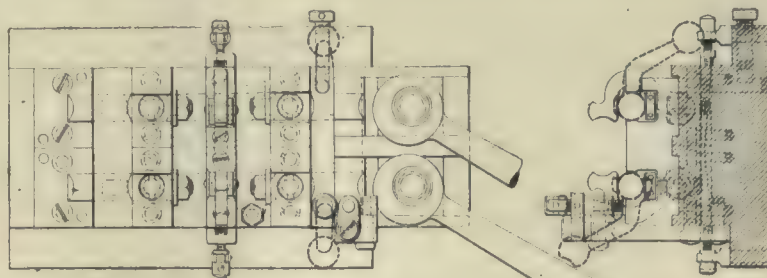


FIG. 629

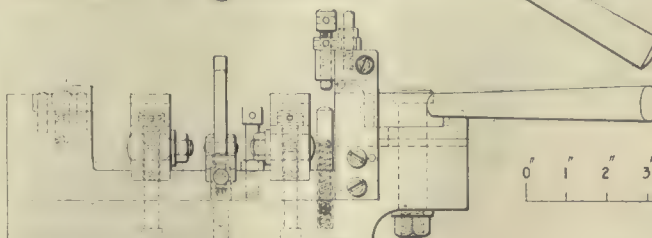


FIG. 629A

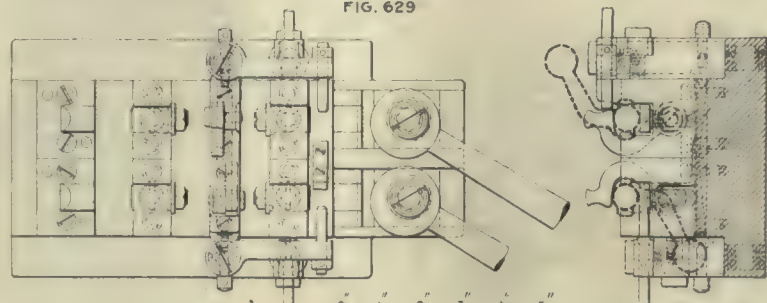


FIG. 631

OPERATION 14

OPERATION 14. MILLING RIGHT AND LEFT SIDE OF LOCKING LUGS

Transformation—Fig. 626. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Machines per Operator—One. Work-Holding Devices—Vise with side and end clamps, Figs. 627 and 628, details in Fig. 629; fingers *A* hold swing over work, which stops against *B*; cams *C* hold at ends. Tool—

Holding Devices—Standard arbor. Cutting Tools—Two sets radius cutters. Fig. 630. Cut Data—Speed, 60 r.p.m.; $\frac{1}{8}$ -in. feed. Coolant—Cutting oil, two $\frac{1}{4}$ -in. streams. Average Life of Tool Between Grindings—2,000 pieces. Gages—Fig. 631, diameter of body; see also Fig. 625. Production—25 per hr.

in the proper place and to the proper size to match in with some of the many functions that the bolt must perform. The small cam cuts in the end of the bolt, both for the cocking piece and for the sleeve lock, are good examples of operations of this kind.

The type of rotating fixture that is largely employed in this work is shown in Fig. 636, this particular operation being the hand milling of the front end of the bottom lug and the top of the locking lug. This illustration

to secure the proper contour. Even then it is not always easy to have the cuts blend into the curve of the turned body, as a slight eccentricity or a slight misadjustment sidewise will affect the proper joining of the curves.

And with all these irregular shapes there is the constant gaging so that all parts may have not only the correct size and shape, but the proper relation to the other parts, the under side of the handle and the back end being the two important gaging points.

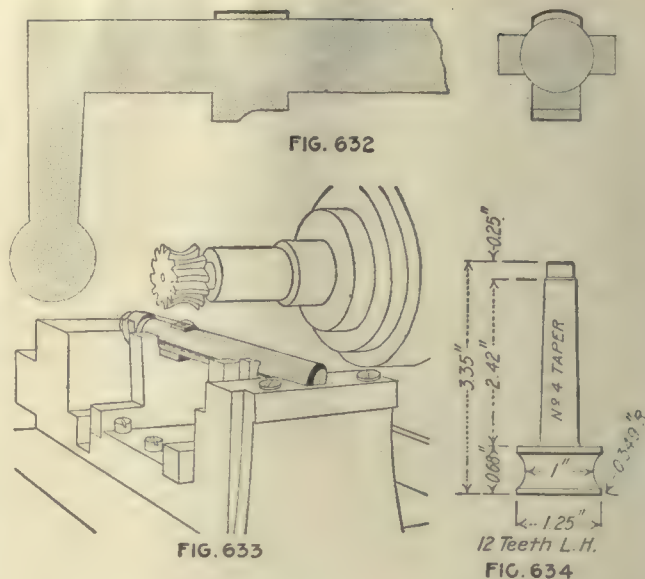
In this connection the use of what may be called finger gages can be clearly seen. One type of these is shown in Fig. 615-C. Here the stud slips inside the firing-pin rod hole to the shoulder at the back, the finger being held out of the way until the gage is in place. Then the finger is lowered onto the work and gages both the bevel of the front end and its distance from the shoulder at the rear.

OPERATION 19. HAND MILLING TO REMOVE STOCK LEFT BY OPERATIONS 12 AND 13

Transformation—Fig. 632. Machine Used—Garvin No. 3 hand miller. Number of Operators per Machine—One. Work-Holding Devices—Vise; jaws clamped on end, Fig. 633. Tool-Holding Devices—Taper shank. Cutting Tools—Radius milling cutter, Fig. 634. Number of Cuts—One. Cut Data—Speed, 300 r.p.m.; hand feed. Coolant—Cutting oil, $\frac{1}{16}$ -in. stream. Average Life of Tool Between Grindings—2,000 pieces. Production—70 per hr.

OPERATIONS 15 AND 24. HAND MILLING FRONT END OF BOTTOM LUG AND TOP OF LOCKING LUGS

Transformation—Fig. 635. Machine Used—Garvin No. 3 hand miller. Number of Operators per Machine—One. Work-Holding Devices—Rotating fixture, Fig. 636; work held by finger A; plate B is rotated on trunnion CC by handle D. Tool-Holding Devices—Taper shank. Cutting Tools—Milling cutters, Fig. 637. Number of Cuts—One. Cut Data—Speed, 85 r.p.m.; hand feed. Coolant—Cutting oil, $\frac{1}{16}$ -in. stream. Average Life of Tool Between Grindings—2,000 pieces. Gages—Fig. 638; A, front end of bottom lug, radius and distance; B, height of safety lug. Production—75 per hr.



OPERATION 19



FIG. 635

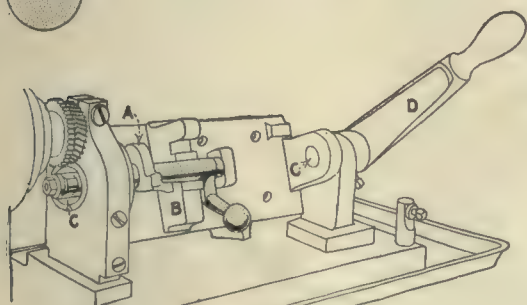


FIG. 636

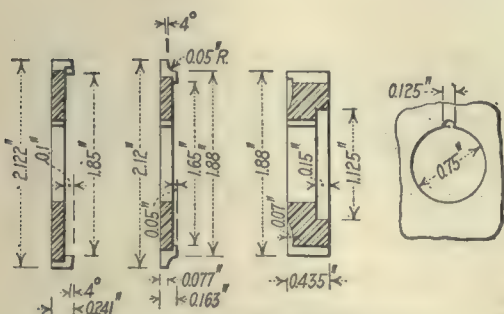


FIG. 637

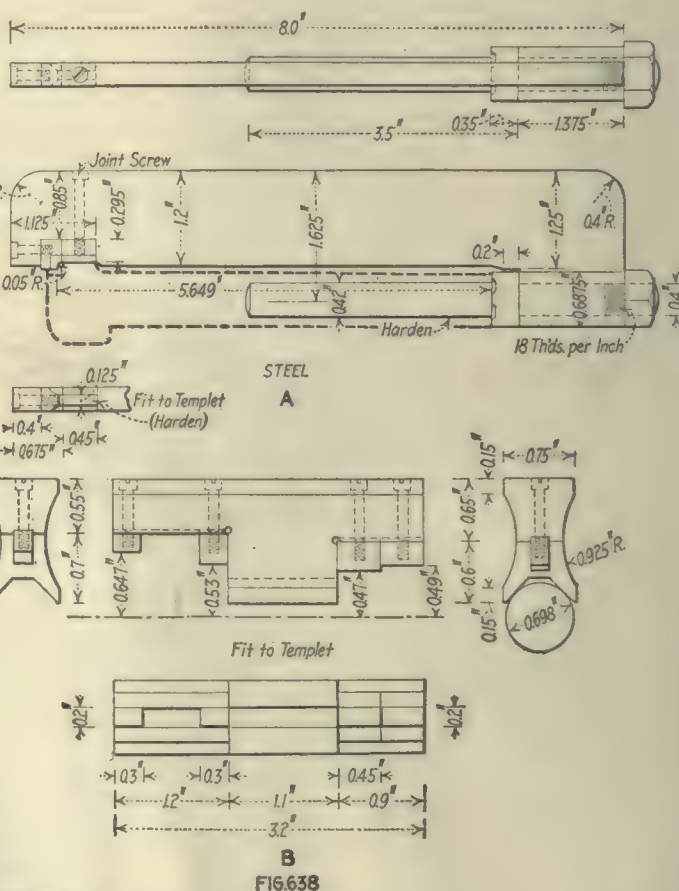


FIG. 638

OPERATION 15 & 24

Another type of finger gage is shown in Fig. 625. This might perhaps be called the cross-finger type, from the location of the finger and the way in which it is used. The fingers, as can be seen in Fig. 625-B, serve to gage the shape of the lugs and of the body at various points.

The bolt is located in V's with relation to the under side of the handle, and the various fingers are dropped into place as required. Suitable stops are placed to hold them in proper position. If they touch the stops before making contact with the work, the bolt is too small at that point, and vice versa. It will also be noticed that there are a pair of vertical fingers near the handle. These

stop against a suitable projection so as to gage the sides of the safety lug at the same time the horizontal fingers are gaging the other portion.

It will be noted that the V gage, or gages with V openings for centering the work, are used to a considerable extent, one instance being shown in Fig. 638. This gages the radius of the bottom lug or its height from the body and presupposes the body being the correct diameter. Other gages for a somewhat similar purpose use the center hole as the guiding point.

Few pointer or indicating gages are used, although one is shown in Fig. 657. The tendency is toward positive

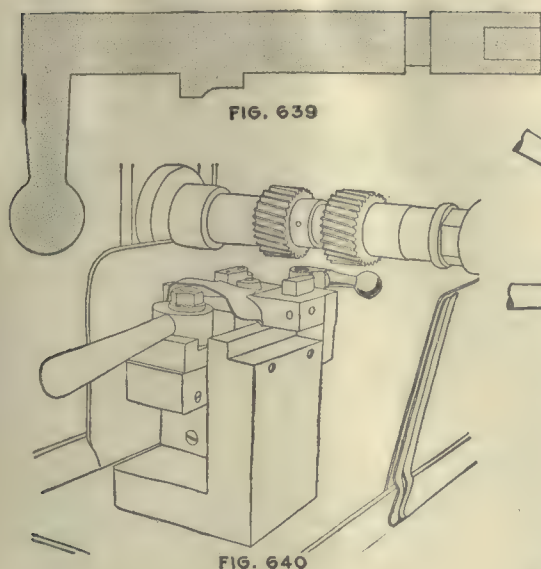


FIG. 639

FIG. 640

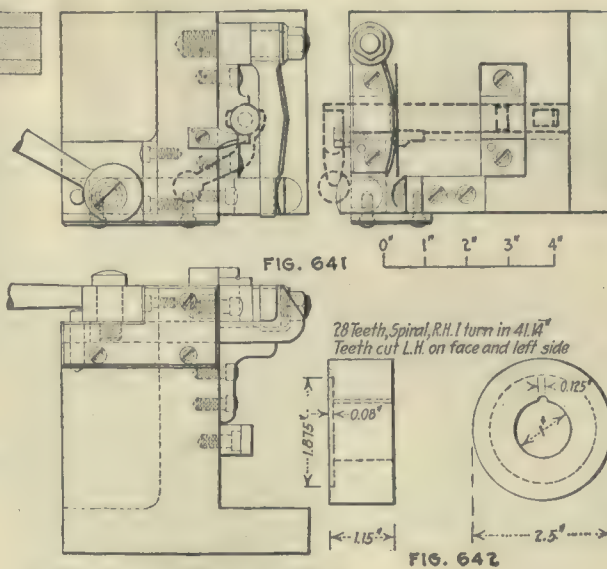


FIG. 641

28 Teeth, Spiral, R.H. 1 turn in 41.14"
Teeth cut L.H. on face and left side

FIG. 642

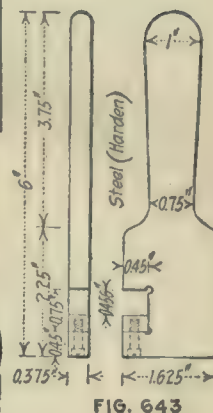


FIG. 643

Operation 20

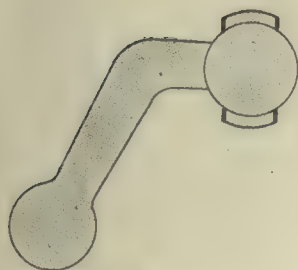


FIG. 644

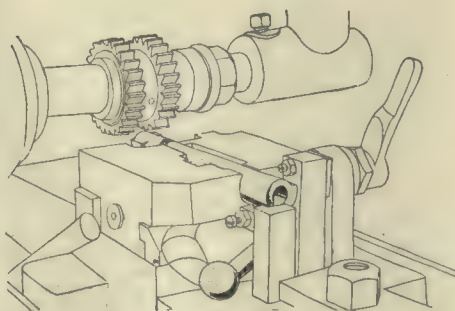


FIG. 645

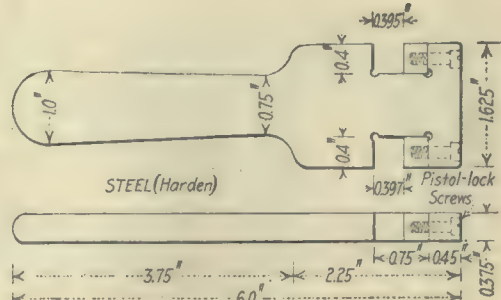


FIG. 648

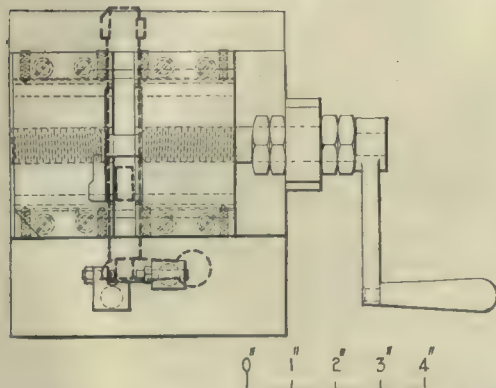


FIG. 646

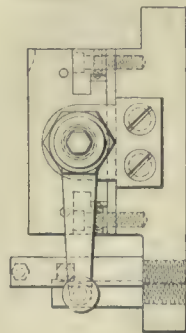
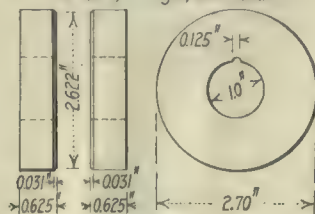


FIG. 647

26 Teeth, Straight, Left Hand



OPERATION 48

OPERATION 20. MILLING REAR OF HANDLE TO GAGE

Transformation—Fig. 639. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Machines per Operator—Two. Work-Holding Devices—Work clamped to block in upright position, Fig. 640; details in Fig. 641; double fixtures are also used. Tool-Holding Devices—Standard arbor. Cutting Tools—Two side-milling cutters, Fig. 642. Number of Cuts—One. Cut Data—Speed, 60 r.p.m.; $\frac{1}{8}$ -in. feed. Coolant—Cutting oil, put on by brush. Average Life of Tool Between Grindings—2,000 pieces. Gages—Fig. 643, thickness. Production—25 per hr.

OPERATION 48. HAND MILLING SIDES OF LOCKING LUGS

Transformation—Fig. 644. Machine Used—Garvin No. 3 hand miller. Number of Operators per Machine—One. Work-Holding Devices—Forms and vise jaws, Fig. 645; details in Fig. 646. Tool-Holding Devices—Standard arbor. Cutting Tools—Two milling cutters, Fig. 647. Number of Cuts—One. Cut Data—Speed, 300 r.p.m.; hand feed. Coolant—Cutting oil, put on by brush. Average Life of Tool Between Grindings—2,000 pieces. Gages—Fig. 648, thickness. Production—65 per hr.

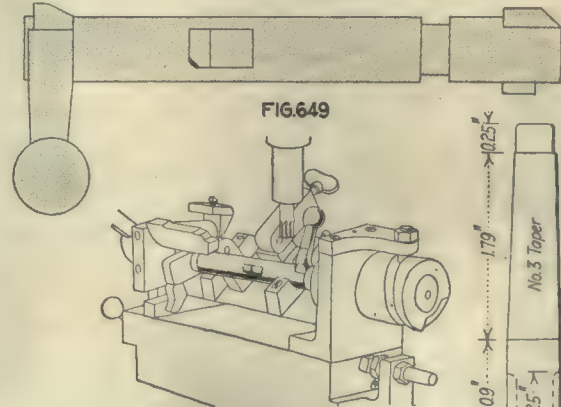


FIG. 649

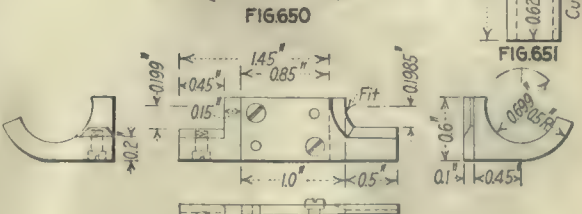


FIG. 650

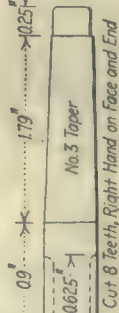


FIG. 651



FIG. 652

STEEL (Harden)

OPERATION 23

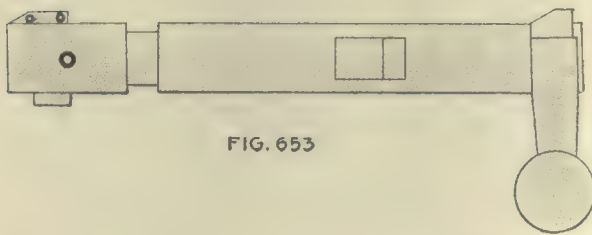


FIG. 653

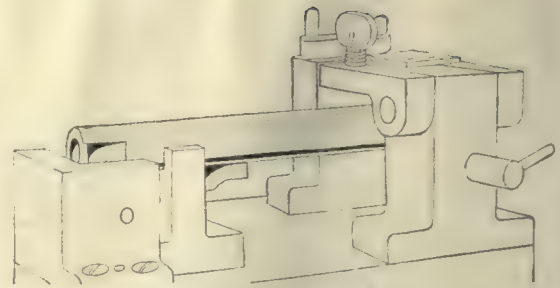


FIG. 654

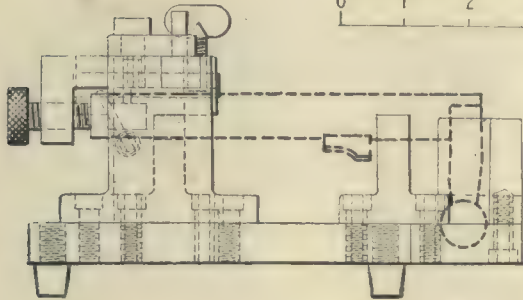
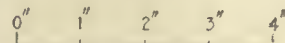
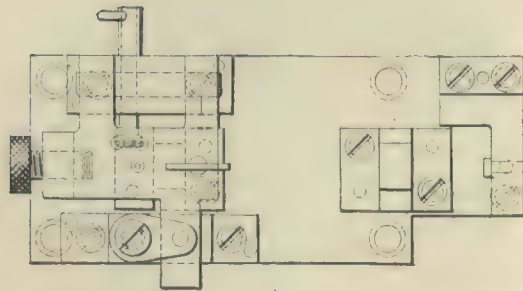


FIG. 655

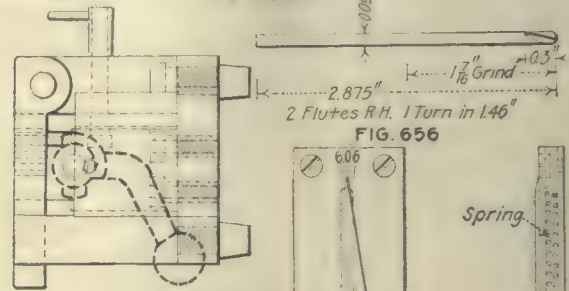
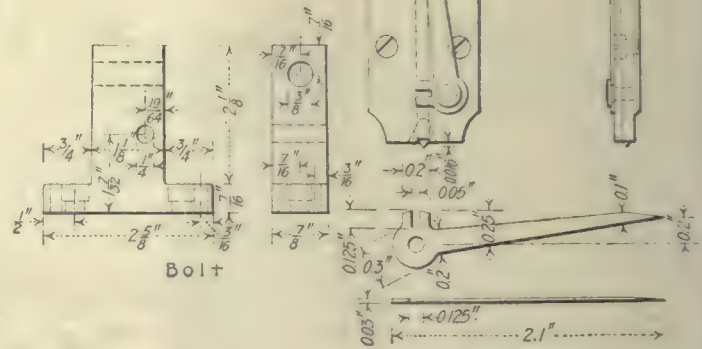


FIG. 656

Spring



Bolt

Finger
STEEL (Harden)

FIG. 657

OPERATION 32

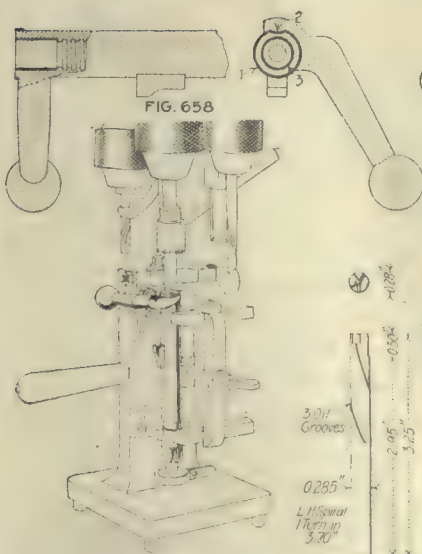


FIG. 658

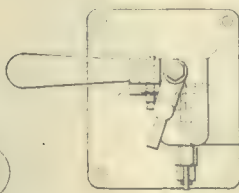


FIG. 660

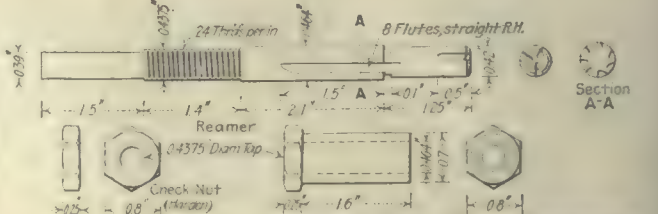


FIG. 661B

FIG. 661A

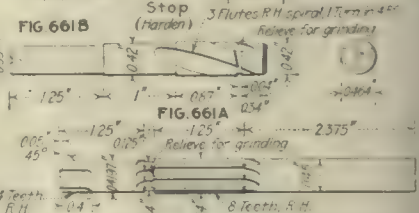


FIG. 661C

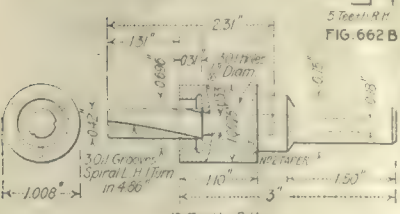


FIG. 662

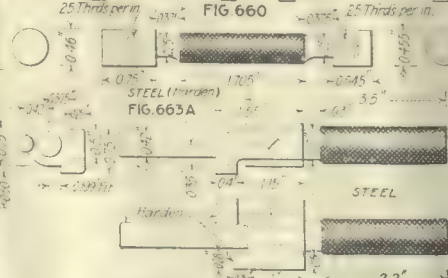


FIG. 663B

OPERATION 21, 28, 29

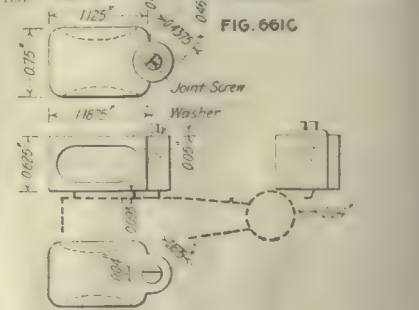


FIG. 663C

gages or those with direct readings instead of multiplication as with a pointer. "Feel" gages, depending on the sense of touch, do not seem to have found their way into the rifle field to any great extent.

As has been intimated before, the machines used are not always those which would have been selected as best

OPERATION BB. REMOVING BURRS FROM REAR LUGS AND UNDER HANDLE

Number of Operators—One. Description of Operation—Removing burrs thrown up around lugs and under handle. Apparatus and Equipment Used—File and scraper. Production—250 per hr.

OPERATION CC. STAMPING STOCK NUMBER

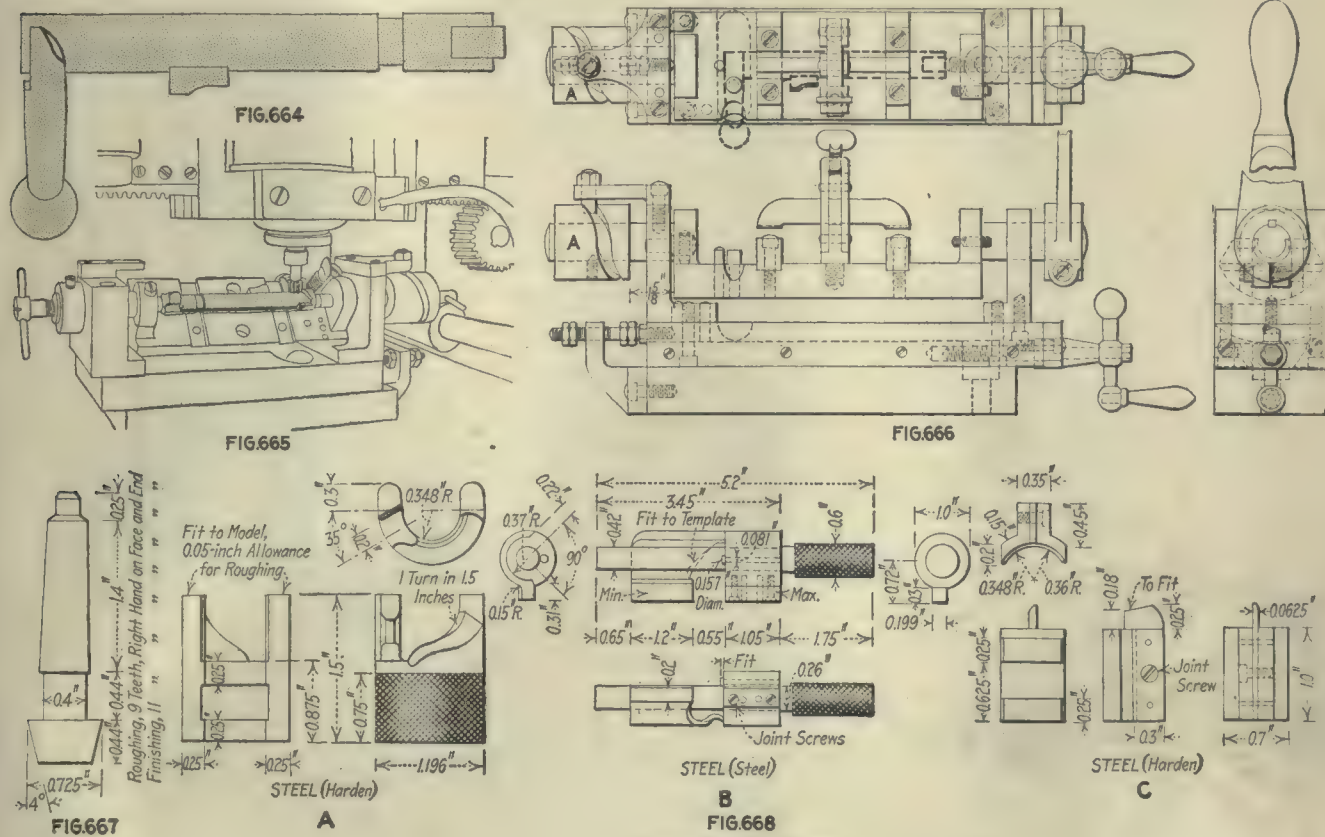
Number of Operators—One. Description of Operation—Stamping stock number on under side of safety lug. Apparatus and Equipment Used—Stamp and hammer. Production—450 per hr.

machines which were already in the shops, and this adaptation has been very skillfully done in nearly every instance.

The casehardening of the bolt requires special attention as it must not be too soft nor yet so hard as to be brittle. A hardness test, either by scleroscope or Brinell

OPERATIONS 21, 28, 29. HOLLOW MILLING AND COUNTERBORING FOR SLEEVE, AND MILLING FOR SAFETY LOCK

Transformation—Fig. 658. Machine Used—Dwight-Slate 14-in. three-spindle upright drilling machine. Number of Operators per Machine—One. Work-Holding Devices—Vertical fixture, Fig. 659; for details see Fig. 660, which holds bolt for all three operations. Tool-Holding Devices—Drill chuck. Cutting Tools—Counterbore, Fig. 661; A, B and C, counterbores; hollow mill, Fig. 662. A and B mills for safety lock. Cut Data—Speed of hollow mills, 260 r.p.m.; of other tools, 540 r.p.m.; hand feed. Coolant—Cutting oil, $\frac{1}{8}$ -in. stream.



STEEL (Steel)
B
FIG. 668
OPERATION 25 & 26

OPERATION 23. HAND MILLING REAR CORNER OF REAR LUG

Transformation—Fig. 649. Machine Used—Ames 16-in. upright drilling machine. Number of Operators per Machine—One. Work-Holding Devices—Rotating fixture, Fig. 650. Tool-Holding Devices—Taper shank. Cutting Tools—End mill, Fig. 651. Number of Cuts—One. Cut Data—Speed, 600 r.p.m.; hand feed. Coolant—Cutting oil, $\frac{1}{8}$ -in. stream. Average Life of Tool Between Grindings—500 pieces. Gages—Fig. 652, angle of corner. Production—100 per hr.

OPERATION 32. DRILLING GAS AND BOLT-STOP PIN HOLES

Transformation—Fig. 653. Machine Used—Dwight-Slate 14-in. three-spindle upright drilling machine. Number of Operators per Machine—One. Work-Holding Devices—Drill jig, Fig. 654; details in Fig. 655. Tool-Holding Devices—Drill chuck. Cutting Tools—Two drills; one, Fig. 656, has a rounded point for bolt-stop pin holes. Cut Data—Speed, 1,500 r.p.m.; hand feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—1,000 pieces. Gages—Fig. 657, depth of stop-pin holes. Production—75 per hr.

OPERATION DD. REMOVING BURRS FROM EXTRACTOR-COLLAR GROOVE

Number of Operators—One. Description of Operation—Removing burrs thrown up at extractor collar. Apparatus and Equipment Used—File and scraper. Production—300 per hr.

Average Life of Tool Between Grindings—500 pieces. Gages—Fig. 663; A, limit gage for counterbore; B, location of safety lock; C, depth of hollow milling at end. Production—40 per hr.

OPERATIONS 25 AND 26. PROFILING EXTRACTOR CAM, ROUGH AND FINISH

Transformation—Fig. 664. Machine Used—Pratt & Whitney No. 2 profiler, Fig. 665. Number of Operators per Machine—One. Work-Holding Devices—Rotating fixture, Fig. 666; cam at A gives proper profile. Tool-Holding Devices—Taper shank. Cutting Tools—Two angle cutters, roughing and finishing, Fig. 667. Number of Cuts—Two. Cut Data—Speed, 900 r.p.m.; hand feed. Coolant—Cutting oil, $\frac{1}{8}$ -in. stream. Average Life of Tool Between Grindings—300 pieces. Gages—Fig. 668; A, contour of cam; B, location from shoulder and locking lug; C, angle of side of cam. Production—60 per hr.

OPERATION FF. REMOVING BURRS LEFT BY OPERATION 28, WITH FACING TOOL

Number of Operators—One. Description of Operation—Removing burrs left by operation 28. Apparatus and Equipment Used—Hand facing tool with pilot. Production—300 per hr.

OPERATION GG. REMOVING BURRS LEFT BY OPERATION 21, FILING

Number of Operators—One. Description of Operation—Removing burrs thrown up by operation 21. Apparatus and Equipment Used—File and scraper. Production—300 per hr.

suited for the work had it been a case of buying new machinery. But, as in the management of railway shops to a large extent, it often becomes necessary to utilize

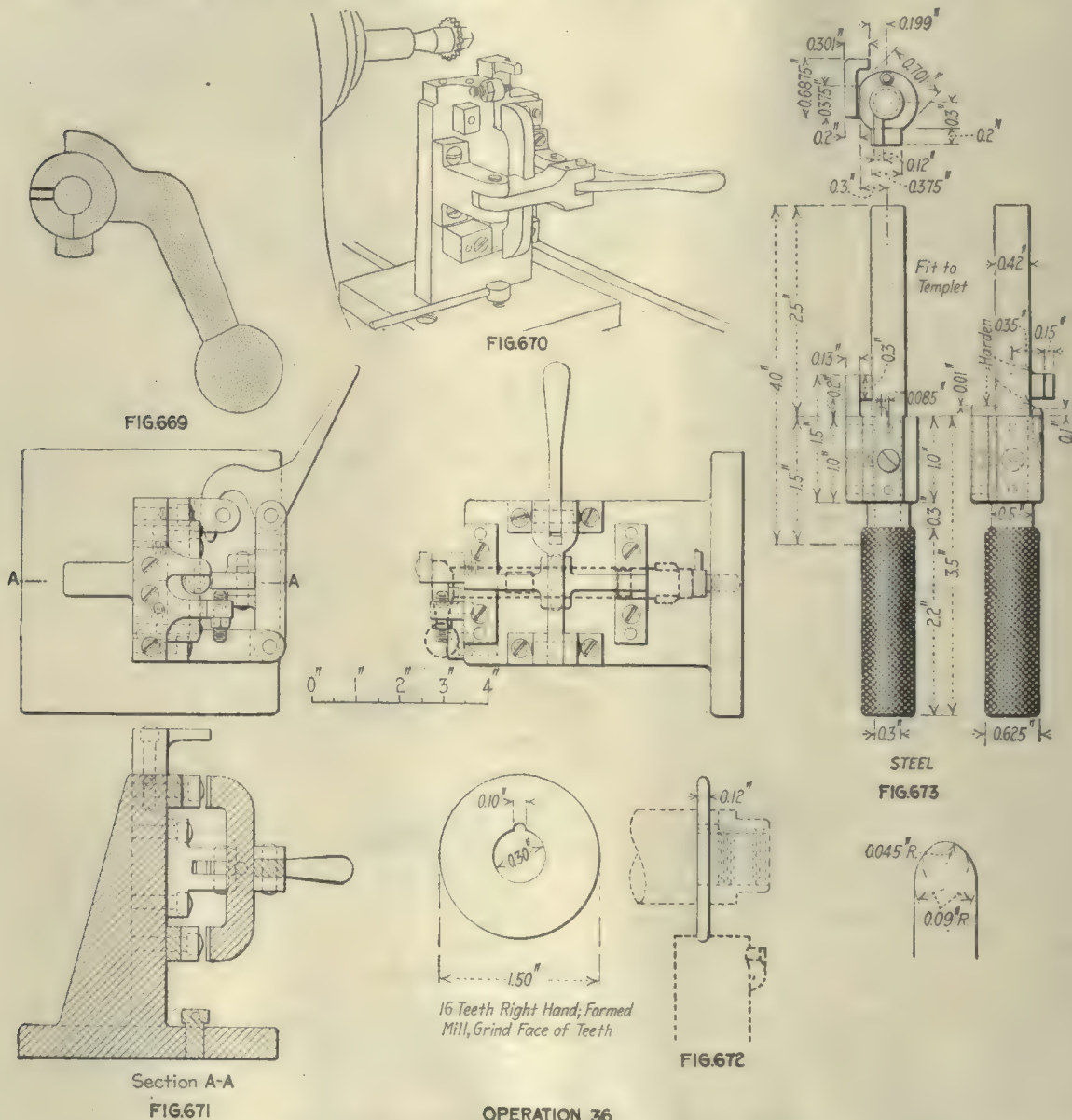
method, is required on 25 per cent. of each of lot receiving the same heat treatment. This care is necessary owing to the high pressure caused by the explosion, this

being 51,000 lb. with the regular cartridge and 71,000 lb. with the high-pressure testing cartridge, or "blue pill," as it is commonly called. Full directions for the case-hardening treatment which has been found useful for the bolt will appear in the remaining article on the manufacture of the bolt.

The question of cutting lubricants or coolants in connection with the making of rifles has had careful study

oil is used in making the soda or cutting compounds, although at times Triumph and even fish oil may be added to thicken it or give it a little more body.

The usual cutting compound is made from 3 gal. of black oil, 8 gal. water and 10 lb. of sal soda, enough being mixed in this proportion to fill the large tank from which it is pumped to the various parts of the shop. This compound is mixed up once a year, during the July vacation,



OPERATION 36

OPERATION 36. HAND MILLING FOR COCK-NOTCH

Transformation—Fig. 669. Machine Used—Garvin No. 3 hand miller, Fig. 670. Number of Operators per Machine—One. Work-Holding Devices—Clamped to fixture, Fig. 671. Tool-Holding Devices—Standard cutter arbor. Cutting Tools—Round-nose slotting cutter, Fig. 672. Number of Cuts—One.

Cut Data—Speed, 450 r.p.m.; hand feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—1,000 pieces. Gages—Fig. 673, location of notch from under side of handle. Production—175 per hr. Note—Work-holding points, top and body; guiding point, under side of tail.

and has been the subject of much experiment. This has resulted in the establishment of a number of cutting mixtures to handle different grades of stock and different kinds of work, each being used where experience has shown it to be most suitable.

The coolants in use in the Springfield armory include lard oil, Triumph oil, cutting oil, Nagle oil, fish oil and soda. Then there is what is known as "black oil," which is the oil that has been used on machines and afterward filtered. This is of course a mixture of all the kinds of oils, the proportions of each being unknown. This black

and the scum is taken off as it rises from time to time. There are also small tanks on or near some machines, where a special mixture can be made, this generally consisting of the addition of more oil to give it body for handling tough stock.

A compound that is working out well for a particularly tough bolt stock is made from 1 gal. of Nagle oil and 4 gal. of water, this seeming to make a better job and be easier on the turning or shaving cutters. It proved to be better than oil in the case in question, which might have been an exceptional case.

Letters from Practical Men

Drilling Knee for Collars

For drilling screw holes, it is the usual practice to place collars, small pulleys, etc., on a stud driven into a hole in a knee, as in Fig. 1. As different diameters of studs are required, it is necessary to drill several holes in the knee to accommodate them.

In Fig. 2 is shown a handy stud-holding knee, wherein the stud is placed in a V fastened down with a cap.

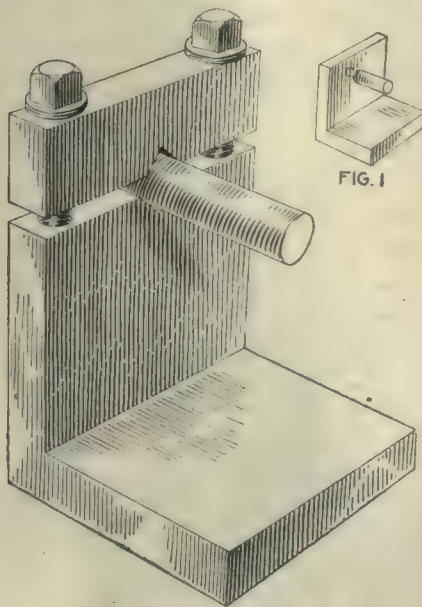


FIG. 2

DRILLING KNEE FOR COLLARS

The V in both cap and knee will take almost any moderate-sized stud. The advantage in using this type of knee is that the studs do not have to be turned on the end, as is the case when they are fitted into a hole. Also, the knee remains true, which it does not when the studs are knocked out.

J. E. Cook.

Hartford, Conn.

Which Is the Better Way To Impart Information?

After all is said and done, this journal is an educator—that is, if we designate education as the distribution of knowledge. We go to its advertising columns to ascertain who makes what and where, and to its reading columns for details of manufacturing methods, etc. Now, Mr. Editor, all those who have given any thought to education will admit that the crux of instruction is to impart knowledge in a way that will be remembered, the all-important point being to have that information stick. You are as interested in doing this as are your readers. Below I give two different expositions of the same thing, and it seems to me that it will be very interesting to have your opinion as to which is the better of the two presentations, and also the opinion of your readers.

First presentation: When a miller or a slotter is not available, the ends of long, comparatively light pieces can be very easily and fairly rapidly machined on a planer by clamping the material in the head and fastening properly shaped tools to the planer bed or securing them on a vise and feeding the work down and across the tools.

Second presentation: It is not infrequently found in machine shops, especially when small, that two or three men constitute themselves a board of approval when a new hand is taken on. This was the case in a little shop up in New England, where Ed Hall was hired as a planer hand. For several days Hall's work was pretty carefully scrutinized by the three self-appointed judges.



THE JOB DONE ON THE PLANER

He seemed to do his work well enough, but the three critics would not give him, so to speak, a clean bill of health. However, he gained his footing on the fourth day, oddly enough, by a mistake as to his job.

When Hall came in one morning, there lay on the bench at one side of his planer four steel racks, 3 in. wide, 1/2 in. thick and about 5 ft. long. One of these held down a blueprint and on the floor was a casting with a blueprint lying across it. As Hall took off his coat, it swept this blueprint off the casting to the floor under the bench. Just then the foreman came to the door of the shop and called to him, saying, "I have got to go out, and I have left a job for you over there by the planer." The foreman then disappeared.

Hall went back and, seeing the blueprint under the rack (not having noticed the one his coat had swept under the bench), supposed that he had his job, yet it seemed a very queer one for a planer. The blueprint showed (see illustration) a reamed hole a certain distance from the end of the rack, which was cut out as shown. Hall was certainly stumped; but having plenty of sand, he made up his mind that he was going to do that job on his planer, as it was evident to him that it had been done there before. He got his scriber, try-square and dividers and laid out the work according to the measurements shown on the blueprint.

Just then one of the shop critics came along and asked him what he was doing. He answered that the boss

had given him a job to do, and he was laying it out. The man laughed at him and replied, "That is no planer job, and it could not be done on a planer anyway."

"I can fetch it," said Hall, and proceeded as follows: He found in the toolroom a counterbore with a $\frac{1}{4}$ -in. pilot, the body size being just right to leave something for a reamer to cut. He then drilled $\frac{1}{4}$ in. to the center of the circular opening in each of the four racks, then worked out these four holes with the counterbore, put two of the racks together and reamed the holes, of course doing the same with the second pair. Putting an arbor through two of the racks, he placed a piece of drill rod between the teeth and further secured them from moving by a clamp. The head of the planer was furnished with four studs $3\frac{1}{2}$ in. apart, in the clear, and these were of course fitted with the usual bridges for holding the tool.

Hall put the two racks he had fastened together into the head and clamped them fairly vertical, setting up tight on the nuts. He then knocked out the arbor. Among the shaper tools he found one that was rather stumpy and made after the manner of a lathe parting tool. He put the vise on the planer platen, setting the tool in it so that its cutting edge looked toward the head. Giving a short stroke to the planer, Hall started up the machine and fed the two racks down on the tool, first cutting along the line *A* and then along the line *B*. Swinging the head over until the line *OO* stood vertical with the square, he again fed down the racks. After two or three cuts he had split the line. Swinging the head over to the other side, he brought the line *KK* vertical and cut to it, thus completing the job. He proceeded in the same way with the other two racks, and with a little light filing he dressed off the tool marks, leaving the job in good shape. After that Hall's position was an assured one, not only in the minds of the shop critics, but of all hands.

There, Mr. Editor, I have taken 60 words in my first presentation, and I have taken over 700 for my second. If either is worth anything, which in your opinion is of greater value and what have your readers to say about it?

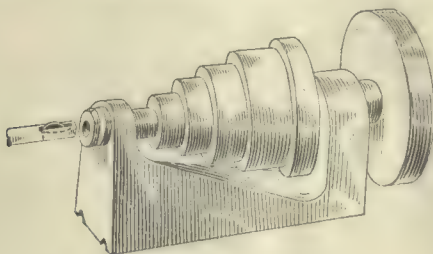
New London, Conn.

W. D. FORBES.

✱

Knock-Out Rod Holder

The knock-out rods used in hollow spindle lathe heads for driving out centers and almond chucks, etc., are usually kept in the spindles. These, as is well known,



KNOCK-OUT ROD HOLDER

rattle around and work out when the lathe is running. In order to keep rods in place and at the same time eliminate the noise they make, the spring attachment shown in the sketch was devised.

Near the end of the rod a groove is milled, and a piece of brass spring wire formed in the shape shown is placed in this. One end is fastened in a hole in the groove. It is easily seen that if the portion of the rod having the spring is always kept inclosed in the spindle, the rod cannot work out.

JAMES E. COOLEY.

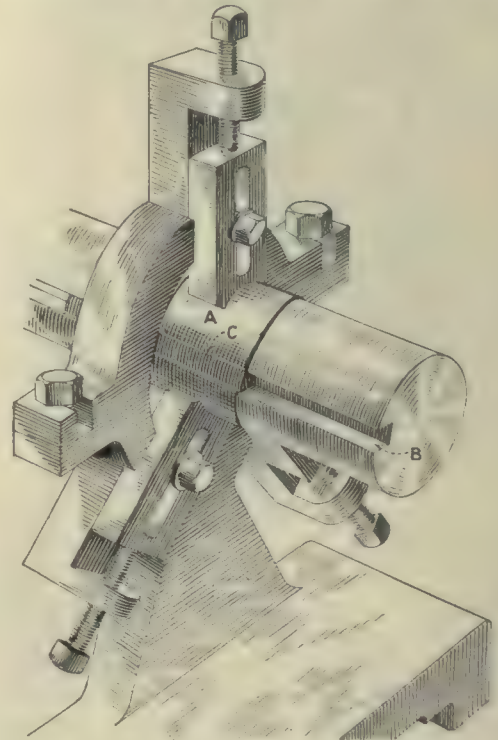
Hartford, Conn.

✱

Holding Keywayed and Finished Work in Steadyrest

It is sometimes necessary to machine a length of steel shafting, or similar piece, after it has had a keyway cut in it and the surface has been finished and polished. By following the ordinary procedure the keyway would interfere and, besides, the steadyrest jaws would scratch and mar the finished surface.

One way to get around this is to cut a strip of thin brass or copper *A*, bend it tightly around the piece with the ends overlapping the keyway *B*, but not enough to



HOLDING KEYWAYED FINISHED WORK

extend into the bottom of keyway when bent over, then drive a key *C* of brass or copper, preferably of the same degree of softness as the strip, tightly into the keyway. The steadyrest jaws then rest upon this strip, but should be adjusted no tighter than necessary. The key should be dressed off even with the rest of the surface, and may be soldered if thought necessary, although heavy cuts have been taken by this method without soldering, the key showing no tendency to loosen.

H. H. PARKER.

Oakland, Calif.

✱

Garage Equipment

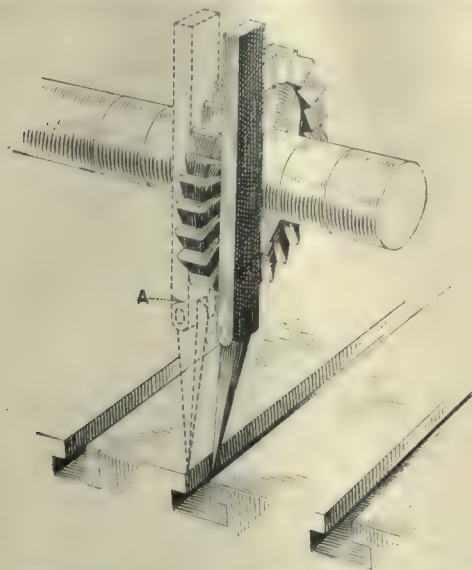
I intend to equip a garage for doing all kinds of repair work, including gear cutting and hardening. What machine tools, small tools and other equipment would I require?

VINCENT FAMA.

Wellington, New Zealand.

Tool for Setting Milling Cutters

The accompanying illustration shows a handy little tool that I have been using successfully and find accurate for centering the cutter with relation to the work or T-slot. In setting up for cutting small gears on the



TOOL FOR SETTING MILLING CUTTERS

mill I find this device convenient for centering the tool with the center line on the tailstock. It can also be used as a surface gage.

In the illustration it is shown centering up a wide cutter with the T-slot. This method is far quicker and more accurate than the old method of holding a scale down the side of the cutter and measuring to the edge of the T-slot with another scale. The stock is made of a piece of $\frac{1}{2}$ -in. square cold-rolled steel; the blade is made of $\frac{3}{16}$ -in. stock drawn down to a point and riveted, as shown at A.

J. A. RAUGHT.

Janesville, Wis.

Drop-Hammer Foundations and Flooring

Four stages in the erection of a line of heavy drops are shown in the accompanying illustration, which was taken in the new drop-forge shop of the Hendee Manufacturing Co., which recently determined to do its own drop forging. Before laying out the drop shop this company engaged the services of the president of a large successful drop-forge concern as a consulting expert and had him check up their plans, equipment and installation, although the drop shop was to be merely a department contributory to the final product (the Indian motorcycle).

The machines were set in pairs along both sides of the room, each group of six to be driven by a separate motor. Those on the farther side of the room, in the background, were put under operation while the line on the nearer side was still under construction. This enabled a photograph to be taken showing all stages of erection at once.

Under the site of each pair of machines a solid block of coarse concrete A-B 6 ft. deep is laid upon the subsoil, which is here a sandy loam with some gravel. This, by the way, is a very good soil. The block extends 2 ft. out from the bases of the twin machines, which are set close together. In the cement are embedded $1\frac{1}{4}$ -in. iron rods,

with 3 in. of the upper end C protruding. These rods make a fence entirely around and a few inches from where the base of the machine is to be. With the base set in place within this fence and leveled, the rough cement foundation is flooded with a finish coat of smooth cement and the whole allowed to harden in place.

This stage of erection is seen in the nearest machine in the foreground around A. The farther half of the same foundation block B, for the mate of the drop at A, is still in the rough.

The space between the fence of protruding bolt ends and the machine base is then filled in with a solid border F of high-grade cement, so as to form a close-fitting box which hugs the base and is held firmly against it by the bolt ends. This cement wall, plainly seen at the foot of the fourth machine in the nearer row, is made to be flush with the outside of the line of bolts, burying and conceal-



DROP-HAMMER FOUNDATIONS AND FLOORING

ing them at the same time that the bolts themselves hold the cement firmly in place and make it an integral part of the big foundation block. This little cement boxing can be easily repaired.

The upper part of the drop hammer at F has meanwhile been erected, and some progress has been made on erecting its mate at E, so that both will soon be ready for power.

There is at first no flooring around the big foundation blocks other than the soil. Down the center of the shop, between the two lines of drops, is a broad concrete floor R for trucking and walking, upon which heavy machinery trucks, or the small trucks and tractors used in inter-department transportation, may run. The soil area about

the machines is now filled in with cinders *K* rolled flush with the middle strip of floor, so that the foundation blocks are concealed and the outer edges are under 3 or 4 in. of springy cinders. Thus there is an excellent footing for the workmen, whose fatigue is thereby greatly lessened. In the illustration this cinder floor surrounding the completed machines as yet only shows beyond the farther edge of the central strip of concrete; but when finished, the other machines will have it also, making a level though composite floor throughout the room.

Forged work discharged from the back of the drop simply falls in a pile upon the cinder part of the floor as at *W*, and is allowed to cool before being shoveled into a truck. Anyone walking through the shop is perfectly safe from burned shoes if he keeps to the cement strip, for even when an occasional piece of work rolls out a little way from the cindered area the black color of the iron shows up against the light gray of the cement.

Oil furnaces are used, set against the wall between the windows. One furnace serves each pair of drops. The lighting conditions are good.

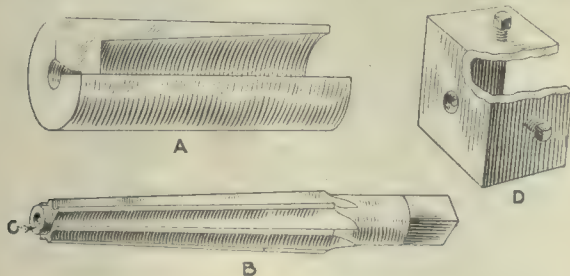
Northampton, Mass.

PETER F. O'SHEA.

Re-Centering Reamers for Grinding

The illustration gives three methods of centering a reamer for grinding, when for any reason the centers may have been damaged or destroyed.

At *A* is shown a sleeve, which may be used for a taper-shank motor reamer. A motor socket that has a center may also be used. A method of centering the small



RE-CENTERING DEVICES

end of the reamer in case of breakage is illustrated at *B*. The end is ground square; the reamer and a piece of brass *C* are heated separately, after which the brass is soldered on. The reamer is then trued up and centered in the lathe. An adjustable center *D* may be used for centering hand reamers or taper-shank reamers that are badly burled.

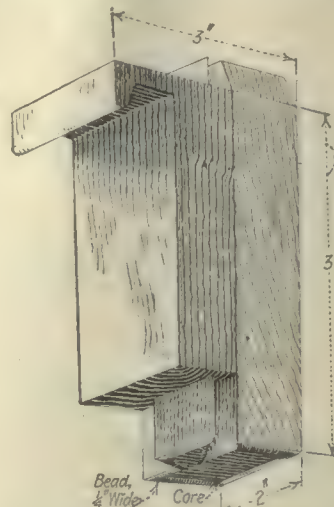
B. A. DONLEY.

Renovo, Penn.

Preventing Shaved Sand from Rising in the Mold

We had a large order for castings off the pattern shown in the sketch. The patterns were sent to us by the customer and had very little draft on them. We had trouble with the core shaving the side of the mold, causing sand to drop to the bottom of the mold when setting the core. The loose sand prevented the core from going into place on the bottom. If we had made more draft on the patterns, a new core box would have been necessary, which would have required time and expense.

To overcome this difficulty, I placed a bead on the bottom of the core print along the outer edge, so that any sand shaving off the side of the mold would drop into the opening made by the bead, allowing the core to go



THE IMPROVED PATTERN

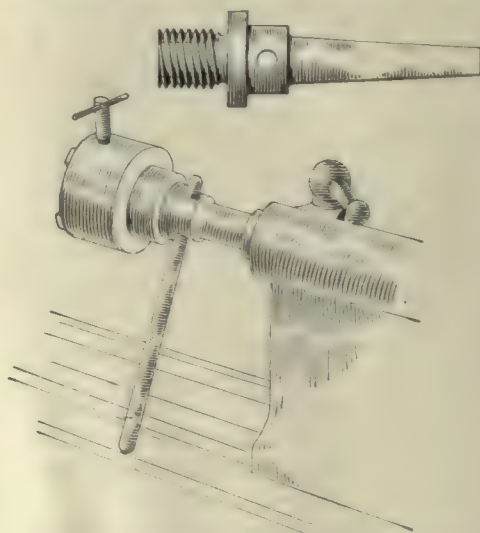
readily into place. This was done with very little expense, and we were able to use the same core box.

Naugatuck, Conn.

A. E. HOLADAY.

Adapter for Holding Chuck in Tailstock

The adapter shown in the illustration was turned up from a piece of cold-rolled steel and tapered to fit the tail spindle of the lathe. The outer end was threaded the same as the end of the lathe spindle, in order to take



THE ADAPTER AND ITS APPLICATION

the lathe chuck and face plates. A hole was drilled, as shown, into which was driven a piece of drill rod long enough to project below the ways, so as to keep the chuck from turning while drilling.

Such an arrangement allows the use of straight shank drills while revolving the work at the live end, or else a face plate may be screwed to the tailstock to be used as a drill pad while the drill is revolved.

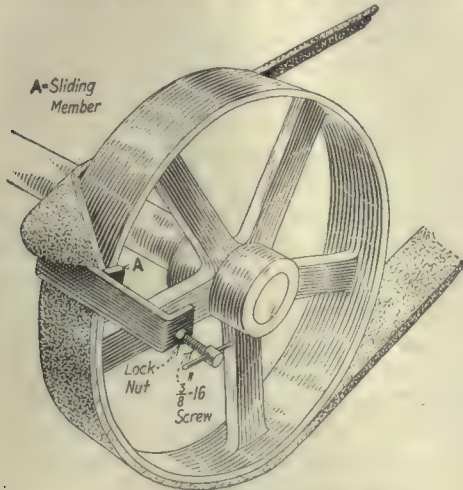
Oakland, Calif.

H. H. PARKER.

Discussion of Previous Question

Placing Tight Belts on Pulleys

Referring to A. E. Holaday's article on page 665, I have used a modification of his idea for some time very successfully. It is substantially the same as Mr. Holaday's, but is adaptable for varying sizes of pulleys, which



THE IMPROVED BELT LACER

is necessary in my own case. The device is made of $\frac{1}{8}$ x 2-in. machine steel, and two or three sizes cover every size of pulley to be found in any ordinary factory. These tools are most valuable, saving much labor and preventing lost time in hunting for a rope or belt lace to lash the belt to the pulley. The construction and use are obvious.

Chicago, Ill.

JAMES TATE.

On page 665 E. A. Holaday shows a method of placing tight belts on pulleys. I have tried this very method and found it to prove disastrous to the belt. In the case of a new belt, a bad stretch will be caused at the point just above the clamp, with the result that there will be a crooked place in the belt throughout its whole life. If the belt is old and hard, especially one that has dried out considerably, it will tear.

The best method I have ever found for putting on a belt that is too tight and too broad to be put on by hand, is to take a small rope sling and put it around the belt and pulley, much the same as the clamp is used. The sling is let out to almost the width of the belt and pulley combined, which will permit the belt to go on a little at a time. By employing this latter method the danger of stretching or tearing the belt is eliminated.

Janesville, Wis.

J. RUNGE.

The Metric System

The article by C. C. Stutz and your editorial, "The Thousandth of an Inch," seem to the writer to be a rather poor defense of the English system of measurements. The very use of a thousandth of an inch is an admission that the decimal system is superior to the cumbersome method of using fractions.

Mr. Stutz admits that multiples of a thousandth of an inch are used in setting limits in the English system, but assumes that when the metric system is used that a limit must be either 0.1 mm. or 0.01 mm. It would be just as logical to assume that a limit must be either 0.01 in. or 0.001 in. As a matter of fact, in both cases multiples are used; and when ten is reached, the point moves over one space.

At present there is considerable work being done in this country according to foreign drawings, some of which use the English while others use the metric system. These drawings show limits set in multiples of the thousandths of an inch and in multiples of hundredths of a millimeter. Quite a common limit is 0.03 mm., which does not differ very much from 0.001 in. There is, however, one decided advantage in favor of the metric measurement—namely, in case closer work is desired, a limit of 0.02 mm. or 0.01 mm. may be set. If closer work than a thousandth of an inch is desired, multiples of the ten-thousandth must be used, and they are certainly hard to measure.

However, the greatest objection to the English system is not the use of the inch as a basis for measurements, but to the cumbersome fractions and to the absurd multiples of the inch.

If the trouble stopped with the lineal measurements, it would be bad enough, but unfortunately it extends into all other measurements. In order to become thoroughly conversant with the troubles of the English system, one should visit an English plant at inventory time and see the clerks struggling with pounds, hundredweights, quarters and tons on the one hand, and pounds, shillings and pence on the other.

Many years ago our money was placed on a decimal basis, regardless of the numerous objections that were raised, and today surely no one would have the courage to advocate a system based on fractions and absurd multiples. Yet this is practically the position of those who object to the metric system of measurements, and they are standing in the path of progress.

New York City.

C. J. MORRISON.

Bore or Plane First, Which?

The question has been raised as to whether it is best to locate flat surfaces from holes, or to locate holes from flat surfaces. It is unfortunate that an answer cannot be given that will apply in all cases. Past experience is the best guide when deciding the sequence on a new job. Most of us have had jobs where we have had to decide between the two methods. All will profit by an exchange of ideas. Therefore, I will contribute my bit.

The first job I have in mind was a malleable casting with two cored holes to bore out and a flat side to machine, the holes to have a definite relation to the flat side. As originally tooled up, the piece was held by the bosses in which the holes went, bored and then milled in a fixture while held and located by the bored holes. Every time

the miller operator guessed wrong on his depth we lost a casting. Every time the table developed a little slack, or the cutter got dull, we got a lopsided one that bothered the assembler. The whole job was cleaned up by machining the flat surface first in a fixture jiggling from the bosses, then boring in a jig while jiggled from the flat machined surface. Under the old method, an error of a few thousandths in milling made scrap. By the new method, small variations made the holes come slightly out of center of the bosses, which marred the appearance only.

The next job was a large gray-iron casting that simply had to be filled with holes. Spots also had to be milled to provide a bolting surface at a definite height above some of the holes. Worst of all, the machining had to start with reference to a semicircular surface that was not machined. Some of the holes were cored, to be reamed out with 3-lip drills. The fixture was made to jig from the semicircular surface referred to, also favoring as much as possible the cored holes. The job worked well.

The third piece was a small crooked malleable iron with two cored holes to bore out and a foot on the extreme end to machine. It was bored first, then the foot was finished in a disk grinder, jiggling by the two bored holes.

The fourth job was also malleable iron. It was wide and flat, with a cam track cast around it. Three holes and two flat surfaces had to be machined with reference to this track. The first set of tools bored the holes, without any consideration for the cam track. Then the cam track was hand-formed with proper relation to the holes. Lastly, the flat surfaces were milled, gaging from the cam and the bored holes. This method was worked over and a new scheme evolved that milled the flat surfaces directly from the cam track, then bored the holes from the flat surface.

Each of the foregoing jobs showed features that called for different treatment, and for different reasons.

The first one hinged upon our ability to make a jig that would bore a hole relative to a flat surface more accurately than we could depend on milling the surface from the holes. I do not say that good work was not possible by the old method, but I do know that we got less scrap from the new tools.

On the second job, every effort had to be made to get the cored holes to clean up with reference to the cast bearing surface. The drills were long, the holes deep, and the drills sometimes ran off a little. By milling last, all error was corrected in the milling operation. Had the milling been done first, a hole that ran off would ruin the casting.

The third job was worked from the holes to the foot, because the foot was small and would have made a poor gaging and holding point for the boring jig, had the milling been done first.

The fourth job was a failure as originally tooled up, principally because it was started from the wrong point, and also because the holes were so short as to provide only an uncertain means of locating the piece for milling. The second method starts from the surface that is not to be machined, mills the large flat surfaces, and then gages from these large milled faces in the boring jig. Note that the hand forming operation is eliminated.

These four jobs were picked from harvester work. There are many more that embody the same principles, sometimes singly, sometimes in combination. All the

factors have to be considered when one is trying to arrive at a method that will prove most satisfactory. When you get two opposites in the same job, you have to change the design, as a compromise between opposites is seldom profitable.

H. W. JOHNSON.

Poughkeepsie, N. Y.

The editorial on page 831, "Which Should Be Done First?" calls attention to a subject of great importance and one that should be properly "thrashed out." It ought not to be a hard matter for any mechanic, after he has been shown the piece to be machined, to decide readily what should be done first, and yet "force of habit" often causes one to do the last thing first and vice versa. In the course of my experience I have found it to be necessary first to plane or mill about 75 per cent. of work. Some time ago I had several marine-engine cylinders to machine, the cylinder and base being a one-piece casting with an open-end cylinder head and a lug cast at each side of the base center for fastening to the foundation. There were also open ends in the base for removable side plates.

The machining operations were: Bore cylinder, face end of cylinder, drill and tap the same for cylinder head studs, bore and face holes in base for side plates, plane off bottom of lugs on base and planing pads on cylinder for intake and exhaust manifolds, drill and tap manifold pads and drill base lugs. There was no question in the minds of those interested as to what should be done first, which was to plane off the bottom of the base lugs (accomplished by clamping the cylinder top end down against the two angle plates set at right angles to each other on the planer table), after which there was something to go by.

The next operation was to clamp the base by its planed lugs to a jig bolted on the faceplate of an engine lathe, then bore and grind the cylinder and face off the end of the cylinder. After that we had plenty of machined surfaces as a gage. As in drilling the lugs, it was only necessary to turn the engine bottom side up on the base of the drill press, which made it level.

The boring and facing of holes in the base for the side plates was accomplished by resting the lugs on parallels on the carriage of a double-headed boring lathe. In this instance it seemed absolutely necessary to do the planing first and the boring, drilling, reaming and tapping afterward. But in machining square railroad brasses, such as are used in side rods, the operations would be the reverse, as the only method I could see would be to bore and face on the lathe, then mount on an arbor and plane or mill. This is assuming that the two halves are sweated together with solder, which is customary.

In machining planer chucks, for instance, there is a question in my mind which should be done first, the milling or the boring and turning, as it would seem an easy matter to design the jigs to do either part first. Much more could be said, but I stop here with these three illustrations, adding that my opinion leans heavily toward milling and planing first in the majority of work.

Janesville, Wis.

J. A. RAUGHT.

As I have had considerable experience in machining flat surfaces and holes, I will give my opinion as to which should be done first.

It is generally better to plane, mill or finish a surface in some other way before attempting to drill holes. The

reason is that, first of all, it is much easier to mark off and center punch on a finished surface. Moreover, the drill can be started without running out, because the hard scale of the casting has already been removed. The boring and reaming should, if possible, be done when the surface is finished. If these operations are performed while the hard scale is still on the casting, the reamer or boring tool will wear more quickly. For this reason it is advisable rather to wear out the planing tool, which can be more readily brought to size than a reamer.

Another objection to planing or milling after the holes have been bored and reamed is that some burr is produced inside the hole by the planing or milling tool and afterward has to be removed. Suppose several large holes in a flat plate were finished—that is, bored and reamed—and one surface of this plate was afterward planed. Unless the planing tool was very rigid, it would be almost sure to dig into the work, as it would tend to spring into the hole and in coming out on the other side would take a somewhat deeper cut than was intended.

Frequently, one surface on a casting needs to be finished only, and holes have to be bored to be at right angles to this surface. In this case it is clear that the surface should be finished first, because the casting can then be turned over and placed on the drilling-machine table or strapped to the faceplate and have the necessary holes drilled and reamed. As was pointed out in the *American Machinist*, it is impossible to give definite rules to be followed for each and every job, because the order of operations must suit the particular piece of work in hand.

Shelton, Conn.

J. LIMBRUNNER.

Using Stools in the Shop

I have had experience in workshops where stools are provided for every mechanic, also in others where sitting is not permitted; yet precisely the same kind of work is done in each instance. Apparently, different establishments have diverse views.

I am foreman in a shop where the work is of an extremely varied character. A number of stools are provided, but not enough from the employees' point of view, the proportion being at the rate of two stools for each three workmen. My sole reason for maintaining this percentage is that part of the work can be best manipulated when the workman is standing.

On the other hand, it is true that effective results can be readily accomplished on a very large proportion of the work when the men are provided with suitable stools. In fact, certain tasks are more likely to be well done and at the same time be performed with great rapidity if the worker can assume a comfortable position. It is simply a matter of judgment on the part of the employer or foreman, when to furnish stools and when not to permit their use.

Having learned from observation and my own experience, I can conscientiously say that providing stools for each man in a shop where the work is of a varied character and not of small dimensions, as in the scientific-instrument and watch-making industries, undoubtedly has a tendency to encourage sluggishness. For instance, often the work may be difficult to manipulate when the workman is seated on a stool, but easily done when he is standing. The loss of time, however, is seldom taken into consideration by employees, if they have the chance

to be comfortably seated; therefore the output of the department is noticeably reduced if the workmen are allowed to sit.

It is known that certain employees are very apt to assert that the foreman is a heartless and thoughtless individual, particularly if he does not happen to allow the men to go in their customary go-as-you-please way. This assertion, however, is frequently unwarranted, as foremen are usually anxious to obtain maximum outputs, no matter how, so long as the work is properly done.

In conclusion, I agree most heartily with Mr. Davis when he says, "There should be no arbitrary rules governing the use of stools—utility and service should determine." As the provision of stools may either increase or reduce the capacity of the individual, the class of work is the determining factor.

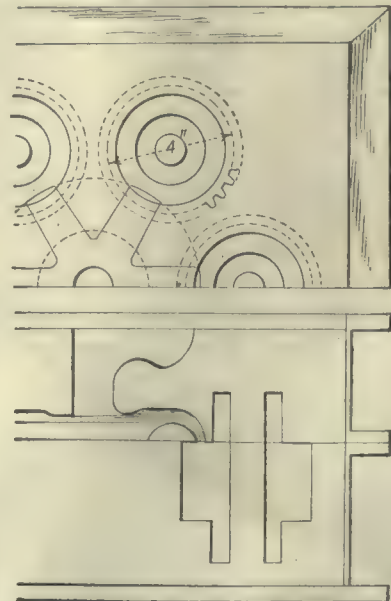
I wish to take exception to the suggestion to "save money by discontinuing the use of chairs and stools in the office part of the works," as the work of the office is usually of a repetitive character. Hence, this work can be effectively accomplished when the individual is comfortably seated, whereas this cannot truly be said regarding extremely varied work in the shop.

Manchester, England.

A. EYLES.

How Would You Gate These Patterns?

Replying to A. E. Holaday, page 557, if a molder made one of these gears he would use a horn gate. I would gate the six gears by using a ring core made to



THE WAY TO GATE THE PATTERNS

fit the print. Fasten the gates to this print, face the seat of the ring core and make it cover the face of the teeth. The plan and section view show the gears gated.

Salem, Mass.

C. K. ROGERS.

Precision Gage-Making Work

On page 122 is shown J. B. Murphy's way of grinding a snap gage. The method is fair, but not the best. If his grinder spindle is not absolutely at right angles with the line of table travel, he will still grind his gage bell-mouthed. The better way is to lay the gage horizontally,

level with the center of the wheel, run back and forth with the regular table movement, allowing the wheel to run over into the recess at the inner end of the gaging surfaces. When one surface is finished, the wheel is turned around to grind the other surface.

Poughkeepsie, N. Y.

H. W. JOHNSON.

Spoiling Work To Pass Inspection

A few days before I read the editorial on page 741, I chanced to walk through the machine shop of a plant that makes a diversity of articles, and I noticed a man performing an unusual operation. The foreman, who was standing nearby, remarked, "We are spoiling good work in order that it may pass inspection." The article in question was a munition piece, and the circumstances were exactly the same as those described in your editorial. The method adopted to bring the outside diameter of the thread to size was somewhat different, however.

It was found that the inside dimension had been held strictly to the minimum limit and this permitted resorting to expanding. A brass mandrel was made and the piece screwed into it. The mandrel was drilled through the center and a plug was driven in by hand until it had entered into the piece for the same distance as the length of the outside thread. In every case the diameter of the outside thread was increased sufficiently to resist the "no go" gage, while the inside dimension was kept within its proper limits.

It seems to me the foreman was not quite correct in his statement. It would appear that the rejection had been overcome without spoiling the work. At the same time this concern, profiting by previous experience, could not present these altered pieces to the inspector as other than new work, as they would have been rejected "on principle."

Incidentally, is this practice of snap-gaging outside diameters of threads purely a European idea, or are we also guilty of it?

H. D. MURPHY.

Jersey City, N. J.

Why Russian Shrapnel Shells Are Polished

Two men were overheard discussing some of the stories of freak methods of inspection that have been going the rounds. One had been explaining that the entire outside surface of the shell must be free from rough spots and tool marks and highly polished. "They tell me," he remarked, "that after the shells are all finished and inspected, the Russians take a cloth and rub it all over the outside, and if so much as a tiny bit of lint is left sticking to the surface, they reject the shell." "Ah, nonsense," the other replied, "I don't believe a tenth part of these silly stories about this munitions stuff; they don't sound reasonable."

The writer once heard one of the Russian inspectors explain why they were so very particular about the finish, even on clearance surfaces, where it would seem a good tool finish should be good enough. Possibly you will recall how the skate runners used to stick to your mittens when, as a boy, you went skating on a snappy cold winter's morning, down on the mill pond in the home town. If some country humorist persuaded you to "taste" the runner, you will certainly remember. The Russians assume that any of the shells made in this country may have to

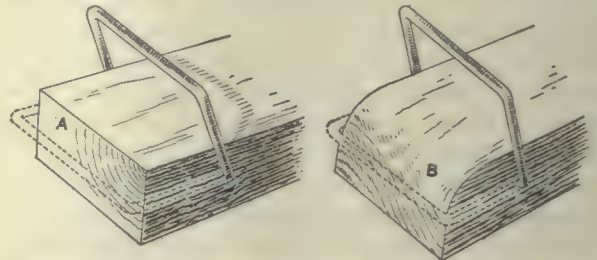
be handled in weather much colder than any you or I have ever experienced. The handling is done by soldiers who are equipped with sheep's wool mittens, very thick and loosely woven to resist extreme cold. If the shells are highly polished, the soldiers have learned that a little dexterity in breaking loose from them makes it possible to let go without much trouble. But if the surface is full of tool marks or rough spots, considerable of the mitten is left sticking to each shell handled, somewhat after the manner that a piece of magnetized work will pick up chips if laid on a dirty bench. The result is that, after a few hours' handling of rough shells, the soldier is minus a pair of mittens. Not so very unreasonable, after all.

P. H. BOGART.

West Philadelphia, Penn.

Emery-Cloth Holder

Readers of the *American Machinist* who may be tempted to make an emery-cloth holder, as described by J. K. Long on page 504, will have greater success in holding



CORRECT AND INCORRECT SHAPE OF BLOCK

the emery cloth if they shape the ends of the holder to the form shown at B.

A. R. WHITTLE.

Quebec, Canada.

The Value of Praising

The editorial on page 1092, Vol. 44, regarding the value of praising, is very good. What a big help it is to be praised just a little now and again, or for the foreman to give you a smile. It helps one a great deal with his work and is very encouraging. It is best not to praise some men too often, or they take advantage of it. I suppose this is why those who would value a little praising do not get it.

Perhaps the lathe operator is working to limit gages, but still I think he is wondering whether the job will pass inspection. He certainly ought to feel reassured if he has made his job right to the gages given him, but why not make reports to the men when the work passes inspection? They soon hear about it if it is wrong.

Weimbley, England.

J. H. DAVIS.

Two Unusual Jig and Fixture Bushings

On page 720 you show a slip bushing held down by a sloping pin in a slot, one side of which is angular and one side straight.

Why is it necessary to make two cuts and two settings? Why not make one angular cut and let it go at that?

Poughkeepsie, N. Y.

H. W. JOHNSON.

[No reason at all, except that the original drawing showed it that way.—Editor.]

Editorials

A Christmas Gift That Lasts

Anyone who visits shops in various industries and in different localities is impressed with the many points of difference in methods and practice. New ideas do not seem to circulate nearly so readily as they should, and many shops are still using methods that have been discarded in other localities, because the newer practice has not been brought to their attention.

Many shop foremen realize the deficiencies of their own shop equipment and methods and often express a desire to visit other shops for the purpose of acquiring information that can be transplanted to their home shop. Some manufacturers consider that it pays to send their men on tours of inspection in order to secure new ideas for their own use and believe that the money so spent is a good investment.

In many instances the *American Machinist* acts as either a substitute for or a supplement to such visits and makes it possible to learn what is going on in other shops. In both cases it is necessary for one to be able to adapt to his particular needs the ideas and methods seen.

Whether one can travel or not, a record of new developments in machine work is essential to the best results; and employers can make no better investment than to see that their foremen have at all times the best information available, just as they have the best systems and tools.

With this in mind it seems seasonable to suggest that a copy of the *American Machinist* would make a most appropriate and desirable Christmas present to those in charge of shopwork and would prove a profitable investment as well. It is a gift that lasts all through the year and that brings week by week the information that makes a man of more value to both his employer and himself. This is suggested by the experience of several who consider the *American Machinist* one of the best forms of present they can make.

Purged Welfare Work

There are fads in our American industry, as well as in our political life. The latter has given us three slogans in a dozen years: Conservation, Progressivism, Preparedness. During about the same length of time industry has been aroused by Welfare Work, Efficiency, and Safety First.

An outgrowth of the last one named is in danger of being confused with the first. Welfare work, or industrial betterment work, ran its course a number of years ago. It was discredited. It was unmasked and stood out honeycombed with self-advertising, self-aggrandizement, paternalism and selfishness. It deserved to go.

But some of the things that were once done in the name of welfare work are being revived. Many a plant today has a hospital, a lunchroom, banking and loan service, recreation facilities and the like. These and others were with us under the old welfare work. But the motive then and today is different.

In an address before the Fifth Annual Safety Congress, Dr. Otto P. Geier, Industrial Physician of the Cincinnati Milling Machine Co., said:

Intelligent modern industry now recognizes the opportunity for service to its employees. As a result we have today many of the finest examples of coöperation between labor and capital in the activities of personal service departments. In the past many abortive attempts at so-called welfare work have signally failed to furnish true and lasting points of the contact and better understanding. These have failed deservedly, because as a rule the supposed benefits have been superimposed upon the group of workers, requiring and asking no service on their part. The average American workman is suspicious of an employer "bearing gifts." This same average American workman, however, is keen enough to engage coöperatively in any undertaking that is frankly advanced by the employer as a mutual advantage. He merely asks that "all the cards be laid on the table."

The new motive, the one behind this purged welfare work, is seen to be coöperation.

Its activities include all of the following and more: Employment service, locker-room facilities, medical service, sanitation, education and safety first, care of the injured, an all-day clinic, dental service, sickness and death benefits, lunchroom and restaurant, building, banking and loan facilities, and recreation.

From the new motive of coöperation for mutual advantages, such activities are not forced, they are not selfish, they promise great things.

As practiced in some machinery building plants today, such service is truly purged welfare work. A newer name for it is "Employees' Service."

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Planning for the Future

The machine-tool industry as a whole has had the habit of putting off the developing of new machines until a period of slackness. When business was good, production was the object of existence; when business was poor, designing came in for a share of attention.

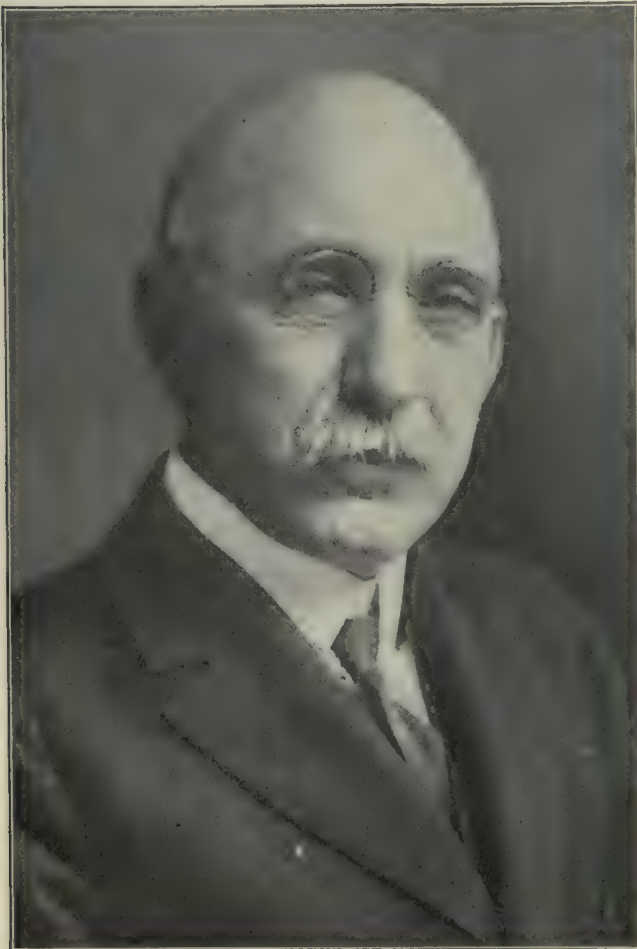
At the present moment this habit seems to have been broken in a number of shops. New machines are on the drawing board or in the pattern shop or even on the experimental floor. In some cases outside engineers and designers have been intrusted with the work of developing the new lines, so as not to interfere with shop production. There is promise of a number of radical improvements in machine tools that will be brought to public notice next year. The development work under way is the wisest kind of planning for the future.

The final results from this far-sighted policy may have a profound influence upon the industry as a whole. A few weeks ago the *American Machinist* commented upon the fact that in the future the machine-tool building industry would undoubtedly be financed much better than it has been in the past; that is, when periods of dullness in business come, machine builders will be in a position to build for stock. The development of new designs during this present period of rushing business is but one of the steps necessary to take advantage of the opportunity to build for the storehouse when the time offers.

Annual Meeting of the A.S.M.E.

The thirty-seventh annual meeting of the American Society of Mechanical Engineers was held in the Engineering Societies Building, New York, Dec. 5 to 8, 1916. The usual committee meetings occupied the first day. The presidential address and the reception to the new president, Prof. Ira N. Hollis, whose portrait appears herewith, occupied the first evening.

The only paper of the second day which is directly in the machine-manufacturing field was the proposed safety



DR. IRA N. HOLLIS, NEWLY ELECTED PRESIDENT OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

code for cranes. This is the work of a committee representing various industries, including an accident and indemnity company. This paper appears on page 1053.

A memorial meeting to Prof. John E. Sweet, past president, honorary member and founder of the society, followed the morning session.

DISCUSSION ON INDUSTRIAL MANAGEMENT

The topical discussion on industrial management was well attended and brought out the experiences of many of the speakers. The topics were outlined in four short addresses: "How to Secure the Coöperation of Workmen," by E. E. Barney; "Standardization in Industrial Management," by Sanford A. Thompson; "Graphical Control on the Exception Principle for Executives," by Frank B. Gilbreth; "Employees' Service Work," by A. J. Baker. The trend of the discussion from the floor was in regard to the relationship between employer and workman. Sev-

eral laid emphasis upon the need of providing the advantages of satisfactory working conditions in addition to adequate pay.

The interest in this discussion indicated that similar sessions might profitably be made one of the features of the meetings of the American Society of Mechanical Engineers.

MACHINE-SHOP SESSION

In the machine-shop session but two papers were presented—one by Carl G. Barth on the "Standardization of Machine Tools," and the other by H. K. Hathaway, chairman of the subcommittee on machine-shop practice, which dealt with a proposed plan for the activities of the committee. The paper criticizes technical societies for not including a research bureau with a permanent and well-paid secretary who would bear the same relation to the society activities as a manager does to the shop. He would employ experts for investigations and so secure their entire efforts, which it is obviously impossible for members of committees to give, owing to the demands of their regular occupations.

The paper refers frequently to the work of the late Frederick W. Taylor and winds up with a proposed classification of machine-shop practice, consisting of what might be called an alphabetical Dewey system, in which letters are used as symbols for designation of the various activities in a manufacturing plant.

Mr. Barth's paper again called attention to the desirability of standardizing machine tools, the main points being as follows:

The object of his paper is to enlist the coöperation of the society in encouraging machine-tool builders to adopt certain standards for machine tools.

The paper deals in turn with the subjects of standardization of the machine equipment of a shop as a whole, standard speed series, standard feed series, the power of machine tools, tool posts for lathes, lathe centers, T-slots, lathe centers and drilling-machine and miller sockets.

Mr. Barth advocates the adoption of a universal speed series by all machine-tool builders for all machines such as lathes, boring mills, millers, drilling machines, etc. It is almost universally accepted that the available speeds of a machine should be in a geometrical progression. Mr. Barth's ideal is represented in the progression:

1	2 ¹	2 ¹	2 ¹	2	2.2 ¹	2.2 ¹	2.2 ¹	4	4.2 ¹	etc., or
1	1.1892	1.4142	1.6818	2	2.3784	2.8284	3.3636	4	4.7568	etc.

The same views hold for feeds, except in the design of lathes, in which the feeds for plain turning are obtained as a constant fraction of the screw-cutting feeds.

While the adoption of a standard speed series for all machine tools would be a wonderful step in the right direction, to get the greatest advantage from this it would have to be accompanied by the adoption of a standardized amount of power. At the present time it seems impossible to recommend any but the time-honored forms of tool posts.

Mr. Barth unqualifiedly recommends the universal adoption of Brown & Sharpe standards for lathe centers and drill and miller sockets. He recommends the universal abandonment of the tang as a method of driving drills, he having adopted a key drive some years ago.

The first valuation session consisted of three papers, the one by Charles Piez on "Perpetual-Inventory and Appraisal Value," being presented herewith:

The establishment of true costs is an essential element in the success of a business, and they can only be obtained when every item of expense is included. What the management of an industry is chiefly concerned in is to provide a fund through a proper scale of depreciation which will reimburse it for the difference between the cost price of a piece of equipment and its fair cash price when discarded or replaced by improved equipment. This difference is properly a part of the cost of the product, but becomes so only by charging depreciation against the expenses of operation.

Proper rates of depreciation can only be determined by those in close contact with and having full knowledge of the operating conditions and operating needs of an industry; and as appraisal companies can hardly claim to have such contact and knowledge, they do their clients positive harm when they enter the field of depreciation.

The problem of determining an adequate scale of depreciation is by no means simple, and it is astonishing to find how widely the practice among different manufacturers in the same line varies. The manufacturers of conveyors and elevators have taken up this subject recently and have adopted a schedule of standard depreciation rates that establish a broad basis upon which fair operating values and the shrinkage therein can be computed, and serve as the preliminary steps to the equitable distribution of these shrinkages, or depreciation in value, over the cost of the product. This schedule follows:

STANDARD DEPRECIATION RATES ADOPTED BY MANUFACTURERS' COST CONFERENCE, FEB. 25, 1916

	Per Cent. on Cost	Per Cent. on Reducing Balance
Buildings and Accessories:		
Reinforced concrete or steel and tile.....	2.0	3.0
Brick and steel with noncombustible roof and concrete floors.....	2.5	4.0
Brick, steel and wood.....	3.0	5.0
Brick and wood.....	3.0	5.0
Steel frame, wooden roof and corrugated-iron walls	3.5	7.0
Steel frame, noncombustible roof and corrugated-iron walls.....	3.0	6.0
Concrete block, with wooden roofs and floors.....	3.5	8.0
All-wood structures, well built (20 years).....	4.5	10.0
All-wood structures, cheap (20 years).....	5.0	12.0
Sprinkler system (20 years).....	4.0	7.5
Heating and ventilating system (20 years).....	4.0	7.5
Water and sewer piping and sanitary fixtures (where separate).....	4.0	7.5
Tanks and reservoirs, steel.....	4.5	10.0
Tanks and reservoirs, wood (10 years) (all repairs and maintenance to be charged to account 8059).....	9.0	20.0
Machinery and Large Equipment:		
Boilers, pumps, feed-water heaters and air compressors.....	6.0	15.0
Power piping.....	6.0	15.0
Switchboards, main wiring and conduit.....	6.0	15.0
Engines and dynamos.....	5.0	10.0
Machinery, motors, machine tools, traveling cranes, etc.....	4.5	10.0
Punch presses, bending rolls, power shears and drop hammers.....	4.5	10.0
Shafting, pulleys, hangers and belting.....	50.0	....
Machine-tool accessories—boring bars, drivers, keyseating broaches, etc. (all renewals to repairs).....	50.0	....
Cupolas, converters, melting furnaces and accessories.....	5.0	10.0
Annealing and heating furnaces, ovens, forges, etc.....	5.0	10.0
Motor trucks.....	20.0	60.0
Storage-battery locomotives (battery renewals to repairs).....	10.0	30.0
Horses and wagons.....	12.0	35.0
Small Tools:		
For machines, net additions.....	50.0	....
Hand tools, net additions.....	50.0	....
Punches and dies (standard), net additions.....	50.0	....
Chills, iron and steel flasks and accessories, net additions.....	50.0	....
Fixtures, Furniture and Miscellaneous Equipment:		
Steel shelving, lockers, etc.....	5.0	12.0
Mechanical appliances, net additions.....	60.0	....
Departmental wiring and electric fixtures, net additions.....	60.0	....
Miscellaneous items (wood), net additions.....	70.0	....
Patterns (Standard):		
Metal, net additions.....	75.0	....
Wood, net additions.....	100.0	....
All patterns required for a particular order or contract to be charged to the job.		

Drawings:

All new standard drawings to be charged to expense
All drawings required for a particular order or contract to be charged to the job

Miscellaneous Real-Estate Improvements:

Pavements, sidewalks, fences, retaining walls, roadways, tracks, yard drainage, general conduits, tunnels, vaults, etc.....

4.5 10.0

It was largely as a result of the recommendations made by the Federal Trade Commission, that the cost-accounting systems of various lines of industry be standardized, that the manufacturers of conveyors and elevators made a determined effort to agree on some standardized form of accounting procedure. The preliminary meeting of the manufacturers and their accountants disclosed the fact that, out of nine manufacturers, two disregarded the question of depreciation entirely, five charged off depreciation to profit and loss, and only two charged depreciation against operating expenses, making it thereby a component part of the cost. The rates of depreciation varied widely, and the first steps taken by the conference consisted in determining a standard schedule of rates of depreciation. As an item of interest and as an incentive for other lines of industry to determine and agree upon similar standards, I have already given the schedule. The rates are but compromises growing out of the judgment and experience of the individual members of the conveyor manufacturers' conference, but their correctness can later be verified by matching the perpetual-inventory values, which these rates will establish, against the actual experience of loss in cash value when equipment or buildings are discarded.

They establish therefore a broad basis upon which fair operating values and the shrinkage in these values, due to wear and tear and change in style, can be computed, and serve as the preliminary steps to the equitable distribution of these shrinkages, or depreciation in value, over the cost of the product.

I recognize the value of the work done by the appraisal companies in establishing authoritative replacement values for purposes of insurance, for the purpose of comparing the physical values of various plants about to be purchased or merged, or as the foundation upon which a perpetual inventory kept by the industry itself can be based; but I am convinced that only a perpetual inventory providing for a sound schedule of depreciation, and intelligently handled by the management of the industry, is of value in determining the true cost of the product.

DETERMINING THE VALUE OF PHYSICAL PROPERTIES

The following paper on the "Valuation of Industrial Properties" was presented by Walter N. Polakov:

The question of determining the value of the physical properties of our industrial establishments and public utilities has been recently brought to public attention. The purpose was primarily to justify the increased cost of commodities, rates and transportation as gravely influenced by heavy investments in the machinery of production. Discussing the subject at the conference on valuation held in Philadelphia in November, 1915, the writer said: "The loss to the companies from the under-valuation of their property is insignificant in comparison to the actual losses due to the lack of proper operating methods. The subject of correct methods of appraising a property is completely overshadowed by the importance of determining the proper methods of using this property. . . . What is needed most is the correct valua-

tion of operating and managerial methods in vogue, and over-estimating the importance of property valuation is like trying to trace old sins instead of preventing the committing of new ones."

It is a fact that the fixed portion of the capital invested in real estate and equipment has materially increased since the tractor replaced the ox plow; modern factory equipment has taken the place of artisans' tools, and transportation is done by rail and automobiles instead of horses. The correspondingly increased financial burden has created a new problem: How to absorb the expense of wear and tear, obligations to money lenders, etc., increased by adopting expensive machinery of production as a result of engineering progress.

The solution offered by financiers and accountants of the old school was to include in the manufacturing cost all the fixed charges of a plant and all the financial obligations of a company irrespective of whether these investments or expenses contributed anything to the value of the commodity or in any way benefited the production. If the instruments of production were completely used up in the process, this theory would be correct. However, in a typical case the value of the instruments of production passes only partly into the cost of commodities as they are produced. Apparently the self-evident fact that the equipment not used in production cannot pass any part of its value into the product was usually obscured by a consideration that it loses value during idleness and meanwhile accumulates such charges as rent, interest, insurance, etc.

The absurdity of including these expenses of idleness in the cost of an article already bearing its share of fixed charges was so clearly exposed at the Buffalo meeting of this society by H. L. Gantt, Mem. Am. Soc. M. E., that any further argument seems superfluous. Present practice manifestly tends to charge against the cost of a product the cost of over-equipment and mismanagement, thus imposing on society the penalty for tolerating these conditions in the industries.

The paradox that adopting improved machinery devised by designers reduces the rate of profit of the enterprise can be explained either by the fact that the improvement is merely illusory or that an improper use is made of the improvements. No careful manager would approve a replacement or new installation of equipment unless study proved beyond any doubt that the advantages offered by such a change are ample to more than pay for the investment. When the cost of production increases after an investment is made, it indicates plainly either that it was poor judgment to make the change or that the method of management does not offer the opportunity to secure the advantages inherent in the new improvement.

Nevertheless, the tendency of the average rate of profit to fall is only a manifestation of the development of the productive powers of society. Automatization, growing speed and capacity of machinery cause the same number of laborers in the same time to convert a larger quantity of raw and auxiliary materials into product. In other words, the fall of the rate of profit is not due to an absolute, but only to a relative increase of the capital invested in means of production over its part invested in labor. This law, though seldom recognized, is actually followed in our industrial development. It requires an increasing mass of total capital for the purpose of using the same quantity of labor to secure the same mass of

profit though at a falling rate of profit. If the mass of profit is to be increased through the introduction of improved machinery—that is, with corresponding increase of investment—without curtailing the wages or lengthening the working day, the intensity of labor must be increased.

In other words, to keep pace with industrial progress in order to meet the requirements and competition, improved instruments of production were adopted. Increase of investments is followed necessarily by reduction of the rate of profit, and in order to secure the same or larger earnings the manufacturer must expand the production, ergo, increase the investments. This is the process we actually observe in our industrial development. No amount of pains given to the subject of proper appraisal of physical property can alter the tendency for the rate of profit to fall. Increasing the selling prices, although a temporary expedient, overtakes eventually the purchasing capacity of consumer and creates a so-called business depression.

The misuse of or failure to use the expensive machinery of production is not a sufficient reason either to advance prices or to lower wages, as both undermine our future. Neither is it necessary. A manufacturer adopting superior methods of planning and managing his business, working with improved methods of production that have not yet become general, can sell below the market price, but above his individual price of production. In this way his rate of profit rises until competition levels it down. During this period the second requisite comes into play—the expansion of the invested capital, facilitated by the previous period of accumulation. According to the degree of his expansion he will be enabled to employ all of his workmen or more; in other words he will be enabled to produce the same or a greater mass of profits. As long as industrial development along these lines is still possible, and this possibility is accentuated not only by European experience, but by our numerous experiments and successful demonstrations of the adaptation of scientific principles to the management of various industries, the revision of our methods is a paramount problem. Therefore the problem of determining the real value of our industrial and managerial methods, if properly solved, offers the opportunity of rectifying the errors of the past.

The appraisal of industrial property, when accurately made, discloses the fact otherwise overlooked that, as a rule, there are more means of production than are made use of, and the idle capital investments represent also idle labor. The revenue-producing factor in our mode of production is not the investment, but the method of its use.

This statement does not imply suggestion to appraise property according to the capitalization of the earnings. The use-value of the plant has nothing to do with its cost-value and is in the highest degree unfit for the purpose, as it varies with personnel, policy and methods. Evolution in our industrial relations will eventually reverse the present situation, and all charges for unprofitable investments and nonproductive forces will not be borne by the consumers, who as yet have no power nor means to take an active part in the management of the industries. Unfit methods and incapable leaders are equally harmful to both investors and consumers, and their interests unite in demanding that methods of the highest value be developed and put into use.

Productive Capacity a Measure of Industrial Value*

By H. L. GANTT

There are only two leading theories as to what cost of production in an industrial plant consists of. They are: (a) That the cost of an article must include all of the expense incurred in producing it, whether such expense actually contributed to the desired end or not; (b) that the cost of an article should include only those expenses actually needed for its production, and any other expenses incurred by the producers for any reason whatever must be charged to some other account.

When plants are operated at full capacity, both theories give the same cost. At less than full capacity, however, the expense of carrying the idle machinery is, under (a) included in the cost of the product, making the cost greater; while under (b) this expense is carried in a separate account and deducted from profits, leaving the cost constant. When costs are figured according to (b), great activity immediately ensues to determine why machinery is idle, and to see what can be done to put it in operation that it may earn at least a part of the expense of its maintenance.

Idleness-expense charts now being made monthly in several large plants enable the managers to determine the causes of idleness in different departments. The expense shown in these charts to be due to lack of work indicates a faulty sales policy or too large a plant—that the demand has been over-estimated. If it be that the plant is too large, an effort should be made so to utilize or dispose of the excess that the expense of idleness may be taken care of, even if at no profit. That resulting from a lack of help indicates that the labor policy must be investigated. That due to lack of (or poor) material is an indication of the efficiency of the purchasing policy and storekeeping system. The charts also reflect the repair and maintenance department. Should the expense of idleness be greater than attributable to all these causes together, the excess must be charged to poor planning.

Under the first system of cost accounting the facts brought out by this method are not available, and the increased cost that a reduced output must bear is a great source of confusion to the salesman. The newer system with its constant cost shows that nonproducing machinery is a handicap to the industry of a company, just as workmen who do not serve some useful purpose in a plant or industry are a handicap to that plant or industry.

Cases are known to all where a change in plant management has turned failure into decided success. The value of a "going plant," therefore, consists of two elements—namely, the value of the physical real estate and equipment, and the value of the organization operating it. The idleness-expense charts, which are a logical outgrowth of a paper read by the author at the Buffalo meeting (1915), give at least a rough indication of the latter value, for they show the expense of inefficient management.

Plants or people, therefore, who do not serve some useful purpose to a community are a handicap to that community, for idle plants represent idle capital, and idle people are not producers, but consumers only. The warring nations have recognized these facts, and put both idle plants and idle people to work wherever possible.

*Abstract of a paper read at the thirty-seventh annual meeting of the American Society of Mechanical Engineers, held in New York City, Dec. 5 to 8, 1916.

Safety Standards for Cranes

Electric Traveling Cranes, General Construction—Proper provisions for strength shall be made for all parts subject to impact and rough usage. Journals and shafts shall be of sufficient size to bring the pressure within safe limits.

All apparatus shall hereafter be designed throughout with not less than the following factors of safety, under static full rated load stresses, based on the ultimate strength of the material used:

A. All gears and complete hoisting mechanism, factor of not less than eight.

B. All other parts, factor of not less than five.

Calculations for wind pressure on outside cranes shall be based on not less than 30 lb. per sq.ft. of exposed surface.

Cranes should be of what is known as "all-steel construction"; no cast iron should be used except for such parts as drums, bearings, brackets, etc. No combustible material should be used.

All bolts should be of the through type and be equipped with approved locknuts or lock washers.

Where access to the crane is necessary, steps or stairs with handrails should be used.

Platforms should be provided for changing and repairing truck wheels on end trucks and have stairways leading to them.

A platform or footwalk to give access to the crane shall be provided, which is accessible from one or more fixed ladders or stairways, and shall be not less than 20 in. in width.

A footwalk shall be placed along the entire length of the bridge on the motor side except when the construction of the crane prevents or when such a platform would not ordinarily be used for the repair or maintenance of the crane. This walk should be at least 6 ft. 6 in. below the bottom of the overhead trusses.

Footwalks should be placed across the ends of the trolleys at right angles to the bridge walks. When so placed they shall be not less than 12 in. in width.

Footwalks shall be of substantial construction and rigidly braced.

On cranes hereafter erected no openings shall be permitted between the bridge footwalks and the crane girder. When wire mesh is used, the mesh opening must not be greater than ½ in.

Each footwalk shall have a standard metal railing and toe guard at all exposed edges wherever practicable.

Not less than 12 in. actual clearance should be allowed between highest point of a crane and the overhead trusses, and not less than 2 in. between any part of the crane and building, column or other stationary structure. Where there are more than two crane runways in parallel, there should be a clearance of not less than 24 in. between the extremities of the cranes.

Means of escape shall be provided for operators of hot-metal cranes.

The operator's cage shall be located at a place from which signals can be clearly distinguished and be securely fastened in place and be well braced, to minimize vibration. It shall be large enough to allow ample room for the control equipment and the operator. The operator shall not be required to step over an open space of more than 18 in. when entering or leaving the crane.

A pail filled with sand or an approved fire extinguisher shall be carried in the crane cage for use in case of fire.

An approved foot- or hand-operated gong or other effective warning signal shall be placed in a location convenient to the operator and be securely fastened.

Ladle and other cranes subjected to heat from below should have a steel-plate shield not less than ¼ in. thick and placed not less than 6 in. below the bottom of the floor of the cage.

The cages of cranes hereafter erected shall be of fire-resisting construction.

All gears on cranes hereafter erected shall be provided with standard guards. This should apply to all existing cranes where practical.

No overhung gears shall be used unless provided with an effective means of keeping them in place, and keys shall be secured in an approved manner to prevent the gears from working loose.

Unprotected keys shall not be left projecting from ends of shafts.

The construction of the crane shall be such that all parts may be safely lubricated when the crane is not in operation.

The installation of the switchboard, wiring and all electrical equipment must fully comply with the United States Bureau of Standards regulations or the identical Pennsylvania Industrial Board Standards.

There shall be a main-line switch or its equivalent so arranged as to cut off all power from the crane and so constructed that it may be locked in its open position.

Open-type controllers shall have an asbestos-lined steel guard over the movable contact parts, both to protect the operator's eyes and to prevent articles from falling on contact parts.

An approved hoist-limiting device should be provided for each hoist.

Suitable brakes shall be provided for the hoist and bridge travel. Each hoist shall be equipped with effective brakes which shall be capable of sustaining at least $1\frac{1}{2}$ times the full rated load.

The drums on cranes hereafter erected shall have a flange at each end to prevent the ropes from getting off the drum, and be so designed that there will be not less than two full wraps of hoisting cable in the grooves when the hook is at its lowest position.

The hook block shall be of a type so arranged that it will lift vertically without twisting.

Bottom sheaves shall be protected by close-fitting guards, to prevent the rope from becoming misplaced.

Crane bumpers shall be provided and shall be at least one-half of the diameter of the truck wheel in height. Both truck-wheel and trolley bumpers should be fastened to the girder and not to the rails. Bumpers shall be built up of plates and angles, or be made of cast steel.

Truck fenders shall be installed which extend below the top of the rail and project in front of all bridge and trolley track wheels, and shall be attached to the trolley or the bridge and frame. They shall be of a shape and form that will tend to push and raise a man's hand, arm or leg off the rail and away from the wheel.

Heavy safety lugs or brackets, shall be placed on trolley frames and bridge end carriages, to limit drop to 1 in. or less if a wheel or axle should break.

A capacity plate showing the maximum capacity of each hoist in pounds shall be placed on each crane girder in such a manner as to be clearly legible from the floor.

A metal tool box or receptacle shall be permanently secured in the cage or on the runway for the storing of oil cans, tools, etc.

The trolley should be completely floored.

Cranes in outside service shall have the following additional provisions:

A. Floors of footwalks shall be so constructed as to provide proper drainage.

B. The cage shall be inclosed and of fire-resisting construction; there shall be windows on three sides of the cage, and windows in the front and the side opposite the door shall be the full width of the cage.

C. The floor of the cage on outdoor cranes should be extended to an entrance landing which shall be equipped with a hand rail and toe guard of standard construction.

D. Where there are no members over the crane suitable for attaching blocks for repair work, a structural-steel outrigger should be arranged on the crane of sufficient strength to lift the heaviest part of the trolley.

All gantry cranes should be equipped with automatic warning signals.

The truck wheels of gantry cranes shall be provided with guards or fenders.

Operation of Cranes, Rules for Operators—Cranes shall be operated only by regular crane operators, authorized substitutes, crane repairmen or inspectors; no one else should enter a crane cage.

Hands shall be kept free when going up and down ladders. Articles which are too large to go into pockets or belts should be lifted to or lowered from crane by hand line (excepting where stairways are provided).

Cages shall be kept free of clothing and other personal belongings. Tools, extra fuses, oil cans, waste and other articles necessary in the crane cage shall be stored in a tool box and not left loose on or about the crane.

The operator shall familiarize himself fully with all crane rules and with the crane mechanism and its proper care. If adjustments and repairs are necessary, he shall report the facts at once to the proper authority.

The operator should not eat, smoke or read while on duty, nor operate the crane when he is physically unfit.

The operator or someone specially designated shall properly lubricate all working parts of the crane.

Cranes shall be examined daily for loose parts or defects. Cranes shall be kept clean.

Operators shall avoid, as far as possible, carrying loads over workmen; this must be absolutely avoided when carrying molten metal or when using a magnet.

Whenever the operator finds the main or emergency switch open, he shall not close it, even when starting on regular

duty, until he has made sure that no one is on or about the crane, and he shall not oil or repair the crane unless the main switch is locked open.

Before closing the main switch, the operator shall make sure that all controllers are in "Off" position.

If the power goes off, the operator shall immediately throw all controllers to "Off" position until the power is again available.

The operator should not reverse a motor until it has come to a full stop, except to avoid accidents.

The operator shall pay special attention to the block, when long hitches are made, to avoid tripping the limit switch or running the block upon the drum.

The operator shall recognize signals only from the one man who is supervising the lift. Operating signals should follow an approved standard; they should be manual, never verbal. Whistle signals may be used where one crane only is in operation.

Before starting to hoist, the operator shall place the trolley directly over the load to avoid swinging it when being hoisted. This precaution is especially important when handling molten metal.

The operator shall not make side pulls with the crane except when especially instructed by the proper authority.

When handling maximum loads, particularly ladles of molten metal, the operator shall test the hoist brakes after the load has been lifted a few inches; if the brakes do not hold, the load should be lowered at once and the brakes adjusted or repaired.

Bumping into runway stops or other cranes shall be avoided. When the operator is ordered to engage with or push other cranes, he shall do so with special care for the safety of persons and cranes.

When lowering a load, the operator shall proceed carefully and make sure that he has the load under safe control.

When leaving the cage, the operator shall throw all controllers to "Off" position and open the main switch.

If the crane is located out of doors, the operator shall also lock the crane in a secure position to prevent it from being blown off or along the track by a severe wind.

Rules for Floormen—Floormen shall give all signals to the operator in accordance with approved standards, preferably manual.

Floormen shall be responsible for the condition and selection of all hoisting accessories and for all hitches.

Before the operator moves a crane upon which an empty chain sling is hanging, the floorman should hook both ends of the sling to the block.

Floormen, where necessary, should walk ahead of a moving load and warn people to keep clear of it. They shall see that the load is carried high enough to clear all obstructions.

Floormen shall notify the foreman in advance when an unusually heavy load is to be handled.

Floormen shall not ride or allow others to ride on the hook or load.

Rules for Repairmen—Repairmen should have a crane that is to be repaired run to a location where the repair work will least interfere with other cranes and with operations on the floor.

Before starting repairs, repairmen shall see that all controllers are thrown to "Off" position; that main or emergency switches are opened; one of these shall be locked.

Repairmen shall immediately place warning signs or "Out of Order" signs on a crane to be repaired and also on the floor beneath. If other cranes are operated on the same runway, they should also place rail stops at a safe distance or make other safe provision.

When repairing runways, repairmen shall place rail stops and warning signs or signals so as to protect both ends of the section to be repaired.

Repairmen shall take care to prevent loose parts from falling or being thrown upon the floor beneath.

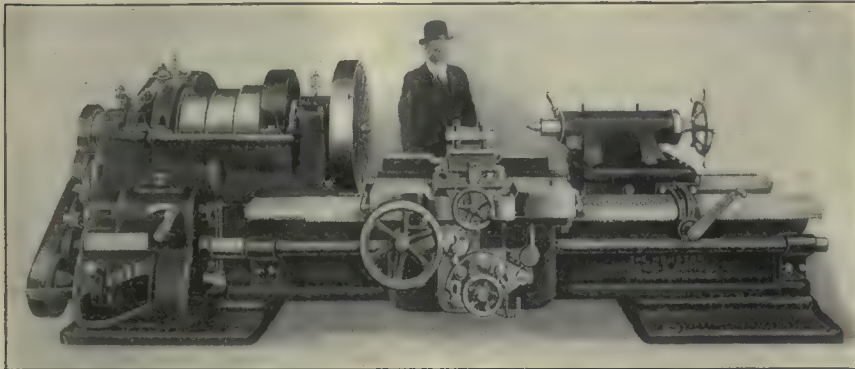
Repairs shall not be considered complete until all guards and safety devices have been put in place and the block and tackle and other loose material have been removed.

How Some Elements Affect the Mechanical Properties of Steel was made the subject of an important paper before the fall meeting of the Iron and Steel Institute in London. The author of the paper, Dr. J. E. Stead, gave a prominent place to the influence of sulphur and phosphorus on iron and steel, and the importance of this phase of the subject was also emphasized in the abundant discussion given the paper. A conclusion reached was that the effect of 0.1 per cent. phosphorus, within certain limits, is comparable with that of carbon, although carbon has a greater influence than phosphorus in reducing the ductility.

Shop Equipment News

Heavy Engine Lathe

The illustration shows a 30-in. quick-change feed heavy engine lathe, which has been put on the market by the Houston, Stanwood & Gamble Co., of Cincinnati, Ohio. This machine is double back geared in a ratio of 3.55 and



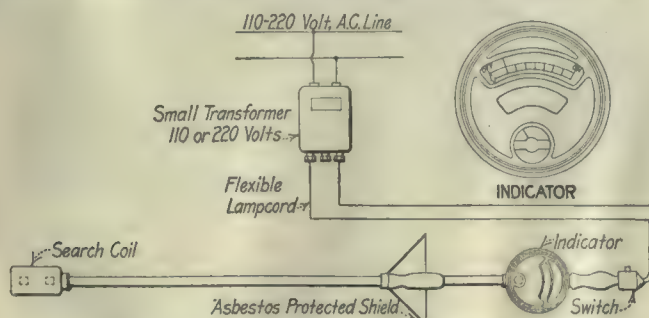
HEAVY 30-IN. QUICK-CHANGE FEED ENGINE LATHE

Front spindle bearing, 8 by 10 in.; rear spindle bearing, $4\frac{1}{2}$ by 8 in.; hole through spindle, $2\frac{1}{2}$ in. in diameter; faceplate, 30 in. in diameter; tailstock spindle, $4\frac{1}{4}$ in. in diameter, 12-in. travel. Length of carriage on ways, 44 in. Width of bridge, 16 in. Swing over vees, $30\frac{1}{2}$ in.; and over bridge, $18\frac{1}{4}$ in. Horsepower transmitted at 243 r.p.m., with belt on middle step, 16. Weight with minimum length of bed, 1,800 lb.

12.5. It has three steps on the cone adapted for 6-in. driving belt. All the gears in this lathe are of steel. The tailstock is of the set-over type, clamped by four bolts. The apron is of the double-wall type and the lead screw is splined to act as a feed rod. This lathe is made with any length of bed up to 30 ft.

Critical-Temperature Indicating Pyrometer

It is a well-known fact that steel in the process of heating loses its magnetic properties when it is brought to its critical point. The pyrometer known as the "Crit Point,"



CRITICAL-TEMPERATURE PYROMETER

which is a product of the Gibb Instrument Co., of Pittsburgh, Penn., takes advantage of this phenomenon. Through the medium of magnetic coils, contact is made with the steel in the furnace. A magnetic indicator is placed in the circuit, and the meter immediately indicates when the steel has reached its critical point.

This pyrometer does not measure temperature, but indicates the presence of the critical point absolutely.

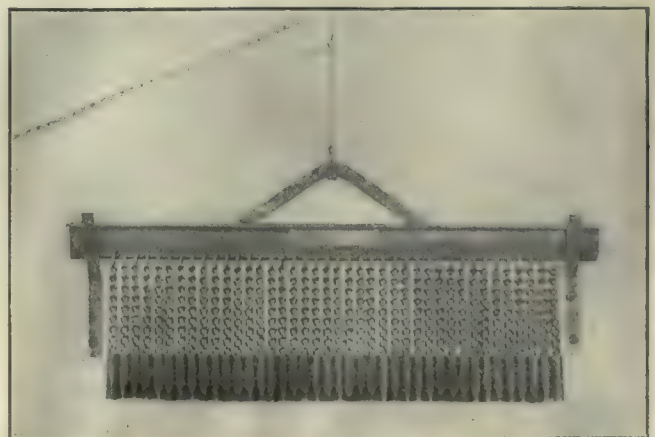
Chain Screen Door

The illustration shows an improved form of chain screen door for oven and furnace openings.

This form of door was designed to eliminate the discomfort of the heat and gases coming out through the uncovered opening, when the doors are thrown open, and the loss of efficiency through the chilling effect of the intruding cold air. At the same time the form of chain door shown permits an unhampered view of the interior, as the glare is toned down. The doors are made in automatic and nonautomatic forms. The automatic is employed mostly in boiler furnaces where the opening of the ordinary fire-door causes the screen to unroll from a cylinder hung above the furnace opening. The nonautomatic, which is much used on ovens and other furnaces, is much simpler in construction. The chains forming the screen are suspended from a bar and may be raised out of the way by a hand chain running through a pulley overhead. When needed, the screen is lowered into supporting brackets fixed at the sides of the opening.

In some plants the chain screens are attached directly to the bottom of the ordinary furnace door. When the door is raised, the screen covers the opening. When the door is lowered, the chain screen drops down below the hearth. This form is used where the hearth does not extend beyond the bottom of the vertically sliding door.

In plants where the furnace or oven charge is handled by means of tongs, the lower half of each strand of chain



CHAIN SCREEN DOOR

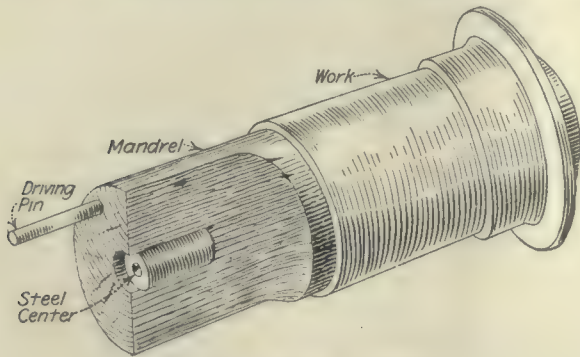
is replaced with a light steel tube as shown in the illustration. This prevents the chains catching in the crotch of the tongs.

The form of chain door shown is the latest product of the E. J. Codd Co., Baltimore, Md.

Wooden Mandrels for Machining Brass Tubing

By H. H. PARKER

In machining brass tubing of large diameter, hardwood mandrels are often used. The sketch shows an improvement over the ordinary type of mandrel, this one being provided with steel centers made of lengths of cold-rolled



THE WOODEN MANDREL

steel driven into the ends of the hardwood cylinder and drilled out with a center drill. Ends are countersunk slightly to protect centers.

If the mandrel diameter is great enough, a steel rod may be driven into one end near the circumference, to set into the faceplate slot in place of a dog.

This makes a good drive when the cut is light and the wood is hard. The driving stud must not be too long however or it may give trouble.

Proposed Southwestern Engineering Society

A. F. Barnes, Dean of Engineering of the New Mexico College of Agriculture and Mechanic Arts, State College, N. M., has been endeavoring to organize a Southwestern Engineering Society. Letters have been received from prominent engineers in the three states of New Mexico, Arizona and Texas expressing the need of such an organization.

The object will be to promote the science of engineering in the Southwest. The principal means for this purpose shall be: First, the holding of meetings for the reading and discussion of professional papers especially upon such questions as are peculiar to this region: second, to give opportunity for social intercourse and thus establish a common interest in the welfare of the engineering profession.

Admission will no doubt not only be open to practicing engineers, but opportunity to join will be given to any person so connected with engineering as to qualify him to cooperate with engineers in the advancement of professional knowledge.

It is planned in a short time to call a meeting of those engineers who have shown interest in the matter and at such a time draw up tentative plans and a program for a general meeting to be held at a suitable place at which time final organization can be effected. Judging by the success of the various other engineering societies the southwestern division of the country, which has been taking on so many important engineering aspects, should be well able to support a society of its own.

Personals

Horace N. Trumbull has been appointed advertising manager of the S K F Ball Bearing Co., of Hartford, Conn.

T. D. Montgomery has been appointed manager of the New York office of the Cutler-Hammer Manufacturing Co., of Milwaukee.

Julius Michaelson has become proprietor of the Up-To-Date Tool Co., of Boston, Mass. He was formerly connected with the Harbor Machine Co., of the same city.

H. O. C. Isenberg has been made chief engineer of the Scripps-Booth Co., of Detroit. He was formerly associated with the Ferro Machinery and Foundry Co., of Cleveland, Ohio.

Eugene E. Hart has accepted a position with the machinery department of the Cleveland Tool and Supply Co., Cleveland, Ohio. He was formerly connected with the Pratt & Whitney Co.

Arthur B. Farr, who for the last three years has been advertising manager of the S K F Ball Bearing Co., Hartford, Conn., has accepted the position of sales manager of the Hess Steel Corporation, Baltimore, Md.

Herbert Chase, who has been connected with the Automobile Club of America for several years as laboratory engineer and chief engineer, has joined the office staff of the Society of Automobile Engineers in the capacity of assistant secretary.

W. C. Stevens has been appointed sales manager of the Cutler-Hammer Manufacturing Co., of Milwaukee. Mr. Stevens is a graduate of Sibley College, Cornell University. He has done much experimental work in connection with controllers for steel plants and unloading plants, these resulting in practical features incorporated in Cutler-Hammer controllers.

Obituary

Charles Wiley died at his home in East Orange, N. J., on Dec. 3. Mr. Wiley was 82 years old and was vice-president and treasurer of John Wiley & Sons, Inc., publishers.

Trade Catalogs

Engine Lathes. The Sebastian Lathe Co., Cincinnati, Ohio. Catalog No. 20. Pp. 16; 6x9 in.; illustrated.

"Gripwell" Pulley Covering. Gripwell Pulley Covering Co., 157 Cedar St., New York. Booklet. Pp. 16; 3½x6 in.; illustrated.

Midvale High Speed Tool Steels. The Midvale Steel Co., Widener Building, Philadelphia, Penn. Pamphlet. Pp. 22; 4x7 in.; illustrated.

Duntley Portable Electric Hoists. Chicago Pneumatic Tool Co., Fisher Building, Chicago, Ill. Bulletin E-45. Pp. 4; 6x9 in.; illustrated.

Oxy-Acetylene Cutting and Welding Apparatus. The Imperial Brass Manufacturing Co., 1200 W. Harrison St., Chicago, Ill. Catalog No. 135. Pp. 28; 7x9½ in.; illustrated.

Econo Expanded Metal Machine and Belt Guards. The North Western Expanded Metal Co., 407 S. Dearborn St., Chicago, Ill. Booklet. Pp. 16; 3½x6 in.; illustrated.

Alloy and Tool Steels. The Midvale Steel Co., Widener Building, Philadelphia, Penn. Catalog No. 33. Pp. 145; 4½x7 in.; illustrated. This contains tables and charts showing critical temperatures and physical properties of the Midvale steels.

Business Items

The Standard Engineering Works, Pawtucket, R. I., is moving into a much larger plant at 289 North Main St., that city, which will greatly increase its capacity and will enable it to take care of its rapidly growing business.

The New Addition to the plant of W. H. Nicholson & Co., Wilkes-Barre, Penn., is now completed. The required machinery is already on hand and is now being installed. The addition will increase the floor space about 100 per cent.

The Business of the Van Wagner Die Casting Corporation (formerly the E. B. Van Wagner Manufacturing Co.) and the Precision Die Casting Co., Inc., Syracuse, N. Y., has been merged into the Precision Die Casting Co., Inc. Alterations and extensions at the works will be made at

once. These officers have been elected: President, T. G. Meacham, also vice-president and general manager of the New Process Gear Corporation; vice-president and general manager, J. Wiltse Knapp; treasurer, Harrol S. Tenney; secretary, E. J. Quintal.

Forthcoming Meetings

Society of Automobile Engineers. Annual meeting, Jan. 9-11. United Engineers Building, New York City. Colver F. Clarkson, secretary, 29 West 39th St., New York City.

American Society of Mechanical Engineers. Monthly meeting, first Tuesday. Calvin W. Rice, secretary, 29 West 39th St., New York City.

Boston Branch National Metal Trades Association. Monthly meeting on first Wednesday of each month, Young's Hotel. W. W. Poole, secretary, 40 Central St., Boston, Mass.

Providence Association of Mechanical Engineers. Monthly meeting, fourth Wednesday of each month. J. A. Brooks, secretary, Brown University, Providence, R. I.

New England Foundrymen's Association. Regular meeting, second Wednesday of each month, Exchange Club, Boston, Mass. Fred F. Stockwell, 205 Broadway, Cambridgeport, Mass.

Engineers' Society of Western Pennsylvania. Monthly meeting, third Tuesday; section meeting, first Tuesday. Elmer K. Hiles, secretary, Oliver Building, Pittsburgh, Penn.

Rochester Society of Technical Draftsmen. Monthly meeting, last Thursday. O. L. Angwine, Jr., secretary, 857 Genesee St., Rochester, N. Y.

Superintendents' and Foremen's Club of Cleveland. Monthly meeting, third Saturday. Philip Frankel, secretary, 310 New England Building, Cleveland, Ohio.

Western Society of Engineers, Chicago, Ill. Regular meeting, first Wednesday evening of each month, excepting July and August. J. H. Warder, secretary, 1785 Monadnock Block, Chicago, Ill.

Philadelphia Foundrymen's Association. Meetings first Wednesday of each month. Manufacturers' Club, Philadelphia, Penn. Howard Evans, secretary, Pier 45 North, Philadelphia, Penn.

Technical League of America. Regular meeting, second Friday of each month. Oscar S. Teale, secretary, 35 Broadway, New York City.

Cincinnati Automatic Bed-Type Millers for Quantity Manufacture

SYNOPSIS—Features of operation are automatic control of the table feed, which gives a quick forward movement to bring the work to the cutter, a proper feeding rate across the work and a quick return of the table; and the automatic stopping of the spindle while reversing the table. Features of construction include a minimum of moving slides, narrow guides, mechanism giving a choice of 24 spindle speeds and 12 table feeds, and mechanism to give the automatic controls. The machine has been designed for the quantity manufacture of machine parts and is made with 12-, 18- and 24-in. table travel.

A line of automatic bed-type millers has been placed on the market by the Cincinnati Milling Machine Co., Cincinnati, Ohio. Fig. 1 illustrates the 12-in. plain machine, and Fig. 6 the 18-in. duplex machine. These millers have been designed for the quantity manufacture

With the purpose of producing a machine requiring a minimum of effort on the part of the operator the movement of advancing the table to bring the work to the cutters and returning it after the cut is finished is made automatic. This reduces the work of the miller hand to chucking new pieces, shifting the starting lever and removing the pieces after they are finished. This result is accomplished by providing a quick forward movement of the table to bring the work to the cutter, then automatically changing to the feeding rate as the cutter traverses the work, stopping the spindle while reversing, and providing a quick return of the table to the starting point. All these movements are accomplished automatically. However, the automatic spindle stop can be easily disengaged when the nature of the work does not require its use. To amplify the features of this automatic feeding control, the following fundamental movements are available:

1. A forward quick feed to the work, feed across the work at a proper rate, automatic stopping of spindle, au-

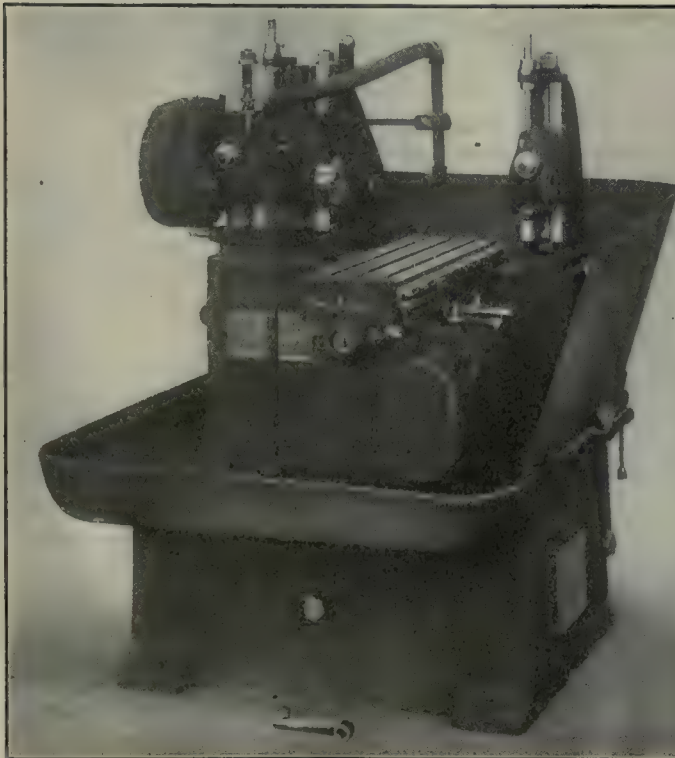


FIG. 1. FRONT VIEW OF 12-IN. PLAIN AUTOMATIC MILLER

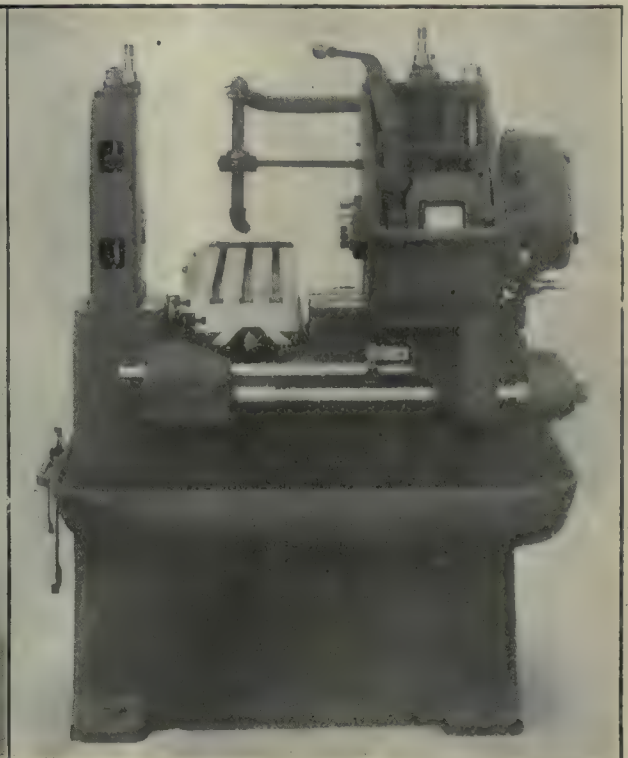


FIG. 2. REAR VIEW OF 12-IN. PLAIN AUTOMATIC MILLER

Working surface of table, $9\frac{1}{4} \times 24$ in.; effective table feed, 12 in.; vertical adjustment of spindle and tailstock, $5\frac{1}{2}$ in.; of tailstock, 3 in.; cross-adjustment of headstock, $5\frac{1}{2}$ in.; of tailstock, 3 in.; maximum and minimum distances from end of spindle to center of table, $8\frac{3}{4}$ and $3\frac{1}{4}$ in.; spindle speeds, 24, ranging from 31 to 603 r.p.m.; table feeds, 12, ranging from 1 to 18 in. per min.; quick forward table movement and automatic return, 100 in. per min.; spindle taper, No. 11 B. & S.; driving pulley, 8×3 in.; pulley speed, 500 r.p.m.

of parts, such as those entering into automobiles, firearms, typewriters, adding machines and the like. A glance at Figs. 1 and 2 shows that the machine illustrated is of the bed, or Lincoln, type with the table supported directly on the bed without any saddle. It has single-pulley drive and a large base pan. A part of its equipment is the Cincinnati system of stream lubrication, but the features that should be first described are the automatic controls for the table feeds and spindle speeds.

automatic reverse, and return to the starting point with the spindle stationary.

2. A forward quick feed to the work, feed across the work at a proper rate, a quick forward feed to clear, and automatic stopping of both feed and spindle. Then, when the work has been removed, quick return of the table to the starting point by shifting the lever on the feed box.

3. If it is desired to chuck a string of pieces on the table, dogs can be provided to produce an intermittent

forward movement, by which the space between the pieces is automatically traversed at the high rate—100 in. per min. This change of rate of advance and feed can be repeated for as many pieces as there are on the table.

All the feeding cycles (14 are listed by the builder) are obtained by a proper setting of dogs on the right-hand side of the table. One of these is shown in place in Fig. 1. This method and the cycles themselves are the same as those previously used on the Cincinnati semi-automatic millers.

FEATURES OF CONSTRUCTION

In addition to the general features of the machine mentioned above, there are a number of others that deserve notice. Cross-adjustment is made by moving the headstock, which slides on the bed guided by a narrow V-guide and is adjusted by a screw carrying a micrometer dial. This screw and dial are seen at the extreme right in Fig. 2. The spindle carrier is guided on the headstock frame by a narrow V-guide and is clamped to the headstock by two bolts. The gibbing is so arranged that the carrier is always held against the headstock even when the clamping bolts are released. The tailstock is provided with an adjustable sleeve, the front end of which receives the bearing on the end of the arbor. When long arbors are used, a bushing is carried in the tailstock in place of the sleeve.

The spindle is driven from a single constant-speed pulley, shown in Fig. 2, carried on the back-gear shaft. The oiling arrangement for all bearings, except the main-spindle bearing, the outer arbor support and one end of the lead screw, is centralized and is fed at only four stations.

A cone brake stops the spindle at once when the table reverses automatically. The main starting lever, best

The second is considered the standard series, and proper back gears for it are furnished unless otherwise specified by the buyer. The equipment also includes one pair of reversible change gears that provide for two of the speeds in this series. If it is desired to use any other series, additional back gears must be procured; and if any other speeds are desired in the series for which the machine is geared up than the two made pos-

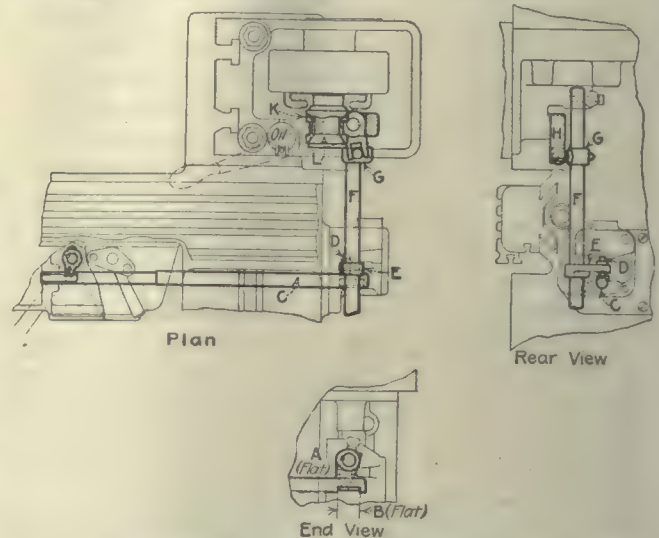


FIG. 5. DEVICE FOR STOPPING SPINDLE AT END OF CUT

sible by the pair of change gears provided, other change gears must be obtained.

This arrangement of speed series makes it possible to equip the machine for slow speeds when necessary and for high speeds when required. Fig. 3 shows the arrangement of spindle driving gears for direct speeds.

Similarly, Fig. 4 shows the arrangement of the gearing for reverse speeds, such as are used for face milling, and also on the duplex machine. The table feed is gear driven from the main pulley through a screw and nut and an automatic weighing safety device, which guards against overloads. A choice of two feeds of 12, covering a range from 1 in. to 18 in. per min., is provided. These feeds are arranged in two series as follows: First series—1, 1.36, 1.76, 2.40, 3.12, 3.87 in.; second series—5.1, 6.4, 8.3, 11.3, 14.75, 18 in. The regular equipment of the machine includes one pair of back gears to provide for one of these series of feeds and one pair of change gears to provide for two

feeds in that series. Both the series and the feeds are expected to be specified by the customer. The first series is considered standard. As a detail of construction, all feed and spindle driving gears are of hardened steel.

AUTOMATIC SPINDLE STOP

Fig. 5 shows in diagram the mechanism of the automatic spindle stop. The shaft C has rack teeth cut on one end to mesh with a segment directly connected to the clutch fork in the feed box. The other end of the shaft has two slots, a narrow one indicated at A and a wider one at B. These slots engage with the eccentric

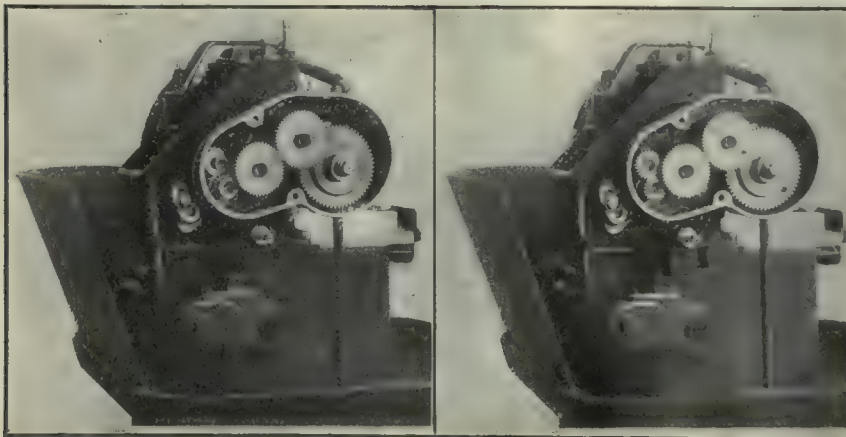


FIG. 3. USUAL ARRANGEMENT OF SPINDLE-DRIVING GEARS

FIG. 4. ARRANGEMENT OF SPINDLE-DRIVING GEARS FOR REVERSE

seen above the lubricant pipe in Fig. 2, starts and stops both the feed and speed simultaneously.

The machine is so arranged that with only a few gears and the simplest mechanism an unusually wide range of speeds are made available.

From a full set of back gears and change gears it is possible to select any one of 24 spindle speeds ranging from 31 to 603 r.p.m. These speeds are divided into three series, as follows: First series—31, 39, 51, 66, 81, 104, 135, 170 r.p.m.; second series—49, 62, 80, 103, 127, 163, 212, 268 r.p.m.; third series—110, 139, 180, 232, 285, 367, 477, 603 r.p.m., making 24 in all.

head of the screw *D*. The slot *A* is used when a machine is set up for automatically stopping the spindle at the end of the forward movement. The slot *B* is used when the work does not require the stopping of the spindle.

By sliding back the lever *E* and rotating the shaft *C* either slot can readily be engaged with the lever *E*, which

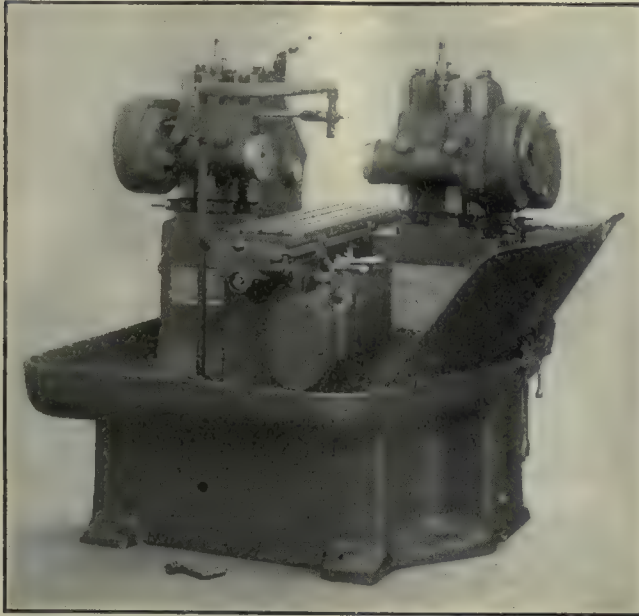


FIG. 6. AUTOMATIC 18-IN. DUPLEX MILLER

The specifications for this machine are the same as for the 12-in. plain machine illustrated in Figs. 1 and 2, except that the effective table travel is 18 in. The maximum distance between ends of spindles is 16 in. and the minimum distance 7 in. This machine is also made in 12-in. and 24-in. sizes

is keyed to the shaft *F*. At the other end of the shaft *F* is keyed the lever *G*, which engages the slot in the lever *A*. This lever is keyed to the same shaft as the starting lever and clutch fork.

The clutch fork straddles the spool *K*, which has shoes fitting into a circular slot in the spool. When this spool is pushed toward the pulley, it expands the clutch fingers and starts the machine. When pushed away from the pulley, the spool is thrust against the brake bushing *L*.

The movement of the spool is properly timed with the tripping of the feed box. Thus the dog on the table, which automatically reverses or stops the table movement, also operates the automatic spindle-stop mechanism by disengaging the driving clutch and immediately stopping the spindle. This is done in the short interval required for reversing or bringing the table to rest, so that the spindle is always stationary when the returning table carries the finished work under the cutter.

Fig. 6 shows an 18-in. duplex machine, the specifications for which are given as a note under the illustration.

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Machine Forging Hollow-Head Setscrews

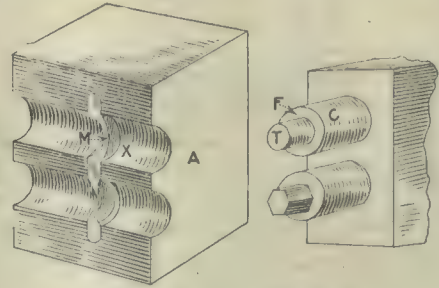
By J. V. HUNTER

It was the excessive cost for some 1½-in. hollow setscrews that were being used to the extent of only a few hundred each year that led to the development of a home-made method for making them. The cost of the dies was many times overpaid by the production of a screw of excellent quality at a cost, even including a high overhead

charge, far below that at which a similar article could be purchased.

The dies were made in a 2-in. standard forging machine. While the setscrew is of unusually large size, the method employed, by varying the size of the dies, produces screws of any diameter; and by a simple means of shortening the plunger or header the lengths may as readily be altered.

In operation the heated bar is first inserted in the upper pass *X* of the die blocks, one of which is shown at *A*, and its corresponding mate, and against a suitable stop that gages it for length. Here, when the blocks are closed together by the machine, the two shear blades *M* some-



THE DIES AND PUNCHES

what more than half sever the bar of steel stock (from which the screws are formed); and the forward portion, which will form the first screw, is then prevented by these same shear blades from crowding back when struck by the header *C*.

The operating end of this header at *T* pierces a round axial hole in the end of the bar, slightly deeper than the required depth of hole in the finished forging. As this piercing die enters the end of the bar, it thrusts the displaced metal forward until it comes in contact with the end of the main stem *F*, which forms a square even end.

It is frequently necessary to take a second heat before the next operation, as light stock cools quickly. The second pass is very similar to the first, except that the shear blade bites a little deeper, but still leaves a little of the stock to bind in the center for stripping. It has also a sort of beveled edge that will be noticed, to put a corresponding bevel on the end of the screw.

The second-pass header is very similar and does its work in the same manner; a hexagon piercing bar is substituted for the round bar, and this forms up the hole to a hexagonal shape for gripping the corresponding bar to be used for a wrench. In placing the bar in the dies for the second operation it should be given a quarter-turn from its position in the first die in order to squeeze away any fins that may have been formed.

The final snipping off of the completed blank is done on the side shear of the forging machine. The blank has been so nearly cut off during the preceding operations that there is no distortion from the wide blades of these shears. Any small fins or burrs are removed by grinding. The blanks are then taken to a standard bolt cutter and held while the threads are being cut by slipping them on a hexagonal mandrel of the same size as the hole.

This same method of producing holes in forged blanks might be used for any number and variety of shapes of openings. However, to get sharp outlines, as in the square or hexagonal, etc., it is advisable always to follow the two-operation method and not try to strike up holes of these shapes in a single pass.

Fixtures and Jigs for Machining Automobile-Truck Parts

BY ROBERT MAWSON

SYNOPSIS—In this article are described various successful milling fixtures and drilling jigs.

On pages 936 and 974 were shown and described various small tools, jigs and fixtures used successfully in

machining elements of commercial vehicles. In this article are illustrated other similar fixtures and jigs.

It will be observed that these tools, like those shown in the previous articles, are of modern design. They incorporate good features in both locating and holding the work, and have also been in service a long while.

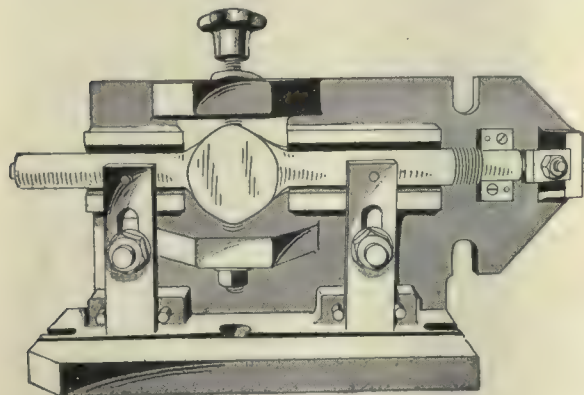


FIG. 2

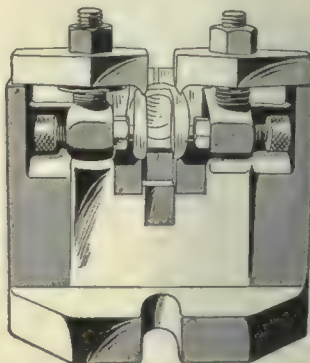


FIG. 4

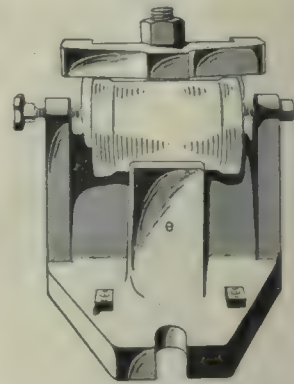


FIG. 6

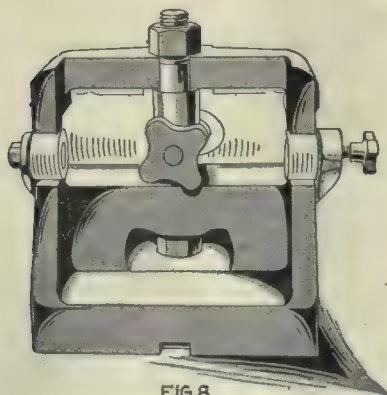


FIG. 8

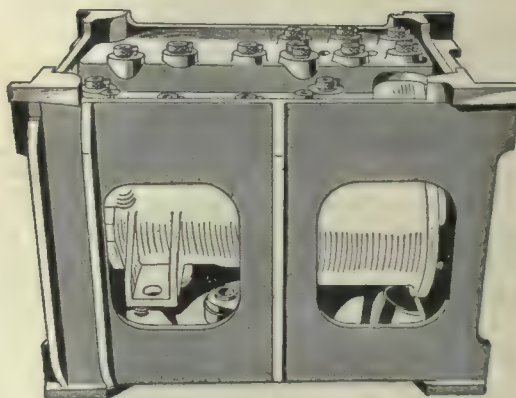


FIG. 10

JIGS FOR MACHINING AUTOMOBILE-TRUCK PARTS, WITH WORK SHOWN IN POSITION

FIGS. 2 AND 2-A

Operation—Milling gear-shifter crank, Fig. 1. The forging, which has been previously turned, is located at the end against a steel stop. The boss to be machined is set against an adjustable stop, being forced against it with a knob-headed screw. Two straps hold the piece securely in position. The fixture is located and held to the machine table.

Surface Machined—Flange, using a 4-in. end mill operating at 150 r.p.m. with a feed of 0.014 in. per revolution.

FIGS. 4 AND 4-A

Operation—Milling gear-shifter rod yoke. The forging is located in two steel blocks that are made with a contour similar to that of the piece. Two knurled-head screws are then tightened against the outer surfaces of the fork end. The piece is held in position by two straps tightened down with nuts. The fixture is located by tongues and held to the machine table with bolts. **Surface Machined**—Slot, $\frac{1}{4}$ -in. cutter.

FIGS. 6 AND 6-A

Operation—Milling rear spring shackle, Fig. 5. The casting is placed in a V-block and located by an adjustable stop at the end. A knob-headed screw is employed to force the piece against the stop. A strap holds the casting securely.

Surfaces Machined—Outer surfaces of bosses, using two 9-in. inserted-tooth side mills operating at 32 r.p.m. with a feed of 0.06 in. per revolution.

FIGS. 8 AND 8-A

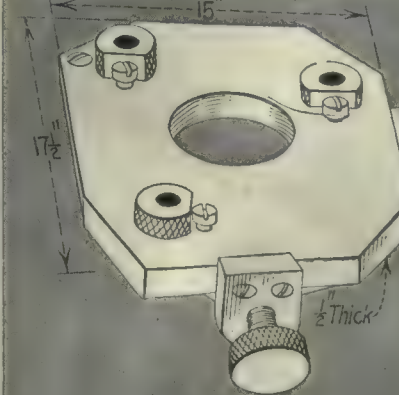
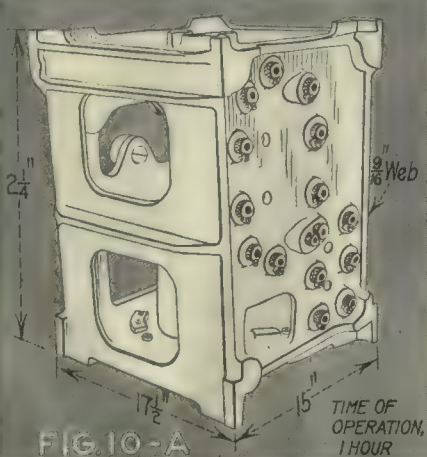
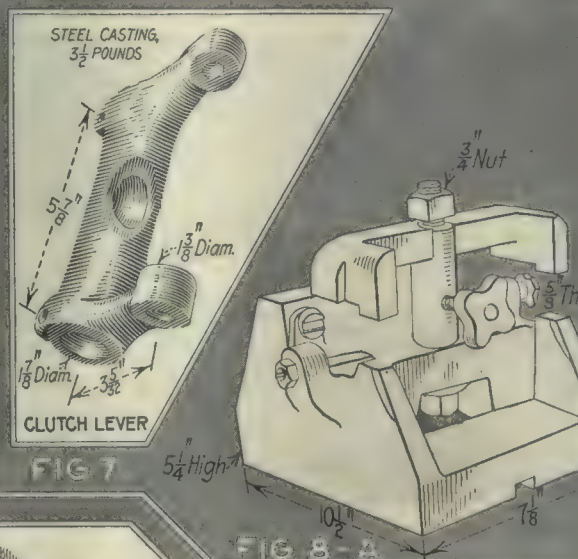
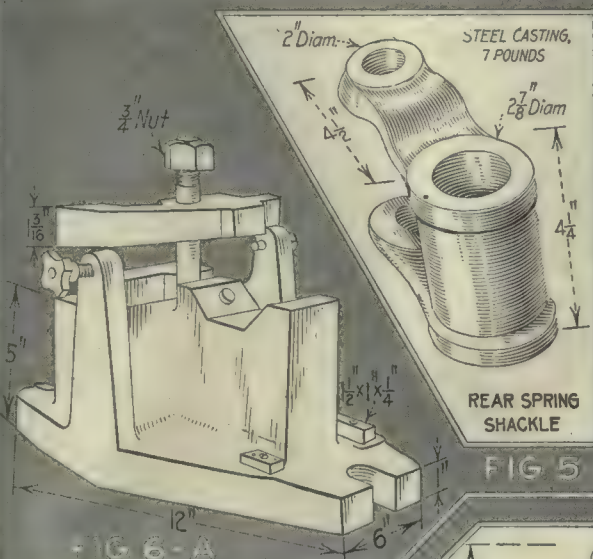
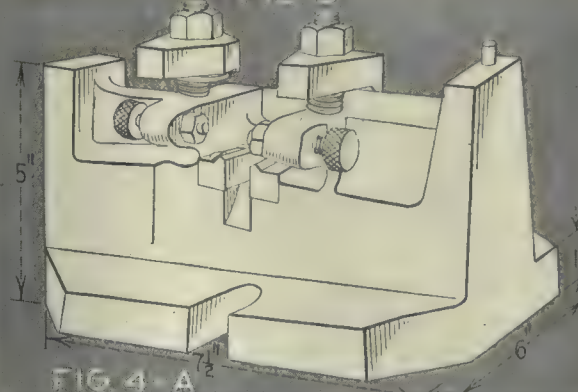
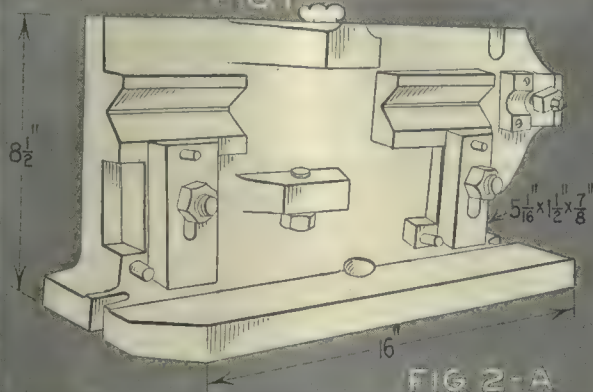
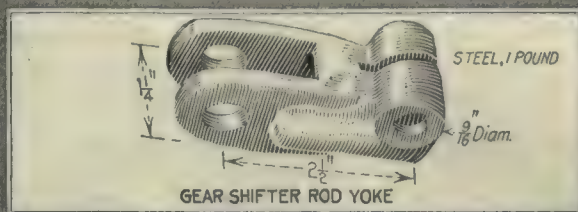
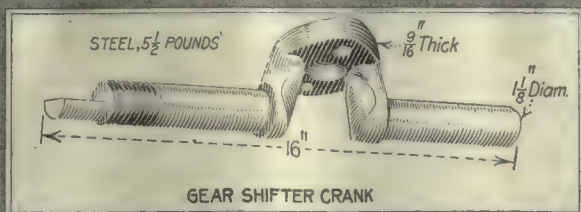
Operation—Milling clutch lever, Fig. 7. The casting rests on two raised pads of the fixture and is located at the end by an adjustable stop and at the sides by two fixed stops. Knob-headed screws at the end and front of the fixture force the piece into position. A strap held down with a nut holds the casting securely. The fixture is located and held in the machine table in the usual manner.

Surfaces Machined—Both sides of arms, using four 5-in. side mills gaged on an arbor. These cutters operate at 50 r.p.m. with a feed of 0.04 in. per revolution.

FIGS. 10 AND 10-A

Operation—Drilling and tapping dumper-gear box, Fig. 9. The casting, which has been previously milled, is located against finished pads that rest against machined surfaces of the casting. An auxiliary jig is placed on the upper flange, being located by a knurled-head screw forcing the casting against a fixed pin. A long bolt with nut and open washer holds the two jigs and casting in position.

Holes Machined—Four $\frac{1}{2}$ -in., sixteen $\frac{10}{64}$ -in., three $\frac{1}{4}$ -in., two $\frac{1}{2}$ -in. drilled; one hole drilled to suit $\frac{1}{4}$ -in. pipe tap, and six $\frac{23}{64}$ -in. drilled. The various slip bushings are then removed from the jig and the $\frac{1}{2}$ -in. holes tapped with $\frac{1}{2}$ -in. U.S.S. threads, the $\frac{10}{64}$ -in. holes tapped with $\frac{3}{8}$ -in. U.S.S. threads, the $\frac{1}{4}$ -in. holes tapped with $\frac{1}{8}$ -in. U.S.S. threads and the $\frac{23}{64}$ -in. holes tapped with $\frac{1}{16}$ -in. U.S.S. threads.



ALL BUSHINGS USED FOR GUIDING TOOLS ARE BLACKENED. ALL JIG AND FIXTURE BODIES ARE CAST IRON, STRAPS AND FASTENINGS, MACHINERY STEEL; GUIDE BUSHINGS ARE TOOL STEEL, HARDENED AND GROUND

Some Methods Employed in a Ball-Bearing Factory

The Hess-Bright Manufacturing Co., Philadelphia, Penn., makes a variety of annular ball bearings using a cage to separate the balls. In Fig. 1 is shown the

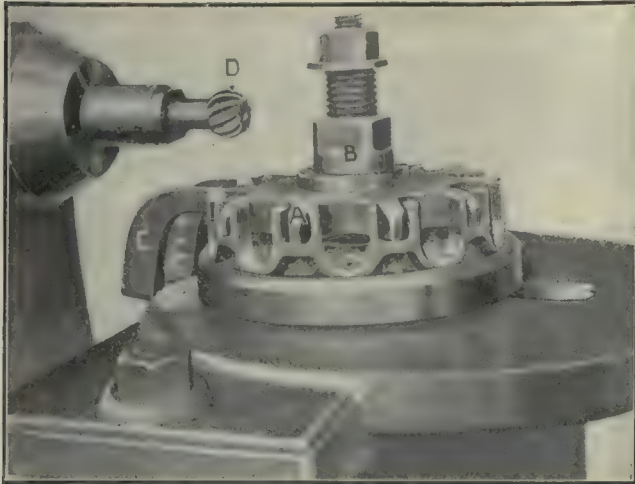


FIG. 1. MILLING THE BALL POCKETS ON THE CAGE

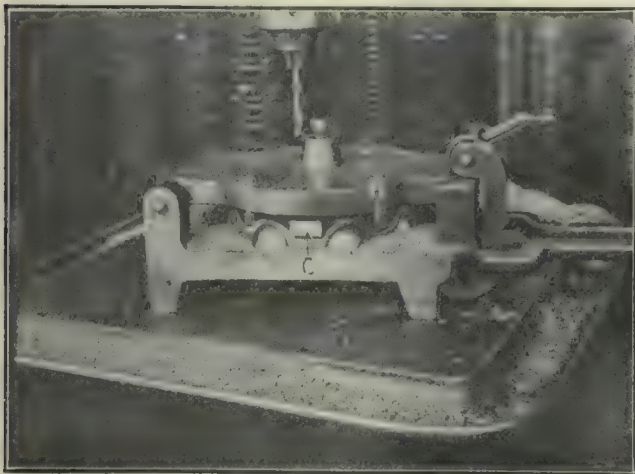


FIG. 2. FIRST DRILLING JIG



FIG. 3. SECOND DRILLING METHOD

method of milling the ball pockets in the cage. The rough cage is placed on the base of the fixture. The clamp A is then placed and held by a nut and open

washer. As the nut B is tightened down, the blank is held rigidly on the fixture. Two supporting fingers C are provided that press against the cage, thus preventing the metal from spreading during the milling operation which is performed with the ball milling cutter D. After one recess has been machined, the work is indexed and the operation repeated.

The jig used for drilling the holes in one member of the cage is shown in Fig. 2. The piece is located by means of balls attached to the upper side of the jig base. After the piece has been placed in the jig, as shown, the cover is dropped down and held by a cam operated by the pin handle A. The pins B and an equalizing strap C contact with and hold the piece securely during the drilling operation.

When drilling the other member of the cage as shown in Fig. 3, steel balls of the diameter used in the bearing are placed in the lower part of the cage. One of the cages that has been drilled is then placed over the balls, as shown. The holes drilled in the previous operation are then used to guide the drill into the other cage.

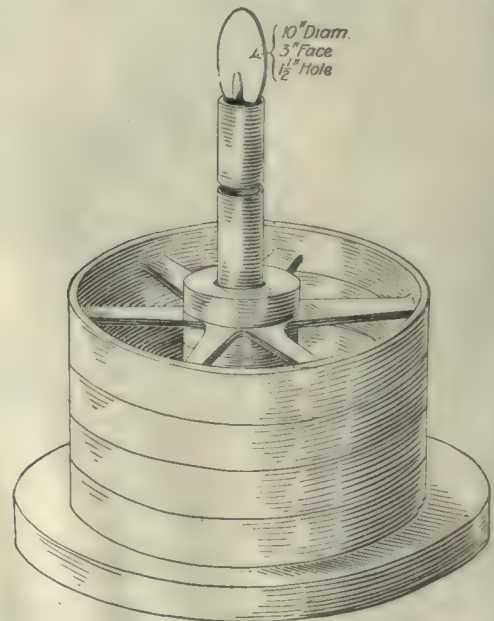
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Markers for Pulleys and Gears

By J. E. COOLEY

There is always more or less trouble in learning the sizes and diameters of pulleys and gears, etc., when these are stacked up on stands in stockrooms or other places. One must take time to visit the stands and lift off the parts in order to scale or caliper their dimensions.

A simple method of marking stands containing pulleys or gears for quick identification, is shown in the illus-



STOCKROOM PULLEY MARKER

tration. The marker is made of stiff cardboard cut in the shape of a disk, and is fastened with brads in a stick which is slit for its reception.

On the marker is printed the diameter of the pulley (or gear), width of face, bore of hole, pitch, or any other information required. As the stands are usually made from wrought-iron piping, the stick end can be placed in the hole in the pipe, where it is readily seen.

Simple Tests for Iron and Steel

By C. R. WHITE

SYNOPSIS—Simple tests for iron and steel are always acceptable. The writer explains a simple method of obtaining pictorial records, without a camera, of steel and iron. With the aid of these records the quality of the material can be judged.

Anyone unfamiliar with the characteristics of the principal materials involved in the manufacture of tools, machines and other metal products does not know where to lay the blame for failures—whether on the design or the material or on abuse. Some form of treating either by

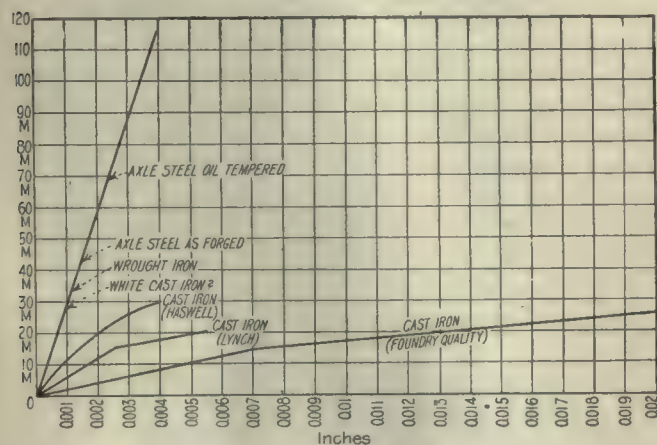
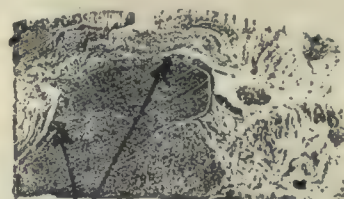
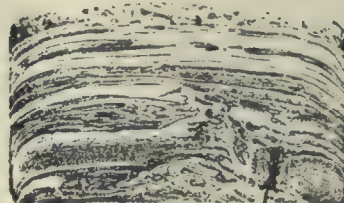


FIG. 1. STRESS-STRAIN DIAGRAM OF COMMON STEELS AND CAST IRON

Sometimes the rolling mill supplies steel instead of iron, or medium or high-carbon steel in place of low carbon, or vice versa. The shopman can get a good idea of the difference between iron and steel by cutting a sliver with a cold chisel and then breaking the sliver. Iron will show up coarsely fibrous, while steel nearly always is



Steel.

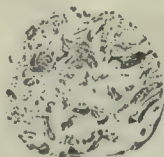


Steel.

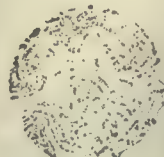
FIG. 3. PRINT OF MIXED IRON AND STEEL



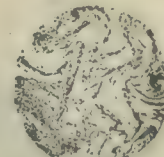
A
Yield 33,300
T. S. 47,900
Red 50.4%
El. in 8" 27.81%



Yield 38,330
T. S. 52,000
Red 32.10%
El. in 8" 23.45%



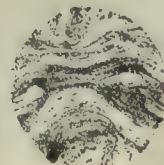
B
Yield 30,266
T. S. 46,960
Red 56.36%
El. in 8" 32.96%



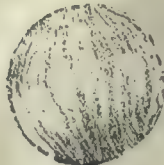
Yield 34,120
T. S. 49,160
Red 51.20%
El. in 8" 31.18%



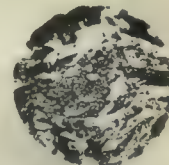
Yield 26,830
T. S. 43,430
Red 55.50%
El. in 8" 31.20%



C
Yield 33,160
T. S. 50,766
Red 50.70%
El. in 8" 30.64%



Yield 37,460
T. S. 51,866
Red 42.4%
El. in 8" 26.5%



Yield 37,160
T. S. 51,080
Red 34.5%
El. in 8" 21.59%

FIG. 2. RECORDS OF STAY-BOLT IRON MADE BY ETCHING AND DIRECT PRINTING

heat or by mechanical means may be considered, but there is a possibility that this treatment may vary from correct practice, owing to misjudgment by the workman, his lack of knowledge, unsuitable apparatus or a material not amenable to the treatment given. As a result there is trouble. The manufacturer is unable to trace the cause, and often besides having his reputation lowered he must meet the costs of replacements into the bargain.

tough, homogeneous and crystalline. If the surface of iron is highly polished, as the surface of a journal, slag lines may be observed running parallel to the axis.

Shearing a bar gives a good test, if it is noticed how the sheared-off piece breaks away from the original bar. There are cases when steel is laminated, but to those who are accustomed to judging fractures there is a difference in structure and appearance of laminated steel and of iron.

The tensile test on a laminated steel gave the results that are compared with average results obtained with iron plates, as shown in Table 1. It will be noticed that the principal difference is in the reduction of area.

TABLE 1. COMPARISON OF LAMINATED STEEL AND IRON

	Laminated Steel	Iron
Tensile strength.....	51,600 lb.	53,800 lb.
Yield point.....	31,400 lb.	37,300 lb.
Reduction of area.....	56.7 per cent.	40.0 per cent.
Elongation in 8 in.....	24.4 per cent.	27.06 per cent.

DIFFERENCE BETWEEN IRON AND LOW-CARBON STEEL

Chemical analysis is sometimes convenient for ascertaining differences, but the principal difference between very low carbon steel and iron is in the manganese content, a point clearly demonstrated in Table 2.



FIG. 4. PRINTS OF AXLE STEEL

TABLE 2. COMPARATIVE CHEMICAL ANALYSES OF CARBON STEEL AND IRON

	Steel, Per Cent.	Iron, Per Cent.
Carbon.....	0.10 to 1.50	0.05 to 0.15
Manganese.....	0.20 to 0.80	Trace to 0.20
Sulphur.....	0.02 to 0.07	0.02 to 0.07
Phosphorus.....	0.02 to 0.10	0.075 to 0.20

Chrome-vanadium steel can be so heat-treated as to present a fibrous fracture, but the appearance is entirely different from that of low-carbon steel or iron. The

analysis of this steel is given in Table 3. After heating to 900 deg. C. for forging, reheating to 875 deg. C., quenching in seal oil, drawing to 450 deg. C., the physical properties of this steel were as shown in Table 4.

TABLE 3. CHROME-VANADIUM STEEL ANALYSIS

Carbon.....	0.50	Phosphorus.....	0.01
Manganese.....	0.92	Chrome.....	1.02
Sulphur.....	0.05	Vanadium.....	0.20

It is possible, then, unless one is familiar with fractures, to make an error. If it is desired to differentiate between iron and steel by physical tests, an expensive

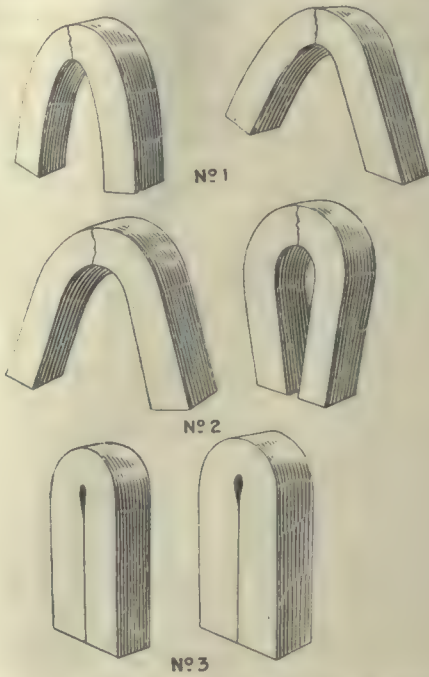


FIG. 5. BENDING TESTS ON AXLE STEEL



FIG. 6. PRINT OF TITANIUM-STEEL RAIL HEAD

tensile-testing machine must be used. Wrought iron and steel have an equal elongation proportional to the equal load, provided the elastic limit is not exceeded. It is therefore necessary to test to destruction. In fact, cast

TABLE 4. PHYSICAL PROPERTIES OF CHROME-VANADIUM STEEL AFTER HEAT-TREATMENT

Tensile strength per sq.in.....	237,500 lb.
Elastic limit.....	221,000 lb.
Elongation in 2 in.....	10 per cent.
Reduction in area.....	29.5 per cent.

iron, wrought iron, carbon and alloy steels are related up to the elastic limit, as is clearly shown in the stress-strain diagrams, Fig. 1, a point that is well worth noting.

An old shop test is to heat a piece of material to a red heat, quench, then bend the material under a press or drop hammer. Any difference in the hardness will give an indication of the carbon content. This test does not take

TABLE 5. ANALYSIS OF TWO STEELS OF SIMILAR TENSILE STRENGTH

	First Steel, Per Cent.	Second Steel, Per Cent.
Carbon.....	0.65 to 0.75	0.90 to 1.10
Manganese.....	0.95 to 1.05	0.35 to 0.50
Phosphorus.....	Under 0.05	Under 0.05
Sulphur.....	Under 0.05	Under 0.05
Silicon.....	Under 0.15	Under 0.15

into consideration the manganese content, which is almost as important as carbon. For example, the analyses of

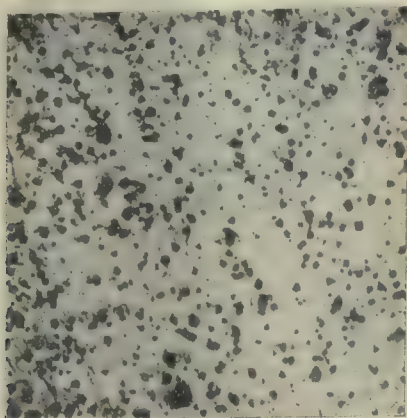


FIG. 7. PRINT OF COMMERCIAL BUSHELED IRON

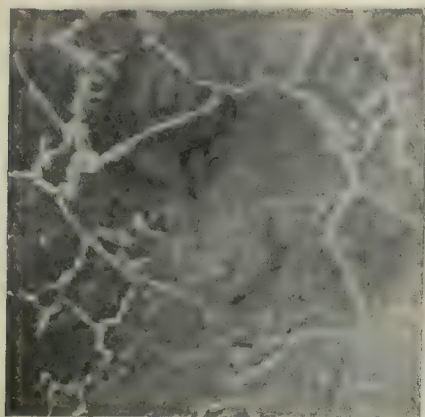


FIG. 9. PRINT FROM SAMPLE SHOWING COARSE CRYSTALLINE FRACTURE

two steels that have practically the same tensile strength are given in Table 5.

Analysis or microscopic examination on the higher magnifications will show differences; but if it is only desired to compare low-carbon steel with iron, etching will produce results that are highly satisfactory. The

Iron is piled or busheled in many different ways before rolling. In railway shops there are generally three or four standard brands of No. 0 iron used. No. 0 iron is the grade of iron selected for plain and flexible stay-bolts and must have a tensile strength of not less than 48,000 lb. per sq.in., a reduction in area of at least 45 per cent. and an elongation in 8 in. of 28 per cent. This iron is used for specific purposes, and service records are kept. By taking samples of each brand of this iron, cutting off a section 1 in. in diameter by 1 in. long, polishing the end and removing with a caustic-soda solution the grease left by the buffing wheel, then etching for about 5 hr. with the iron-etching solution, inking the etched face with an ordinary printers' roller covered with printers' ink and using a letter press, it is possible to make prints and by these prints to identify the various brands when failures occur. The prints also give an idea of the care exercised in busheling and rolling. It is of course necessary to make up a sample sheet of such prints first, so that comparisons can be made. Such a sheet is shown in Fig. 2.

On service test the iron shown at A, Fig. 2, did not compare favorably with that shown at B and C. From the large size of the slag areas etched out in this sample, this result is just what one would expect.

Pieces of nut iron that were hard on taps were polished and etched, with the result that steel was found mixed with the iron. A print of this iron is shown in Fig. 3.

Steel splice plates that failed in service were etched with nitric acid and printed, with the result that after corroboratory evidence had been added from tensile, chemical and microscopic examination the failure was attributed to service conditions.

SULPHUR PRINTS OF AXLE STEEL

Considerable trouble was experienced with axles, and three were selected as representing three manufacturers and typical breaks. Sulphur prints were made as follows: A fresh section of the axle was cut at right angles to the axis; it was polished and put firmly on a bench. A piece of Azo photographic paper moistened with a 3 per cent. sulphuric-acid solution was laid on the polished face, care being taken not to let it slip, and all bubbles of air were smoothed out from under the sheet.

After approximately one minute the paper was removed, washed in cold water and put in a hypo bath, after which it was washed in cold water and dried. Prints of two of these axles are shown in Fig. 4. It will be noticed that the samples contained oxide and slag.

The analysis and microscopic results are given in Table 6. The bending tests are illustrated in Fig. 5 and have corresponding numbers. These tests confirm the physical results, as reduction and elongation confirm the

TABLE 6. PHYSICAL, CHEMICAL AND MICROSCOPIC ANALYSIS OF AXLE STEEL

	Yield, Lb.	Tensile Strength, Lb.	Elongation in 2 in.,		Fracture	Manganese	Phosphorus	Sulphur	Carbon	Microscopic	Sclero- scope Hardness
			Per Cent.	Per Cent.							
No. 1....	36,400	78,300	38.2	26.0	irregular	0.46	0.032	0.056	0.42	Small grain + 1 in., porous and dirty	28.4
	36,000	78,000	41.2	28.0							
No. 2....	39,700	78,500	34.5	25.0	angular	0.47	0.028	0.042	0.38	Medium grain, porous and dirty	32.2
	40,700	75,800	32.5	22.5							
No. 3....	54,800	82,000	56.5	30.0	cup	0.91	0.057	0.060	0.29	Fine grain, a few blow-holes and considerable oxide	28.8
	55,000	85,000	57.0	32.0							

iron is etched with a solution consisting of 3 parts sulphuric acid, 1 part hydrochloric acid, 9 parts water. For steel etching, a 5 or 10 per cent. solution of nitric acid is used.

The iron-etching solution given has practically no effect on steel, but it attacks and eats the slag in the iron.

ductility or ability to bend flat on itself in the case of the third sample. All the axles had similar fractures at the original breaks.

It is interesting to compare the sulphur prints, Fig. 4, with the print, Fig. 6, of a clean piece of titanium rail. This rail was etched with equal parts of tincture of iodine

and alcohol, which is particularly good for developing oxide. In Fig. 7 is shown a piece of commercial bushed iron that is magnified 75 diameters. This is at least 40 per cent. slag, which accounts for the failure. In Fig. 8 is shown a bar that did not work well in the smiths' shop. It was polished and photographed and shows three rails

portion is so small that the whole will let go. The fracture shows one or more smooth planes, and the last break shows crystalline. Many think these smooth planes are flaws, whereas they are fatigue failures or fractures in detail caused by alternate stresses, repeated possibly millions of times. Detailed fractures are the result of using

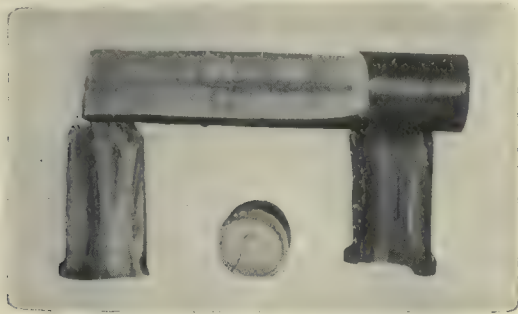


FIG. 10. DEFECTIVE PISTON ROD AND JOURNAL

rolled into it. In Fig. 9 is shown a sample having a coarsely crystalline fracture with low reduction in area and elongation and a large grain size. The analysis of this sample is given in Table 7.

CHANGE IN SIZE OF CRYSTALS IMPOSSIBLE WITHOUT HEAT

Much has been said about the growth of crystals, but there is no change of size when temperature is not a factor. If a bar is nicked and broken off sharp and

TABLE 7. ANALYSIS OF SAMPLE SHOWN IN FIG. 10

Carbon.....	0.52
Sulphur.....	0.03
Manganese.....	0.54
Phosphorus.....	0.037
Tensile strength per sq.in.....	100,300
Reduction.....	24.5 per cent.
Elongation in 2 in.....	15.4 per cent.

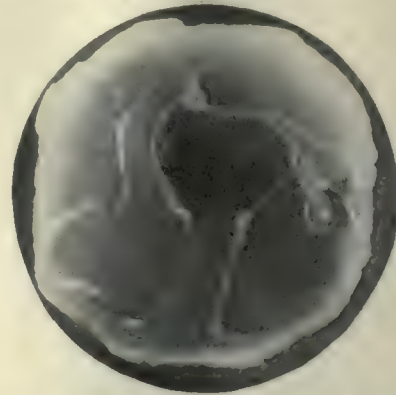


FIG. 8. PRINT OF PIECE WITH THREE RAILS ROLLED INTO IT

undersized material, overloading or using the material too long. The results given in Table 8 clearly illustrate that the material is not always at fault.

Failures of springs are largely due to the fact that the modulus of elasticity is figured at 30,000,000 lb., wherea

TABLE 9. ANALYSIS OF CHROME-VANADIUM PISTON ROD

Carbon.....	0.33
Manganese.....	0.44
Sulphur.....	0.035
Phosphorus.....	0.001
Chromium.....	0.16
Vanadium.....	0.20
Tensile strength, lb. per sq.in.....	136,000
Yield point, lb.....	69,600
Reduction in area, per cent.....	53.2
Elongation in 2 in., per cent.....	20.5

TABLE 8. CRANKPIN, MAIN- AND SIDE-ROD FAILURES

Measurement of Main Rod Bearing Plus or Minus Allowable Limit	Fracture	Microscopic Analysis, Magni- fication 50 Diameters	Physical Tests				Chemical Composition			
			Tensile Strength, Lb. per Sq.In.	Yield, Lb. per Sq.In.	Reduction in Area, Per Cent.	Elongation in 2 In., Per Cent.	Carbon	Manganese	Sulphur	Phosphorus
1-in. diameter, minus	Detail, close to wheel	Maximum grain, 1/4 x 1/4 in., fine uniform grain, well worked	71,090		55	32	0.36	0.57	0.027	0.044
1 1/2-in. diameter, plus	Detail, close to wheel	Maximum grain, 1/4 x 1/4 in., insufficiently worked	62,060	32,200	47	32	0.35	0.28	0.011	0.033
1 1/2-in. diameter, plus	Detail, close to wheel	Maximum grain, 1/4 x 1/4 in., insufficiently worked	58,890	24,380	54	35	0.29	0.26	0.010	0.037
1 1/2-in. diameter, plus	Detail, close to wheel	Maximum grain, 1/4 x 1/4 in., good, slowly cooled from good temperature	67,049	30,800	49	30	0.31	0.58	0.048	0.040
1-in. diameter, plus	Detail, close to wheel	Maximum grain, 1/4 x 1/4 in.	68,690		42	30	0.24	0.74	0.065	0.062
1 1/2-in. diameter, plus	Detail, close to wheel	Maximum grain, 1/4 x 1/4 in., worked very little	86,900	45,500	49	26	0.24			
1 1/2-in. diameter, plus	Detail, close to wheel	Maximum grain, 1/4 x 1/4 in., coarse grain	86,700		42	24	0.36	0.88	0.036	0.046
1 1/2-in. diameter, plus	Detail, close to wheel	Maximum grain, 2 1/4 x 1 1/4 in., very coarse grain	87,100	33,400	33	21	0.43			
At limit.....	Detail, close to wheel	Maximum grain, 1/4 x 1/4 in., uniform and moderate	85,650		49	28	0.47	0.53	0.022	0.052
At limit.....	Detail, close to wheel	Maximum grain, 1/4 x 1/4 in., grain coarse	81,200	41,200	38	24	0.44	0.48	0.028	0.041
1 1/2-in. above.....	Detail, close to wheel	Maximum grain, 1/4 x 1/4 in., dirty	87,200	43,500	45	25	0.35			

Main and Side Rods, All Detailed Fractures

Kind	Section	Material Remarks	Tensile Strength, Lb. per Sq.In.	Yield, Lb. per Sq.In.	Reduction in Area, Per Cent.	Elongation in 2 In., Per Cent.	Carbon	Manga- nese	Sulphur	Phos- phorus	Metal
Side.....	I	Large amount of fine slag	52,730		30	16	0.05	0.01	0.225	0.030	Iron
Side.....	I	Insufficiently worked	64,090	28,780	34	27	0.31	0.28	0.014	0.032	Steel
Side.....	Square	Small amount slag, but dirty	50,880	29,800	32	22	0.07	0.08	0.215	0.033	Iron
Main.....	I	Maximum grain, 1/4 x 1/4 in., good, fine and homogeneous	68,290	41,000	58	27	0.21	0.51	0.078	0.041	Steel
Main.....	I	Maximum grain, 1/4 x 1/4 in., good	82,180	43,900	41	26	0.46	0.44	0.023	0.034	Steel
Main.....	I	Maximum grain, 1/4 x 1/4 in., grain, fairly good	71,100		21	19	0.34	0.41	0.027	0.039	Steel
Side.....	Square	Maximum grain, 1/4 x 1/4 in.	79,980		51	28	0.31	0.46	0.016	0.042	Steel
Side.....	I		74,800		15	15	0.45	0.43	0.013	0.030	Steel

quickly, it may appear crystalline; and if bent slowly and broken, the same bar may appear fibrous.

Frequently a piece will fracture little by little, though not necessarily on the same plane, until the remaining

from actual test this should be 28,000,000 lb. Often when quenching steel, particularly alloy steel, it cracks. If these cracks are opened up, defects will be observed, as shown in the center of the piston rod illustrated in Fig.

10. On the upper edge of the rod the original crack shows clearly and the pipe in the center may also be observed very distinctly.

The defective piston rod rests on the halves of a journal from a shaft that was hammered up from scrap that was oxidized during forging. The weld was imperfect, with the result that the center portion pulled out. The analysis of this chrome-vanadium piston rod is shown in Table 9. The physical results give no indication of the trouble. In this grade of steel the chromium should be above 1 per cent., as there is a loss of 0.9 per cent. Something must be wrong. To avoid getting material with hidden defects

that do not develop till the piece is passed into service, some companies subject the material to drop or to regular transverse tests that are a certain percentage of the elastic limit. A drop testing machine was developed for this purpose. An interesting point in its construction is a tooth on the tup to catch in the rack when the tup rebounds. This tooth is actuated by the force of the blow or the jar of impact due to the inertia of a small sliding latch. The height of rebound was used as a means of comparison for material of similar grade and size and is a convenient though not altogether scientific means of comparison, but one that answers for relative indications.

Making Typewriter Type--II

BY FRANK A. STANLEY

SYNOPSIS—Milling, piercing and grinding, with the type body located in the respective fixtures by means of the crossmarks at each end of the type. These fixtures hold the type at the necessary angle, so that they are finished according to the angular position in which the type bars will be assembled and used on the typewriter.

According to the work schedule previously indicated in Fig. 5, the next operation consists in cutting off the type from the shank, which is performed by the hand miller with the aid of the tools illustrated in Fig. 11. Alongside the splitting saw that severs the type proper from its

Fig. 12 shows a somewhat similar fixture and a somewhat similar operation, although in this case the saw is used not for severing the blank, but for cutting down a corner or making a shoulder square for the ends of the type bar and undercutting at the corner enough to clear that corner for subsequent operations. The fixture is so clearly shown as to require no explanation except to comment upon its simplicity. This last operation is called milling the type-bar shoulder and establishes an exact distance for the shoulder from the front end or working end of the type bar proper.

The piercing tools in Figs. 13 and 14 present some novel features in design and construction. These tools have to take care of all the type made in this department

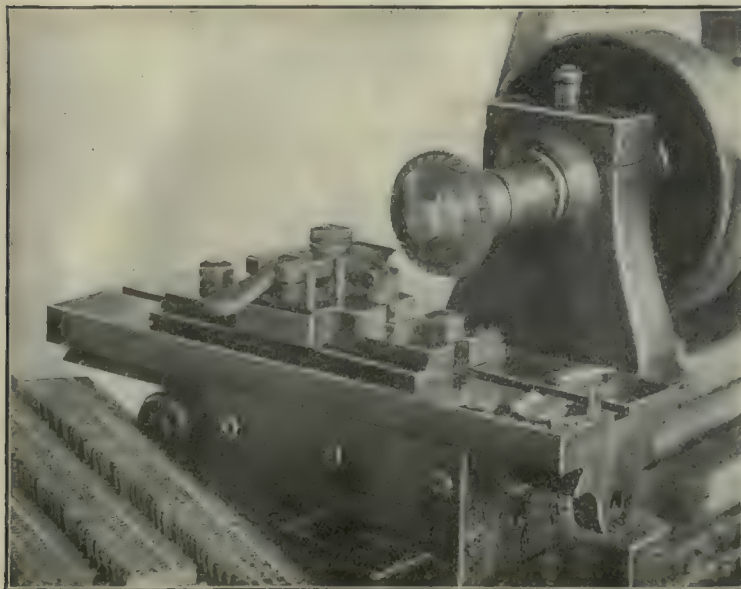


FIG. 11. SAWING THE TYPE FROM THE SHANK WITH A SPLITTING SAW

shank, or original blank, is a thin saw used to take off the burr that is raised by the saw in passing through the cut. This makes a second burring operation unnecessary.

The fixture for holding the work in this operation consists of a simple V-block, a clamping strap with the forward end adapted to draw the work to the bottom of the V-block and with the rear end provided with a light cam handle. This, when lifted, tends to depress the forward end of the strap and draw the work into position.

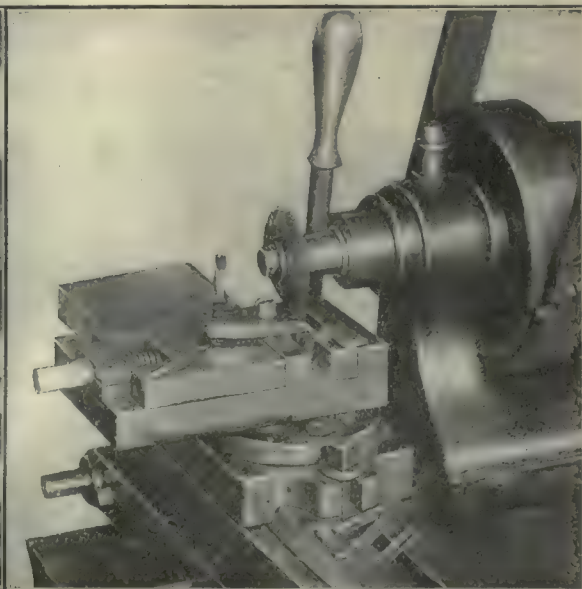


FIG. 12. MILLING THE SHOULDER TO FIT AGAINST TYPE-BAR

and must therefore be adaptable to conform with the various angles to which the bodies of the type are milled in relation to the working faces of the characters. The three holes are 0.0055 in. in diameter, the centers being spread 0.90 in. apart. In placing new work in the holding fixture or nest under the punch and over the die the work is nested against the spring at the back, is purposely pushed in too far and the holder closed. The locator in the jig then floats up to suit the angle. At the same time

the operator pulls over the lever that draws the work back from the spring and holds the clamp, thus keeping the type fast in the proper position. The work is accordingly set in the tools locating from the crosslines on the locating marks of the two inverted-T crosses already referred to.

tools are a few of many ingenious devices developed at this plant for performing unusual operations.

Another illustration, and not the least interesting of the group, is the one in Fig. 15, showing the grinding of the type body—grinding the guide shoulders on the

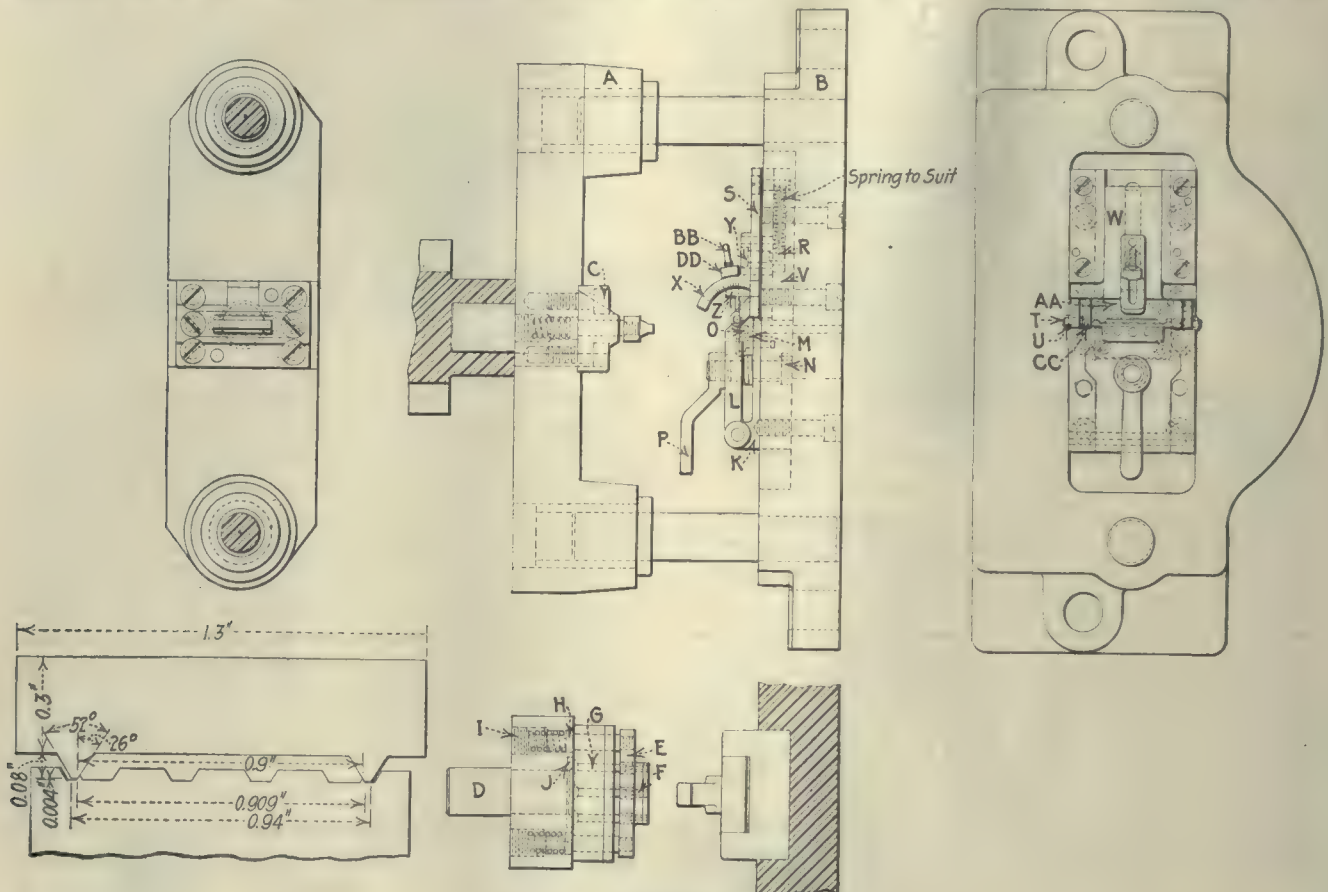


FIG. 14. PIERCING DIE TYPE

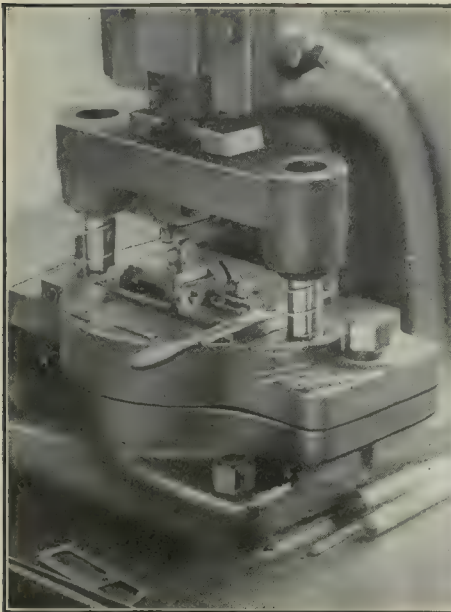


FIG. 13. PIERCING TOOLS

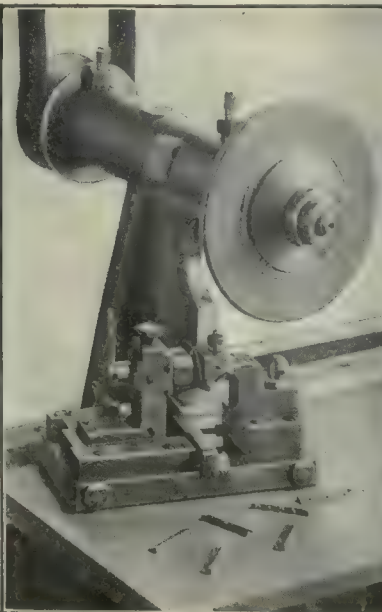


FIG. 15. A NOVEL FIXTURE

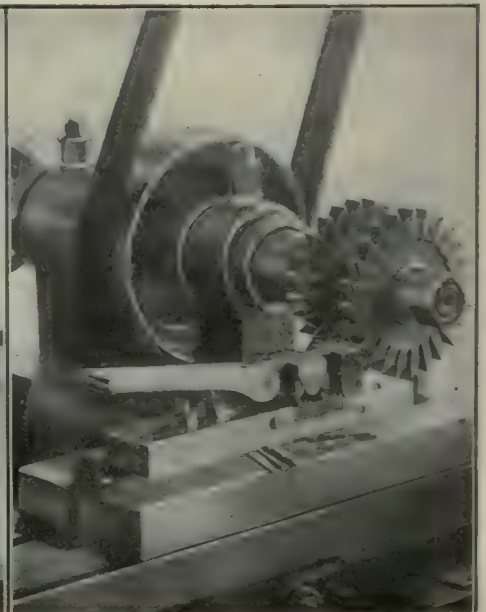


FIG. 17. MILLING ENDS OF TYPE BODIES

The arrangement of the piercing punches, the clamping apparatus, the angular floating locating device for setting the work by the crossmarks and the spring-controlled mechanism for the nesting apparatus are all clearly shown in Fig. 14 and require no detailed explanation. These

type described. They are ground from 0.045 to 0.076 in. thick, dependent upon the position in the typewriter; that is, as the type bars all enter the center guide at different angles, the thickness of the guiding shoulders (which are made exactly to fill the guide) varies from one bar to the

next, according to the degree of angularity from the center line.

This fixture, as shown in Figs. 15 and 16, is for grinding type shoulders for side alignment, and here again provision has to be made to take care of the different degrees of angularity between the type face and the body of the type. In this case the holder for the work locates the type by the locating cross at the ends, and the ball that fits in the socket sleeve allows the holder to tilt as required to the necessary angle. There is a diamond set in this fixture at an exact height, and this is used to dress up the grinding wheel at the right distance from the table.

which shows the vertical adjustment necessary above or below center to accommodate the degree of angularity for the type bodies for the different characters used in the typewriting machine.

FURTHER OPERATIONS

Next, the pierced holes are countersunk to remove the burr, and the back end of the body of the type is milled off at an angle, as seen at operation 12, Fig. 5. The process in milling the ends on the type is carried out in the fixture illustrated in Figs. 17 and 18, with the aid of a pair of straddle mills on the spindle of a hand miller.

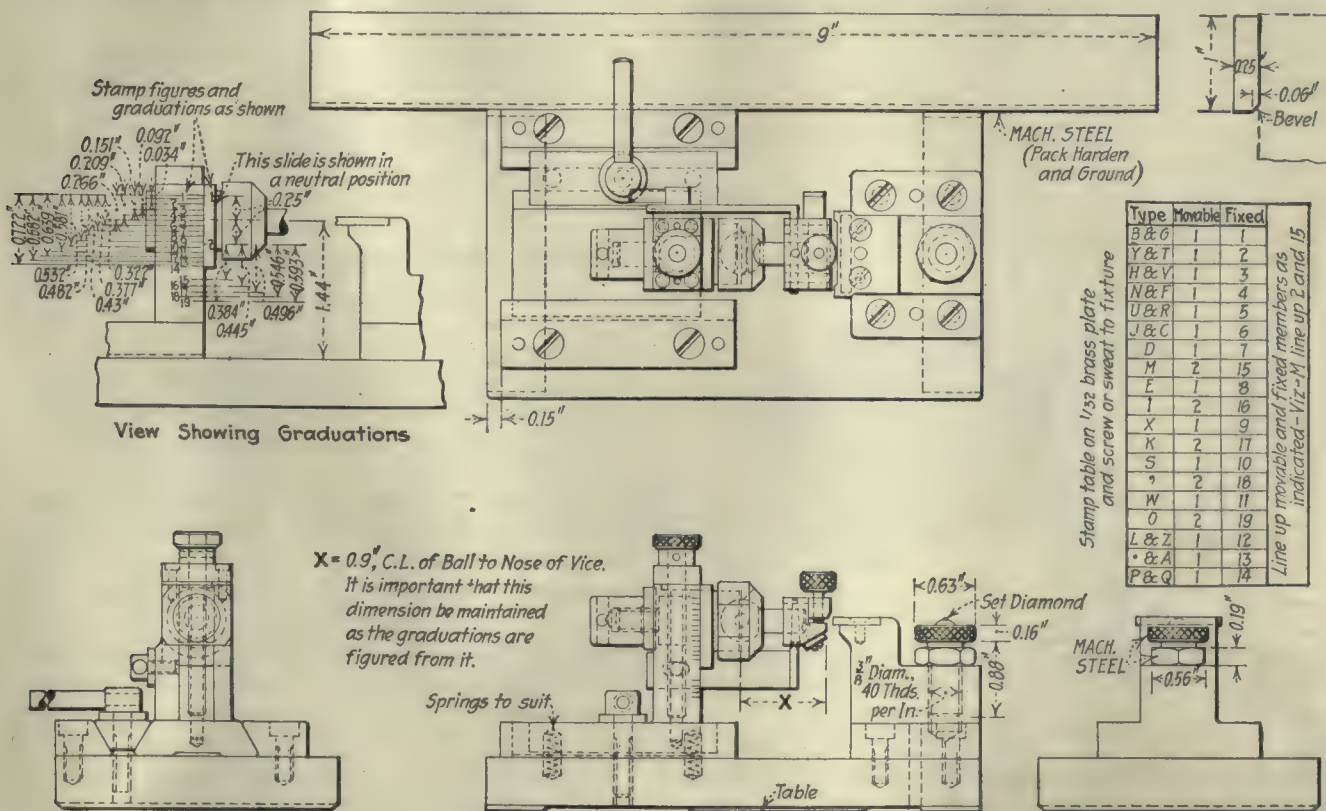


FIG. 16. SIDE ALIGNMENT OF TYPE

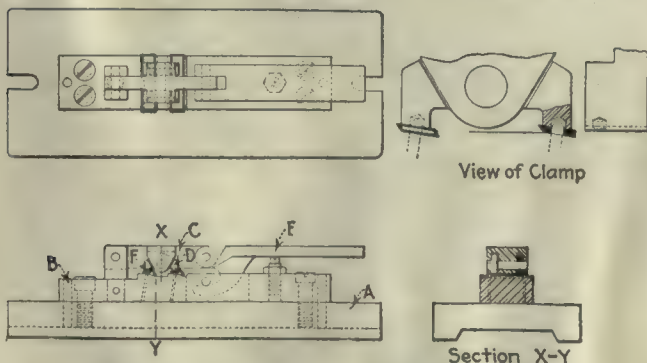


FIG. 18. MILLING FIXTURE FOR TYPE

The fixture has an index plate—that is, a table for different settings—attached to its base, and graduations on the upright show just what lines are to be set for each type character. This gives the same angular setting for grinding, at which the type later operates in the typewriter. The type is located and placed in this fixture, as already mentioned, by vertical lines on the inverted-T crossmarks, which were struck up in the rolling process. The index plate is reproduced at the right in Fig. 16,

In this operation two type bodies are held at the same time by an equalizing pressure device forced down upon the two pieces of steel by means of the cam handle *D*, which locks the work with the clamp block *E*, resting upon both pieces with an equal pressure. In this fixture the work is located over a pair of pins, in each case entering the holes at the ends of the type bodies. The large detail at the bottom of Fig. 18 shows clearly the nature of the locating pins which, with their conical heads, make it easy to position the type bodies quickly and correctly. Following this last operation the type, which are of soft machine steel, are casehardened by heating in a cyanide bath, then cooling in clear water. They are dipped for about 10 min. in the cyanide bath, 300 or so in a basket at one time. The type are now ready for testing, after which they are assembled on the respective type bars.

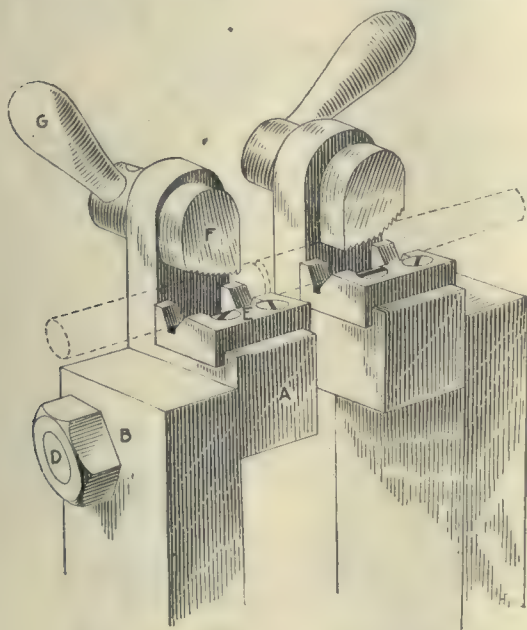
The process of straightening and testing for printing, which follows immediately after hardening, comprises many features of interest in connection with the straightening of the type themselves, the testing of their accuracy in regard to width of guiding shoulders, position of characters, thickness overall for alignment and the location of guiding shoulders.

Butt-Welding Attachment for Electric Spot Welders

BY A. J. CHAMBERLAIN

In these days of high-priced materials manufacturers whose products are made of sheet and bar-stock metals find it profitable to utilize much of the scrap stock that was formerly discarded. Some have redesigned a part of their product to enable them to utilize scrap pieces of metal. I know of one instance where new goods that could be made of the sheet-metal scrap from the press department were added to a manufacturer's line.

In steel switch-box manufacture one concern has placed on the market a small steel box formerly made of two



THE BUTT-WELDING ATTACHMENT

pieces, which is now made by spot welding together four pieces that were formerly scrap. This is real economy in this case, as the increased cost of sheet steel greatly offsets the extra labor required.

We use a great deal of $\frac{3}{8}$ -in. round mild steel, which is cut up into different lengths ranging from 6 to 18 ft. and threaded on the ends to be used as tie rods for supporting street-lighting fixtures. These rods are purchased in long lengths from the steel mill; and although we find it more profitable to cut them to size, as 6 ft. is the shortest length we can use, the scrap loss is quite an item.

UNSUCCESSFUL ATTEMPTS TO DISPOSE OF THE MATERIAL

We tried to dispose of this material by offering it to bolt manufacturers, but were unsuccessful, for they require undersize rods, owing to rolling most of their threads. It was then decided to butt weld these short rods into usable lengths, if it were possible to do so on our electric spot-welding machines.

This decision led to the design of a butt-welding attachment, shown in the illustration, which consists of two copper die-holders A that are held to the copper arms B of an electric spot welder by the nuts D, as shown. The copper dies E are slotted to fit the holders A and held by the fillister-head screws shown. These copper dies have V-grooves into which the rods, shown by dotted lines, are clamped by the steel gripping jaws F. The latter are

opened and closed by the short handles G; and as is readily apparent, they are self-tightening, for the tighter the ends of the rods are brought together the tighter they will grip the rods. The copper dies E can be made of different thicknesses when several sizes of rods are to be welded.

An attachment of this kind will readily convert an electric spot welder into a butt welder and will be found profitable by concerns doing spot welding and occasionally butt welding, but not in quantities sufficient to warrant the expenditure for a butt-welding machine. However, when the rods to be welded are long, more work can be welded with a butt-welding machine, as the work on a butt welder is held horizontally and can therefore be handled more conveniently.

This attachment will also butt weld high-speed steel tips on carbon-steel shanks. By butt welding the round shanks of worn-out high-speed drills to carbon-steel rods the tool maker can make many cutting tools that would otherwise be quite expensive.

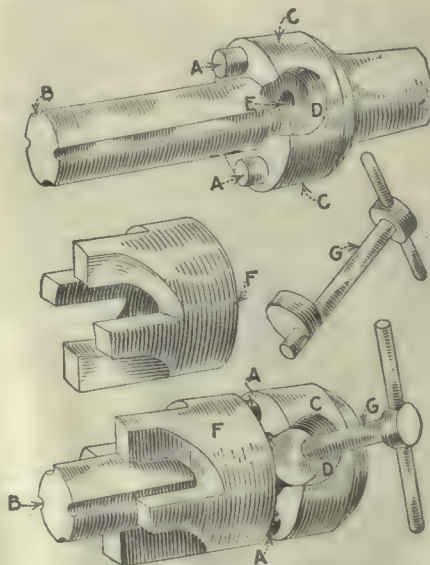
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Easily Ground Four-Lipped Counterbore

BY J. A. RAUGHT

One of the most bothersome things about a counterbore is the trouble encountered in connection with the necessity of keeping it ground in condition to turn out a big quantity of work.

The illustration shows an easily ground counterbore that I have been using for some time. The shell F is made a wringing fit up to within about $\frac{3}{8}$ in. of the collar C on the shank. The rest of the way it is somewhat tighter. The eccentric key G is used only to force the shell E off the tight fit at the top of the shank, when sharpening becomes necessary. The rest of the way it is



DETAILS OF AN EASILY GROUND COUNTERBORE

twisted off by hand. The solid collar C has tool-steel driving pins A forced up into it. At the collar D is a counterbore for the reception of the eccentric cam on the key, and at E is a hole for the pilot of the key. Dust grooves B are provided on the pilot. While this may not be the cheapest counterbore to produce, it is rapid and does not clog with chips, which is a decided advantage.

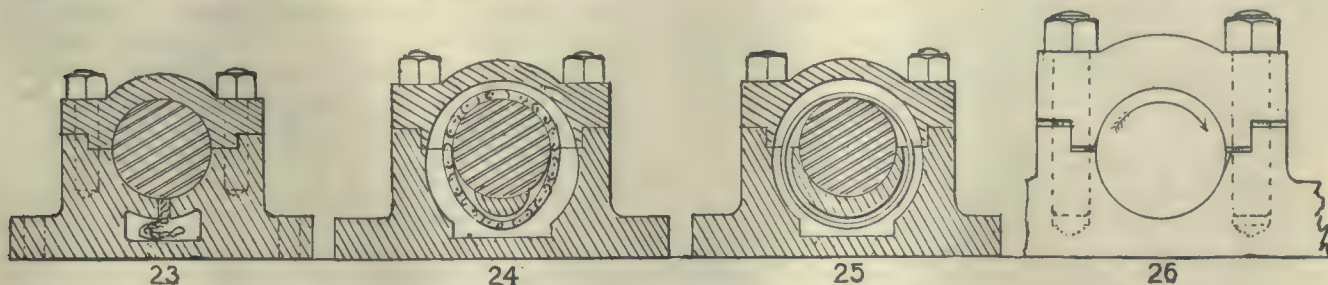
A Book on the Looks and Details of Machines--III

BY JOHN E. SWEET

SYNOPSIS—This third installment is devoted to bearing lubrication and bearing design, taking up many forms of journal, engine and step bearings and pointing out good and bad features. Professor Sweet repeats a principle of wear that he was fond of teaching, "Surfaces that do not have a tendency to wear out of true do not wear much."

Journals and sliding surfaces running on a lubricant are so various in load, speed, material and degrees of accuracy that to decide on what is best for the place and purpose is often a vexatious proposition. Results are often so erratic as to discourage one's best judgment. As a fundamental proposition the heavier the load and the

When journals are inconvenient of access and where the speed and service are excessive, continuous automatic feed seems necessary. One of the most simple and to a certain extent successful plans is to provide chambers to receive the waste oil, Fig. 23, and to carry it back to the journal by a cotton wicking. This method has the advantage of filtering the oil and the disadvantage that it will not carry oil back very fast or deposit it on the slack side. Oil chains, Fig. 24, and oil rings, Fig. 25, as substitutes for wicks are better, as they carry back the oil in a flood and deposit it on the top of the shaft. The ring is better than a chain, as it does not cut away the bottom of the box; and if grooves are turned on the inside of the ring, it will carry up as much oil as the chain and deposit more of it on the shaft at high speed. In all half- or quarter-boxes where



FIGS. 23 TO 26. WAYS OF OILING JOURNALS

slower the speed the heavier the lubricant needs to be. Farm wagons are often satisfactorily lubricated in ho weather with tar, but with spinning spindles where the load is light and the speed high a very limpid oil is necessary.

Generally, the more nearly perfect the flat surfaces of slides and the more nearly true cylinder journals and journal bearings are, the better the fits—if not too tight, the better. Yet at times these things give great trouble, and some sort of mutilation seems to be necessary to overcome it. Cutting grooves or roughening the surface of the shaft often prevents heating, when the opposite result would naturally be expected. Provision should always be made to introduce lubricant on the slack side of a box. This comes naturally where the revolving shaft rests with its weight in the box; but where the shaft remains at rest and the wheel or pulley runs around it, then, if practical, a hole should be drilled in the end of the shaft and the oil let out at the bottom.

In most machinery, where neither the speed nor the service is too great, the occasional introduction of oil from a squirt can meets all requirements so well that no additional expense seems advisable to make the feed automatic or continuous. A semiautomatic feed is obtained by the use of sight-feed oilers with adjustable devices, whereby the oil is allowed to flow to the wearing surfaces, a drop at a time, the rate of feed being controlled by the attendant. This, in most cases where the speed is high and the service exacting on the part of the attendant, is an improvement on the greater quantity at less frequent intervals, and also a distinct gain in economy

there is an opening at the joint, the edges should be cut away, Fig. 26, so as to leave a thin wedge-shaped gap to lead the oil in between the surface rather than to scrape it off.

Moving surfaces are easier and maintain better lubrication when moving in two directions than when following a single straight path; that is to say, a journal works more easily and maintains its shape and better lubrication if it

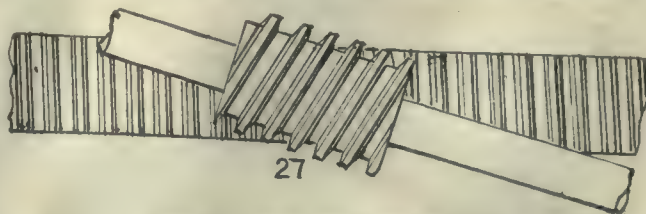


FIG. 27. THE SELLERS WORM

is allowed free end play. This cannot be done in such machine parts as the lathe spindle, and can in an engine or dynamo shaft.

The ease with which a heavy body can be made to play back and forth when revolving seems at first almost a paradox. A two-ton flywheel when revolving about 200 r.p.m. is easily moved back and forth $\frac{1}{4}$ in. at the rate of once in two or three seconds by pushing with a tooth-pick. A little consideration of the problem will show that the actual work done is very slight. The work is of two kinds—that of overcoming the inertia, which is no more than swinging that weight if suspended at the end of a rope of infinite length, and the sliding of the journals. This is not, as would appear, $\frac{1}{4}$ in., but only the difference

between a base line and a hypotenuse of a right-angle triangle in which the perpendicular is the $\frac{1}{4}$ in. If the wheel is mounted on a 5-in. shaft and makes three revolutions while moving the $\frac{1}{4}$ in., the only work the tooth-pick has to accomplish is that between the base and hypotenuse of a right-angle triangle, where the base is about 47 in. and the vertical $\frac{1}{4}$ in.—an amount quite as insignificant as the tooth-pick when compared to the two-ton flywheel.

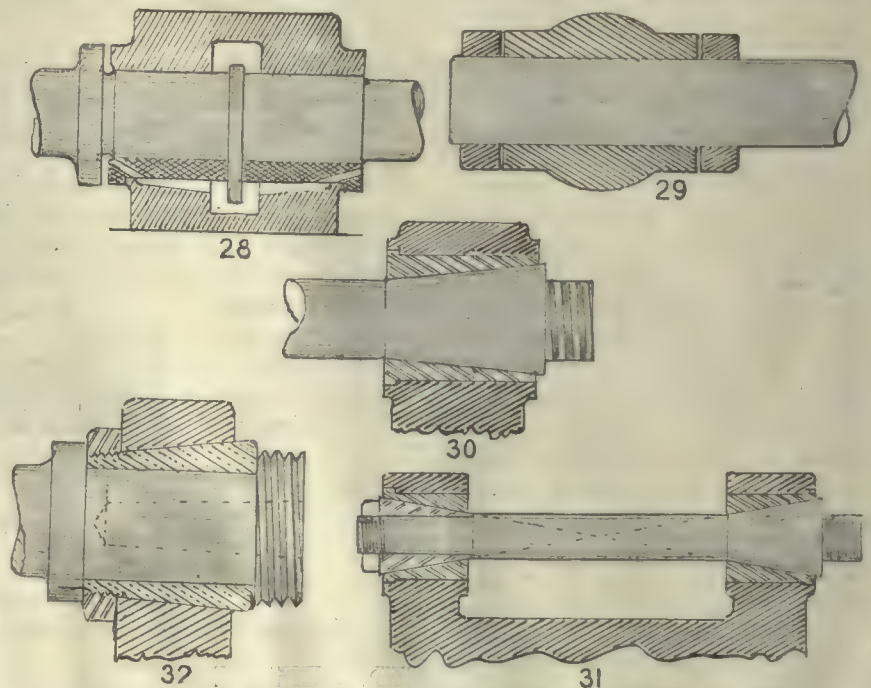
The fact that end play of journals secures easy running is no doubt due to polishing action, which keeps the journals smooth, preventing streaking up. The cause is hardly explainable, though it usually occurs in the case of journals where there is no end play. It is seldom possible to give side play to sliding surfaces, though it would be equally beneficial.

When the magnitude of the machine and the necessity for thorough lubrication are of enough importance, forced lubrication is justifiable, as is the case in large steam engines. In this case the usual practice is to allow all waste oil to accumulate in a reservoir below the lowest journal. From this, some sort of pump is used to return it to a reservoir above the highest journal or slide and to lead it through pipes to the various wearing surfaces. The real merit in the system comes from the fact that each surface can be flooded. Such lubrication is much more efficient than when the lubricant is applied in small quantities.

In the case of heavy engines the lubricant can be forced by a sufficiently powerful pump, under the bottom of the main journals, to float the load, so to speak, and insure thorough lubrication. The conditions under which journals and slides work, the different materials used for shafts, bearings and slides are so various and the methods of lubrication so different that what proportions are best to use for the varying service is a thing that no fixed rule can determine. To say that a journal will carry some certain number of pounds to the square inch depends so much upon what the journal has to do, how fast it runs, whether the strains are up or down or constantly down, directly sidewise or back and forth, whether long or short, whether loaded on one side or both, that it is almost a useless rule. The designer must resort to following precedents or use his own judgment, prefaced by experience and a process of reasoning. As a simple proposition, small long bearings will run more easily than short large ones; but conditions will not always permit or justify the use of small long ones, although they sometimes will. Journals four times their own diameter in length work perfectly in lineshaft bearings, and they will do this though the shaft be so heavily loaded each side of the box as to bend it within the bearing. The bend is always in one direction; and as soon as the box wears to fit, it runs as perfectly as if straight. That lineshafts should run as free as possible is very important. The cost of running them is always a dead loss and always goes on, the friction load often amounting to as much as the power required for the machines.

As an example of another kind, consider the condition of that of the main bearing of a lathe. A bearing four diameters in length would be about as bad as bad could be, even as a bearing, regardless of the strength. The strain coming on it is variable in quantity and direction, the faceplate end of the box would be sure to wear out bell-muzzle shape, so while the journals would appear to be long the bearing would in fact be short and far from the faceplate. The friction of the main journal of an ordinary lathe does not amount to anything compared to the cut, and easy running has no bearing on the subject. This is a case where an absolutely rigid structure with a truly circular motion is wanted, and this holds good with machine tools generally. A main bearing in the headstock of a lathe, if as large as it ought to be, will have bearing surface enough if but one diameter in length and be better than if longer. This, however, may not be true for lathes where no use is made of the faceplate and the load is heavy and constant.

To show that a bearing surface will carry any fixed load per square inch is untenable. It is only necessary to consider an extreme case. Take the mechanism of the Sellers system of driving planer beds—a worm working diagonally in a rack, Fig. 27. The pressure sometimes must run up to a thousand pounds or a ton, and theoretically the two surfaces in contact make but a line—in fact, probably not measurable—and yet they do not cut (abrade) and seem to last indefinitely. The reason no doubt is that the bearing does not remain in the same place on either piece any length of time. The pressure per square inch is almost indefinite, but the time is too short to heat the surfaces to a welding heat, which may



FIGS. 28 TO 32. DETAILS OF BEARING DESIGN, SHOWING TAPER ADJUSTMENTS AND COLLARS

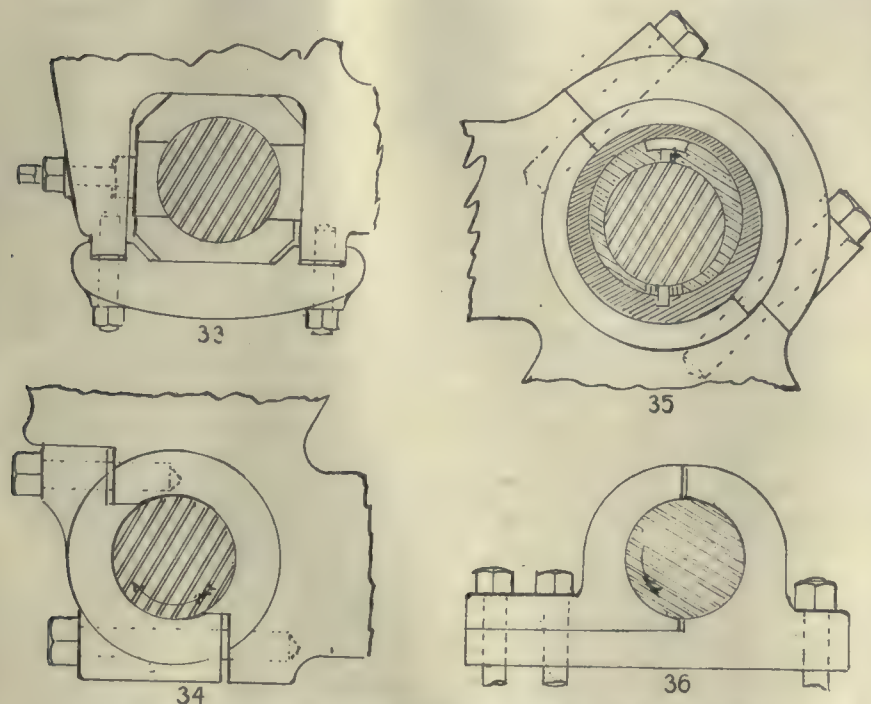
be what occurs when bearings cut. Surfaces running slowly as a general rule will carry a greater load than when running fast; but there are exceptions to this rule, particularly in the case of worm gears. Journals will stand heavier service where the strains are back and forth, as in the case of crankpins and the journals of upright engines.

When shafts are permitted end play in the bearings, the wearing surface in the box and the wearing surface of the journal should be of equal length, Fig. 28. This can only be done by scoring the journal, or its equivalent.

Where a shoulder on a shaft runs against the end of a box, the box should be cut away so as to leave a washer of the same diameter. In both cases it is only a question

When the shaft is not subject to end pressure, with double-cone bearings, Fig. 31, of such taper that lines drawn from the two sides of each cross in the center, no matter how much either the shaft or the frame is expanded the fits will remain the same; but if a step or shoulder was required, it would best be at the intersection of the lines. The same principle is embodied in the poppet valves used

in some engines. If the four-valve faces radiate from one common center, expansion does not disturb the fit nor the relation of the various parts. Methods for compensating for wear are as numerous as most other things about machinery, and a conical bearing unless subject to wear wholly in one direction is theoretically ideal. But if the pressure is in one direction, taking up the wear does not tend to restore it to its proper position. Where a parallel journal is required and yet it is desirable to close up the box uniformly all around, this can be done to a limited extent by fitting thin boxes into conical seats, Fig. 32, and closing them up by absolute compression of the metal. Cast-iron boxes on steel shafts, after worn to a loose fit and yet smooth, can be brought to a perfect fit and for many purposes make as satisfactory a bearing as one need wish. Plain cylindrical cast-iron shells instead of conical boxes can be made to do the same thing by simply putting tissue paper around



FIGS. 33 TO 36. VARIOUS TYPES OF ADJUSTABLE BEARINGS

Fig. 33—Four-parted box. Fig. 34—A box that does not scrape off oil. Fig. 35—Box with eccentric cheek piece. Fig. 36—Box cap held by friction

of equal-length wearing surfaces. If journals and shoulders did not wear, then there would be no occasion to observe this; but they do wear and will not remain true unless the surfaces are equal. Surfaces that do not have a tendency to wear out of true do not wear much. When collars are used to prevent end play, they should both be at the two ends of one box, Fig. 29, and not inside of two boxes some distance apart; for if from any cause the framing springs out of shape, or if the shaft heats, it will bind against the collars. When both collars are at the same end, heating will have no tendency to set up binding, as the box and shaft will expand together.

So many lives have been lost by setscrews projecting from collars that it ought to be declared a criminal offense to use such things around machinery. Many ingenious devices in the way of concealed setscrews have been devised, but collars shrunk on are the simplest and safest and best. Usually, cast iron will do. If it becomes desirable to remove the collars, they can easily be cracked off with hammer, or chisel and sledge.

Conical journals in solid boxes, Fig. 30, possess one advantage over parallel journals with parted boxes—namely, that when perfectly fitted the space for oil is uniform all around, when separated by moving the shaft endwise. When made of hardened and ground steel and where absolute alignment is important, it is difficult to do better. When the shaft is subject to end pressure, an end step has to be provided. If that has to be at a considerable distance away, heating of the shaft would interfere with the fit, which must of course be very carefully avoided for satisfactory results in operation of the bearing.

so compressing the shell to the journal. When the load is always down, as in a grindstone, or up and down, as in a vertical engine, half-boxes meet all requirements better than anything else. When the thrust is back and forth, as is the case with a horizontal engine, then three or four different methods are open to designers. The four-parted box, Fig. 33, common in engine work, unfortunately wears in such form that the edges of the cheek pieces are just right to scrape off the oil.

Another plan is so to part the box, Fig. 34, that in closing up wear horizontally it opens the proper form of entrance gaps to lead the oil in rather than scrape it off, as is done by the quarter-box.

The eccentric cheek piece, Fig. 35, meets certain conditions better than others. It is in all essentials a solid box and yet one in which the side wear can be compensated for. Since the cheek pieces are wedge shaped, letting them down closes up the opening sidewise. The cheek pieces are held in place by a feather and liners at the bottom and a wedge at the top. Removing the liners at the bottom and placing them at the side of the wedge provides for the adjustment. No opening is left at the bottom for the escape of oil, and the adjusting cannot be done while the machine is in motion.

A kind of box in which the box cap is set to place and held by friction, Fig. 36, possesses the merit that, if oiled before it is put on, it cannot be set too tight. For light work, this is really a very meritorious plan when properly applied.

Boxes at the crank end of a connecting-rod of horizontal engines, parted vertically as is necessary, possess one bad

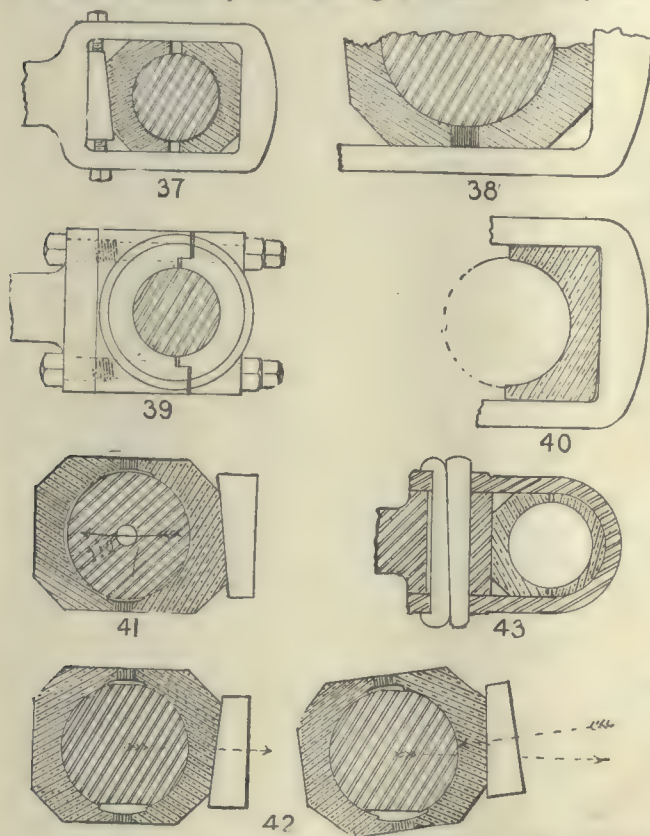
feature: If the two halves are left apart so as readily to admit of taking up wear, a joint for the escape of oil is left open (see Fig. 37). If put metal to metal, then they have to be taken off to file away the metal. This objection is best overcome by introducing a bundle of very thin

save brass the corners of the boxes were cut off, forming a box octagonal in form. Later, engineers conceived the idea that the job would be better if the brasses filled the strap completely, Fig. 40; but this was a mistake and led to any amount of trouble by the peening action on the outer side, closing in the box on the pin.

An exaggerated case will make this plain. Lay a flat piece of metal on a flat anvil and strike it in the middle with a hammer; the result will be that the two ends of the piece will bend up. The action is the same with a brass box—in the strap and against the end of the rod. If the surface of the box against the rod and strap is wider than the one against the pin, the box will bend and close up on the pin. Partly to overcome this and because there is no wear at the sides of a crank box, it is not an uncommon practice to cut away the metal for some distance. In a horizontal engine this may be done more on the bottom than on the top, as the weight of the rod calls for additional bearing. While the wear on a crankpin box comes equally on the two halves of the box, it comes on only one side of the crank, unless the engine is a reversing one. The pressure always comes on the back side, or should, because if a thing is to be pushed ahead the force must be applied at the back. Thus the front of a crankpin may be cut away to admit oil freely, Fig. 41, and is so cut away by some engine builders; instead of leading the oil out radially, it goes out on the back side. Slow-speed engine cranks can be oiled through the box, but in high-speed it is better to oil through the pin and out by centrifugal force.

In the case of crosshead pins and their boxes there is not much difference between the service on the crank and the crosshead pin except the speed and the direction of motion, which is in one direction in the case of the crank and back and forth on the pin. The box may be relieved top and bottom, Fig. 42—more on the bottom than on the top—for the same reason, and the pin flattened off a good deal; but less on the top than on the bottom, where the engine runs with the top of the wheel away from the cylinder for a reason that can be thought out in two ways.

With such an engine the pressure is always down on the crosshead and of course is an equal amount down on the crosshead pin; hence, the pressure is not only back and forth, but down, and for this there is a demand for more bearing on the top than on the bottom. Or to consider the



FIGS. 37 TO 42. VARIOUS CRANK-PIN BOXES

Fig. 37—Parted crankpin box. Fig. 38—Liners between halves of box of connecting-rod. Fig. 39—Bolts tapped into one-half of box. Fig. 40—Peening action of strap on box. Fig. 41—Front of crankpin cut away to admit oil. Fig. 42—Top and bottom relief of crankpin. Fig. 43—Strap, gib and key construction for link-motion bearing.

liners, Fig. 38, where the design is such as to permit their ready removal.

When bolts are used to secure the outer half of the box, or what is known as the "marine end," then unless liners are used or the box brought "brass and brass" there are two places instead of one for wear to take place—that is, between the crankpin and box and between the box and nuts on the bolts. Where the rod end is in the form of a T and the box is made in two separate pieces, unless the one half-box is firmly secured to the rod there are two more joints to wear or make a noise, one between the box and rod and the other between the T-head of the rod and the bolt heads. All these places to wear call for more frequent attention. When the bolts pass through the T-head and are tapped into the first half of the box, Fig. 39, two of these loose places are done away with. Where straps, gibs and keys are used, unless the boxes are brass and brass, or with liners, and keyed up solid, the outlet for oil between the boxes and the loose joints is the same as in the marine end.

In the early days of steam-engine building, while the end of the rod and strap left a rectangular opening, to

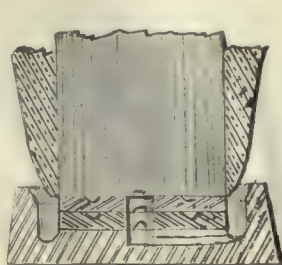


FIG. 44. LOOSE WASHER STEP BEARING

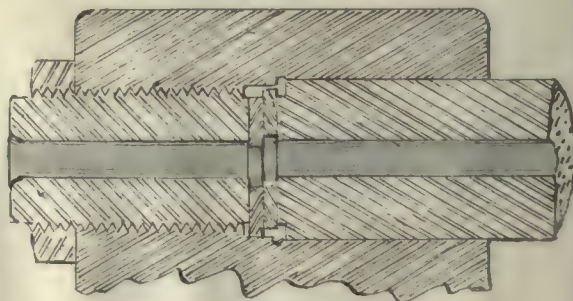


FIG. 45. HORIZONTAL THRUST BEARING

question in another way: Assume the engine to be set with the piston at the head end of the cylinder. All the pressure is put on one side of the pin going forward. Start with the connecting-rod horizontal, then with the rod pushing down at an angle when the crank is on the half-stroke and again horizontally at the end of the stroke.

Thus the pressure on the side of the pin varies from horizontal to a certain angle, and the wearing surfaces should coincide when that angle is split. On the return stroke it is the other side of the pin that does the work, and the same process of reasoning will show that both sides of the pin should be alike.

Connecting-rods are simply links, and the boxes may vary from the two half-boxes with strap, gib, key and bolts to a simple hole in the solid link or a bushed hole; and with different material they vary in all degrees of hardness from lead to hardened and ground steel.

When lead was substituted for bronze in railway-carriage work, trouble from hot boxes was eliminated, but frequent renewals were encountered. For all high-speed engines—and in the main for general work in this country—babbitt-lined metal boxes are used. In the best work the babbitt is cast around a small mandrel and hammered into place and then machine bored; in agricultural machinery it is usual to cast it on a mandrel slightly larger than the shaft itself, or if on the shaft have it coated or smoked. In some cases where it is simply a lining in a solid box it is cast too small and a ground mandrel forced through.

For light work a conical bush of babbitt is used and forced in to compensate for wear. When thorough lubri-

cation is insured, almost anything will make a good box; but where doubtful, the soft metal such as babbitt does better, as the result of a dry journal is less harmful. All link motions are difficult of lubrication, but in slow motions and slight movement one application of oil lasts a good while. Where absolute rigidity and perfect alignment are secured, hardened and ground pins and bushes or ground-steel pins and bronze bushes make a much neater and quite as satisfactory piece of work as the more complicated and expensive strap, gib and key, Fig. 43.

Step bearings for vertical shafts should have one or more loose washers, Fig. 44, and the whole should be surrounded by a cup larger than the shaft, or at least with holes to take oil down, outside, under and up through the center with radiating oil grooves on both sides of the washers, the rotation of the shaft circulating the oil.

In the case of horizontal shafts a good plan is to have a cavity larger than the end of the step and the end of the shaft, with a washer one-half the difference larger, Fig. 45. If there is a hole through the shaft and step, as is the case with a hollow-spindle lathe, then the hole in the washer should be as much larger than the hole in the shaft as the washer is larger than the shaft. This allows the washer to assume different positions and prevents cutting, thus adding to the probable life of the bearing in actual service.



Repair Work in a Sugar Mill

BY FRANK A. STANLEY

SYNOPSIS—Views of a sugar-mill repair shop in Hawaii, showing the machine tools used and some of the work done. Because of the size of the pieces lifting and transporting devices are of particular importance. A typical truck, traveling crane and outside trolley support are shown.

Reference has been made in earlier articles to the general character of the repair and upkeep work in connection with the operation of sugar-mill machinery. As already pointed out in connection with Hawaiian sugar plantations, most of the big mills on the Islands have their own repair shops for handling the usual run of work which is not too heavy to be taken care of by the equipment in the repair shop. Sometimes, of course, as in other big plants, it is necessary to install some big piece of equipment or repair some important member, which because of its size must be sent to a general jobbing shop for attention. But as a rule, the greater percentage of work requiring replacing or overhauling can be looked after satisfactorily in the mill's own machine shop.

The tools in these shops consist usually of medium sized lathes, planers and upright drills, with a good sized radial drill, which can be swung about to operate on big castings and plates; and there is commonly an installation of pipe machinery for cutting off and threading pipe of various sizes, of which a large quantity is required around all establishments engaged in the manufacture of sugar. In addition to the standard machine tools there will be found, as in most repair shops, quite a number of special devices which have been constructed for certain operations that have to be performed at fairly regular

intervals, these including simple jigs and templates, appliances for keeping rolls in working order and special slings and hoisting tackle for picking up heavy parts that would be awkward to handle otherwise.

A TYPICAL REPAIR SHOP

The illustrations show pretty clearly the important features of the repair shop at one of the sugar factories near Honolulu.

Figs. 1 and 2 are interior views, showing a medium sized planer, radial drilling machine, shaper and several lathes.

Referring again to Fig. 2, a long steel bar is shown in the foreground mounted on the roller support and fitted up with a series of long, narrow steel blades. A similar piece of apparatus is seen at the left in Fig. 3 resting on the floor ready for inspection and remounting. This view is taken in the sugar factory alongside one of the roller mills. Immediately at the right will be seen a heavy truck on which is mounted a piece of special machine-shop equipment for operations on the sugar-mill rolls. This consists of a base casting, similar to a planer crossrail, which forms a support and guide for two heads for carrying the cutting tools. The adjustment of the heads to the proper position for operating is secured by the screws passing longitudinally along the center of the rail.

A similar device is seen on the blocks on the floor at the left of the view in Fig. 4. In front will be noticed a big roll ready for placing in the mill. Behind the roll is shown a part of a special sling for picking the roll up by its necks, so that it may be suspended evenly and placed properly in its boxes or, similarly, removed when

necessary. This rig consists of a pair of heavy I-beams long enough to extend the full length of the roll and carrying at either end swivel attachments for rope slings around the roll necks. This acts as a spreader for the slings, and the swivel members may be adjusted toward the center or toward the ends of the I-beams, according to the width of the span required. The pair of I-beams are connected to a swivel member at the top, consisting of shorter I-beams riveted together. When the whole

ber of extra rolls around a sugar mill, and in unloading these in the yard or in picking them up for installation in the building, it is important that suitable hoisting apparatus be available. In the illustration a substantial steel structure is shown erected in front of the main doorway, with trolley and hoisting tackle overhead of sufficient capacity to suspend any part required.

Two other outside views at the rear of the repair shop are shown in Figs. 7 and 8. In both these views the



FIG. 1. A SUGAR-MILL REPAIR SHOP



FIG. 2. ANOTHER VIEW IN THE REPAIR SHOP

affair is picked up by the crane, the roll may be suspended evenly and swung by either end as may be required for placing it in the machine in the proper position or for dropping it in any position desired.

It is necessary in a factory of this kind to have a good sized overhead crane with a broad span to enable any

narrow-gage tracks leading into the structure are visible and also the overhead trolley service for unloading material from cars. Under the projecting roof in the middle of the view in Fig. 7 will be seen a hydraulic press for forcing car wheels onto axles and for putting other parts together. Naturally, a large part of the work coming to

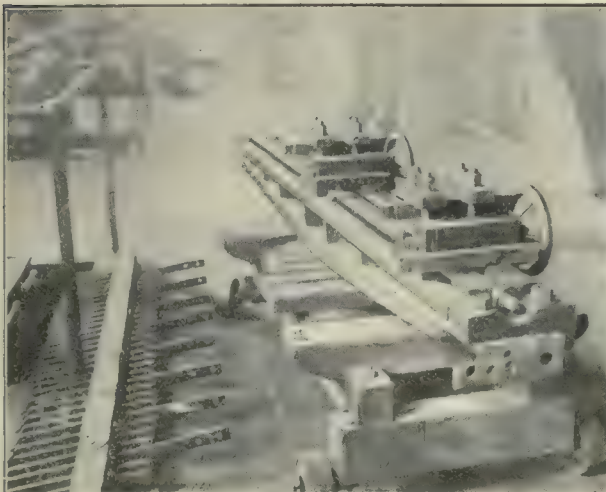


FIG. 3. SPECIAL EQUIPMENT FOR USE ON ROLLS

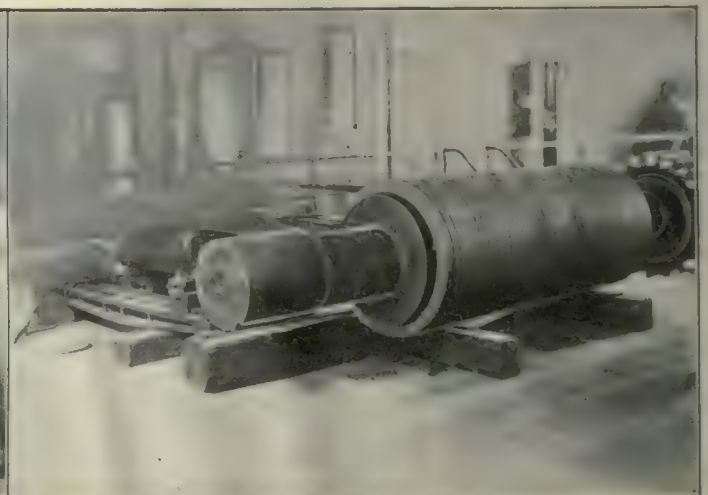


FIG. 4. SUGAR-MILL ROLL AND HOISTING TACKLE

part to be taken out of a machine and moved anywhere on the mill floor and again replaced after overhauling. The general arrangement of a crane for this purpose is seen in Fig. 5, which is a typical view in a sugar mill with up-to-date equipment. It will be seen that the crane has two trolleys. Fig. 6 shows a part of the apparatus outside of the mill for facilitating the handling of rolls, heavy gears and other big pieces of equipment. There are always a num-

ber of extra rolls around a sugar mill, and in unloading these in the yard or in picking them up for installation in the building, it is important that suitable hoisting apparatus be available. In the illustration a substantial steel structure is shown erected in front of the main doorway, with trolley and hoisting tackle overhead of sufficient capacity to suspend any part required. Two other outside views at the rear of the repair shop are shown in Figs. 7 and 8. In both these views the

Fig. 8 is of interest chiefly as showing facilities for storing bar stock, piping and other material ordered in considerable quantities and classified in the storage racks by size and grade. It is necessary to carry large stocks of

they start at the least expected time and place. The study of this class of fires has always been beset by difficulties arising from a lack of exact knowledge of the chemistry of oxidation and lack of convenient methods of studying



FIG. 5. DRIVING SIDE OF SUGAR-MILL ROLLS AND OVERHEAD CRANE



FIG. 6. EXTERIOR OF MILL, SHOWING HOISTING APPARATUS

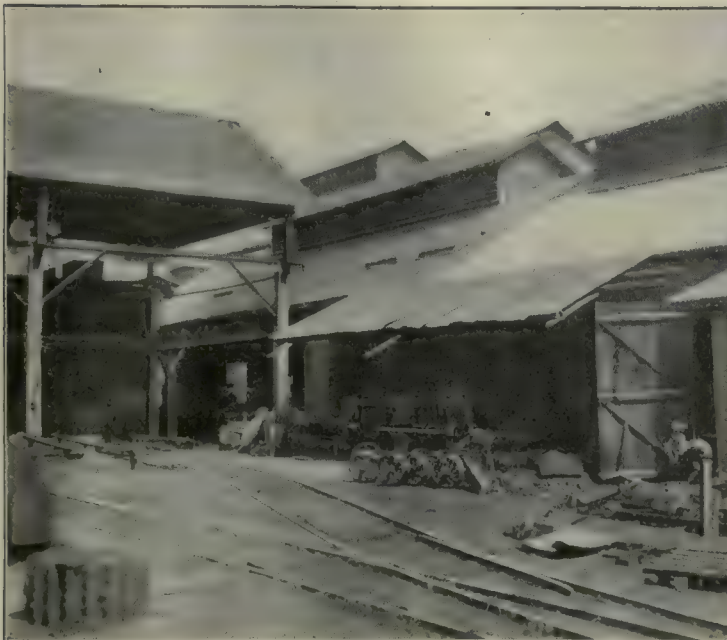


FIG. 7. STORAGE SHEDS FOR MATERIALS



FIG. 8. BAR-STOCK RACKS AND SCRAP PILE

these materials in a plant of this kind and quite essential to be able to get at the size required without undue delay or inconvenience.

A Study of Spontaneous Ignition

BY FREDERICK J. HOXIE*

Spontaneous ignition is a much more common cause of fires than is generally supposed. Many familiar substances can ignite at slightly elevated temperatures or if acted upon by strong sunlight. Fires from this source are in the class most dangerous to life and property, because

the early stages of combustion, and it was with this in view that the author's experiments were undertaken.

Absorption curves of these oils show that the spontaneous-ignition danger from cottonseed oil would not be great at temperatures below 150 deg. F. and that linseed oil could be used for almost any purpose with comparative safety below 80 deg. if kept out of the sunlight; also that lard oil would be more hazardous than cottonseed oil at room temperatures. At room temperatures sunlight increases the rate of absorption of cottonseed and linseed oils by about 10 times, while with lard oil it apparently has less effect.

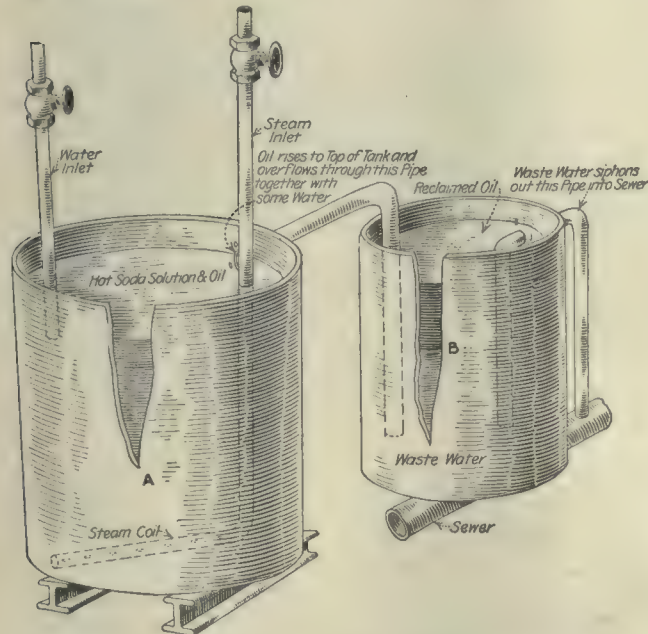
Some kinds of charcoal are more susceptible to spontaneous ignition than others, as indicated by the intensity of the images they form on a photographic plate.

*Presented at fall meeting of A. S. M. E.

Method of Reclaiming Mineral Cutting Oil

By P. G. LITTLE

In shops having many automatic lathes and screw machines it is necessary to use a large quantity of cutting oil on the work, and in most shops of this kind the oil that is carried away on the finished parts and washed off is wasted. The sketch shows an arrangement for washing the parts and reclaiming the oil. This method has



THE RECLAIMING OUTFIT

been adopted in a machine shop employing 150 hands on automatic machines. About 25 gal. of oil, formerly wasted, is reclaimed every week at this factory, and the reclaimed oil is used on drilling and similar work.

As shown in the sketch, the tank A is filled with a solution of soda and water for cleansing purposes and is fitted with a water inlet and steam coil. The parts to be washed are placed in a wire basket and dipped into the solution. The oil that is washed off rises to the top of the tank and passes through the overflow pipe, together with some of the solution, into the tank B. In the tank B the oil naturally rises to the top and is removed in buckets. The waste solution, which remains at the bottom of the tank, siphons through the outlet pipe into the sewer. Except for removing the reclaimed oil the process is automatic, and the quantity of oil reclaimed has made the installation well worth while.

The illustration shows the arrangement at this plant, but of course many modifications can be made to suit existing conditions. Mineral cutting oil does not combine with the soda and saponify, as would animal or vegetable oil.

Holder for Grinding Tool Bits

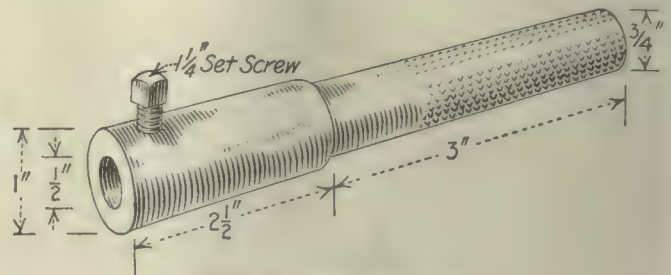
By HERBERT M. DARLING

With ordinary care the average tool holder should last almost indefinitely; but in most shops one finds tool holders that show abuse at the hands of the men using them. The worst abuse probably is caused by the com-

they are in place in the holder. While grinding in this way the operator will usually strike the holder itself against the emery wheel, and after this has been done enough times the head of the tool holder will be badly ground, especially right under the tool seat, where strength is most required.

The operator can hardly be blamed for this. If he attempts to hold the high-speed bit in his fingers while grinding, he cannot apply the necessary pressure to grind it quickly without it becoming unpleasantly hot.

To overcome this trouble I use a holder, as shown in the illustration, which will hold tools up to $\frac{3}{8}$ in. square.



THE TOOL BIT HOLDER

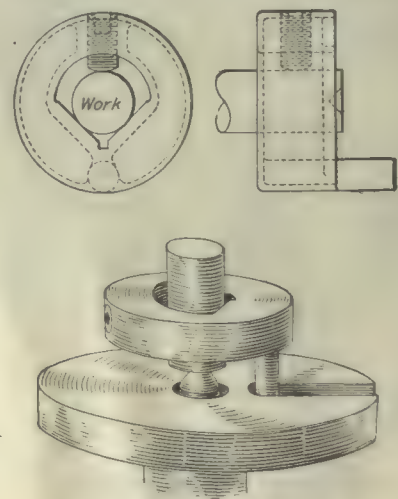
This holder can be made in a few minutes from an odd piece of machinery steel by an apprentice. In use the tool to be ground is inserted in the $\frac{1}{2}$ -in. hole and secured by the setscrew. It can then be ground in a businesslike manner without loss of time or the danger of burning the fingers or marring a tool holder.

■

Simple and Easily Made Safety Lathe Dog

By JOSEPH V. DOLAN

The accompanying illustration shows a safety lathe dog which consists of a cast drum and socket screw for



SAFETY LATHE DOG

clamping the work. I think this could be made lighter and cheaper than most safety dogs now on the market. It has been used in our shop with a great deal of satisfaction by the lathe hands, who prefer it on account of its safety as compared to the old type, which must be continually watched. The sense of security that comes from the use of such a device is worth more than its cost.

United States Munitions*

The Springfield Model 1903 Service Rifle

Operations on the Bolt--III

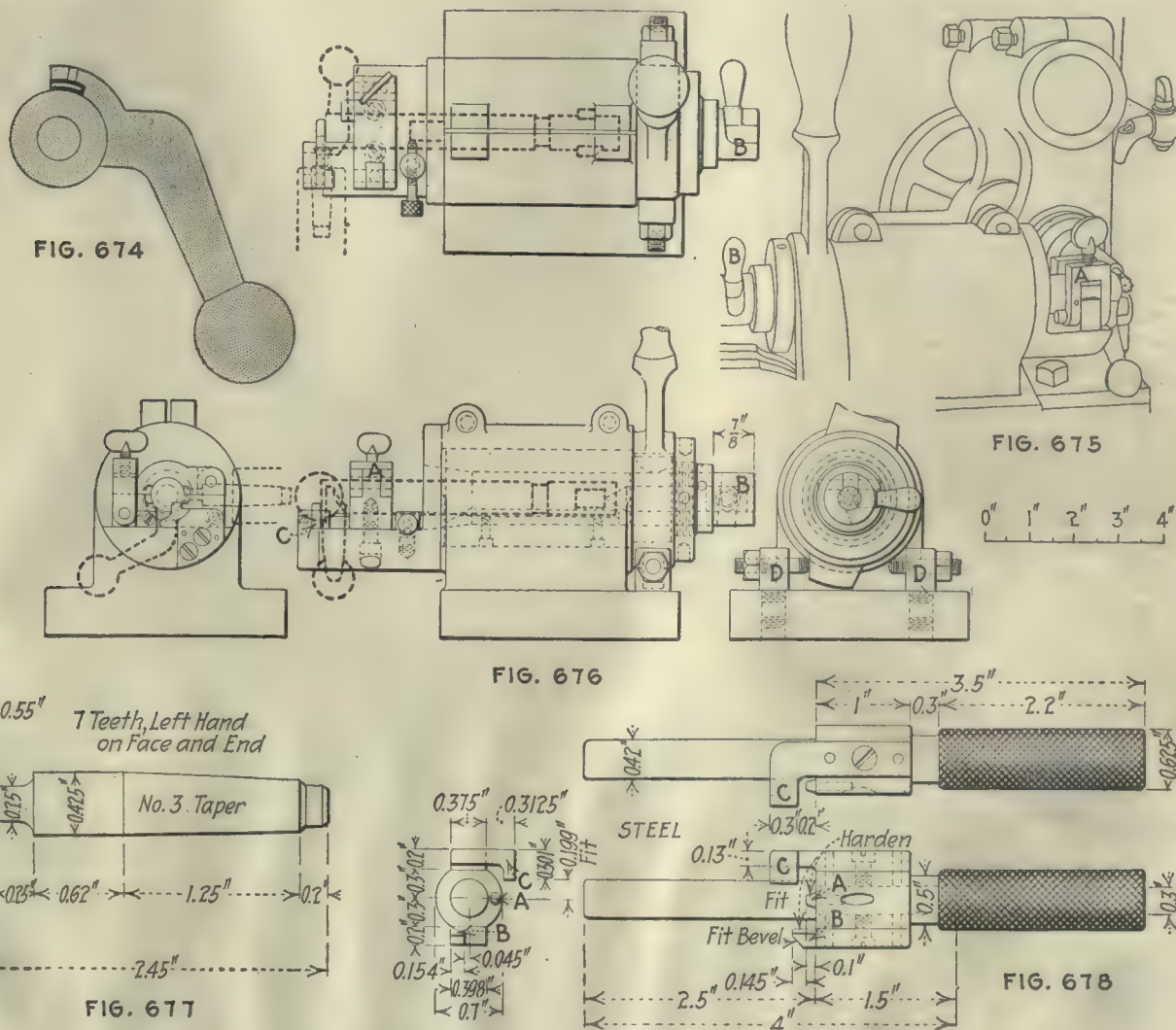
SYNOPSIS—This is the concluding article on the bolt. Operations are described in detail, the production time is given, and tools, jigs, fixtures and gages are illustrated.

This issue takes up some of the smaller operations, which are, however, of vital importance in the operation of the rifle mechanism. The sleeve-lock cavity, for ex-

*Copyright, 1916, Hill Publishing Co.

ample, is a small circular cut at the back end of the bolt, having an angle on the upper side for the bevel of the sleeve lock, thus serving to lock the sleeve to the bolt. The usual type of rotating fixture, Fig. 676, makes this a simple hand-milling operation. The gaging is also of interest, the location being determined from the under side of the handle. The inserted taper pin measures the depth of the slot as well as its angle.

Another small operation is milling the extractor groove, as shown in operation 27. The method of doing this is clearly given in Fig. 684, the gage, Fig. 686-A, being also of interest. The body of the bolt lies in the V-grooves



Operation 32½ and 33

OPERATIONS 32½ AND 33. HAND MILLING FOR SLEEVE LOCK

Transformation—Fig. 674. Machine Used—Whitney Manufacturing Co. hand miller, Fig. 675. Number of Operators per Machine—One. Work-Holding Devices—Rotating fixture, Fig. 676; bolt is clamped by A, while bayonet locking cam B forces it against hardened stop C; fixture is rotated between stops D.

Tool-Holding Devices—Taper shank. Cutting Tools—Slotting cutter, Fig. 677. Number of Cuts—One. Cut Data—Speed, 600 r.p.m.; hand feed. Coolant—Cutting oil, 1/8-in. stream. Average Life of Tool Between Grindings—1,500 pieces. Gages—Fig. 678: bevel for sleeve lock; pin A fits safety-lock groove and B measures bevel, while C fits bottom of handle. Production—75 per hr. Note—Holding points, center hole and body.

shown, while the pin at the end fits into the groove and measures depth as well as location.

The special tapping machine, seen in Fig. 696, was built in the armory. It carries three taps, so set and geared together as to divide the work up among them. Each tapping spindle is threaded with the proper lead to feed positively into the work and at the proper rate.

OPERATION 22. HAND MILLING TOP OF HANDLE

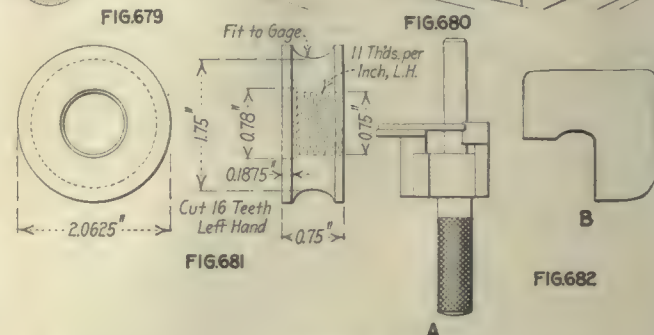
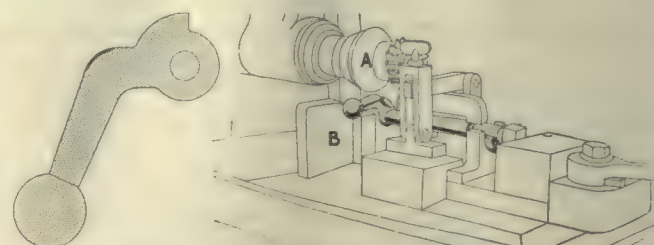
Transformation—Fig. 679. Machine Used—Whitney Manufacturing Co. hand miller. Number of Operators per Machine—One. Work-Holding Devices—Held on forms and clamped at end, Fig. 680; roller A guides cutter on form B to give proper contour. Tool-Holding Devices—Taper shank. Cutting Tools—Form cutter, Fig. 681. Number of Cuts—One. Cut Data—Speed, 180 r.p.m.; hand feed. Coolant—Cutting oil, $\frac{1}{8}$ -in. stream. Average Life of Tool Between Grindings—1,000 pieces. Gages—Fig. 682; A measures form along handle; B, form crosswise. Production—75 per hr. Note—Work-holding points, under side of handle, and ends.

OPERATION 27. HAND MILLING EXTRACTOR GROOVE

Transformation—Fig. 683. Machine Used—Whitney hand miller. Number of Operators per Machine—One. Work-Holding Devices—Rotating fixture, Fig. 684. Tool-Holding Devices—Taper shank. Cutting Tools— $\frac{1}{8}$ -in. slotting cutter, Fig. 685. Number of Cuts—One. Cut Data—Speed, 1,200 r.p.m.; hand feed. Coolant—Cutting oil, $\frac{1}{8}$ -in. stream. Average Life of Tool Between Grindings—1,000 pieces. Gages—Fig. 686; A, depth of groove; B, width of slot and distance from end. Production—100 per hr. Note—Work-holding points, body and tail.

OPERATION 34. HAND MILLING SLEEVE STOP

Transformation—Fig. 687. Machine Used—Whitney Manufacturing Co. hand miller. Number of Operators per Machine—One. Work-Holding Devices—Held on forms clamped on top and at ends, Fig. 688. Tool-Holding Devices—Taper shank. Cutting Tools—End mill, Fig. 689. Number of Cuts—One. Cut Data—Speed, 900 r.p.m.; hand feed. Coolant—Cutting oil, $\frac{1}{8}$ -in. stream. Average Life of Tool Between Grindings—1,000 pieces. Gages—Fig. 690; pin A locates cut while finger B rests on under side of handle. Production—75 per hr. Note—Form screwed to side of fixture; follower on cutter arbor.



OPERATION 22

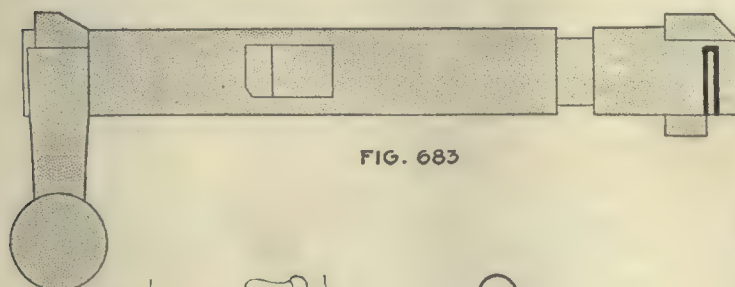


FIG. 683

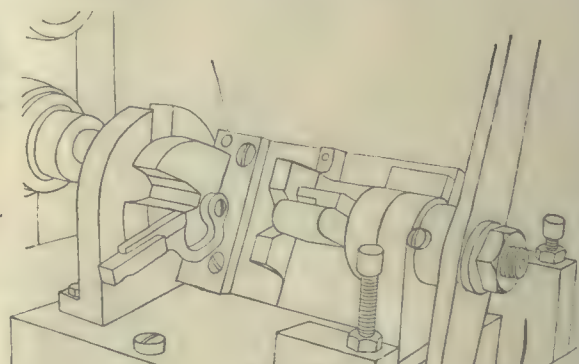


FIG. 684

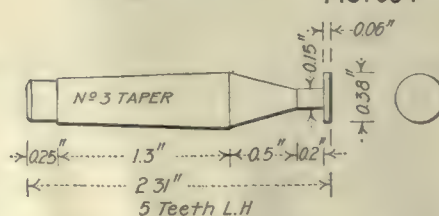


FIG. 685

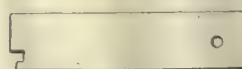


FIG. 686 B



FIG. 686 A

OPERATION 27

OPERATION 35. HAND MILLING FOR SLEEVE LOCK

Transformation—Fig. 691. Machine Used—Whitney Manufacturing Co. hand miller. Number of Operators per Machine—One. Work-Holding Devices—Held in forms, clamped at end, Fig. 692. Tool-Holding Devices—Drill chuck. Cutting Tools—End mill, Fig. 693. Number of Cuts—One. Cut Data—Speed, 1,200 r.p.m.; hand feed. Coolant—Cutting oil, $\frac{1}{8}$ -in. stream. Average Life of Tool Between Grindings—1,000 pieces. Gages—Fig. 694, location from under side of handle. Production—100 per hr. Note—Working point, body and tail.

OPERATION 31. TAPPING FOR SLEEVE

Transformation—Fig. 695. Machine Used—Pratt & Whitney special tapping machine. Number of Operators per Machine—One. Work-Holding Devices—Held on center and rest at rear end, Fig. 696; details, Fig. 697. Tool-Holding Devices—Taps held in collar by pin. Cutting Tools—Three taps, Fig. 698. Cut Data—Speed, 40 r.p.m. Coolant—Cutting oil, $\frac{1}{8}$ -in. stream. Average Life of Tool Between Grindings—2,000 pieces. Gages—Fig. 699, thread diameter and depth. Production—40 per hr.

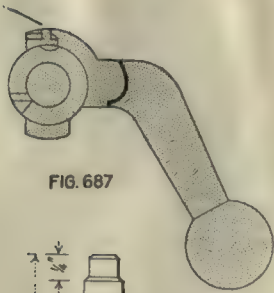


FIG. 687

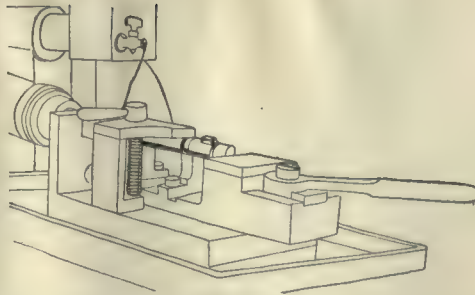


FIG. 688

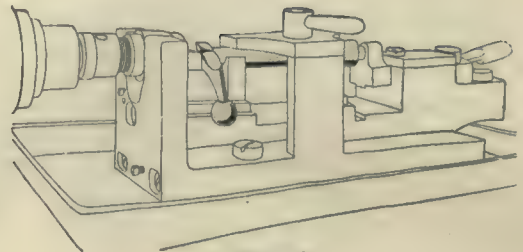


FIG. 689

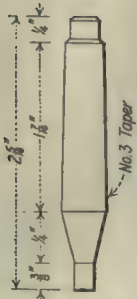


FIG. 689

OPERATION 34

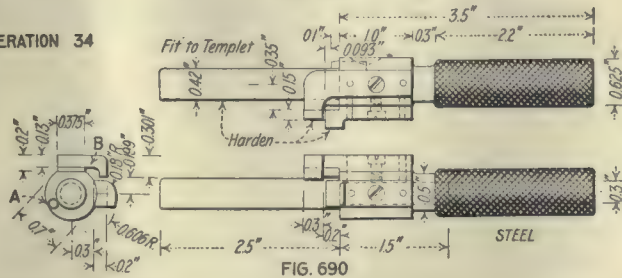


FIG. 690

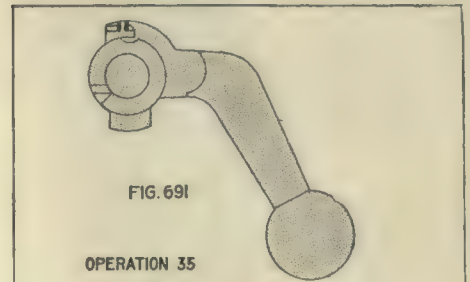


FIG. 691

OPERATION 35

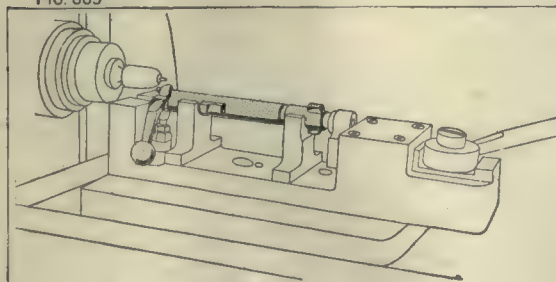


FIG. 692

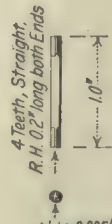


FIG. 693

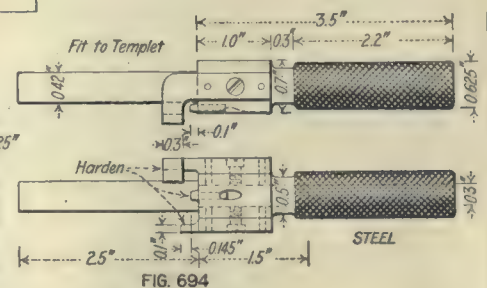


FIG. 694

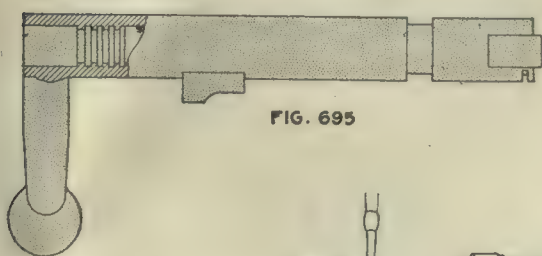


FIG. 695

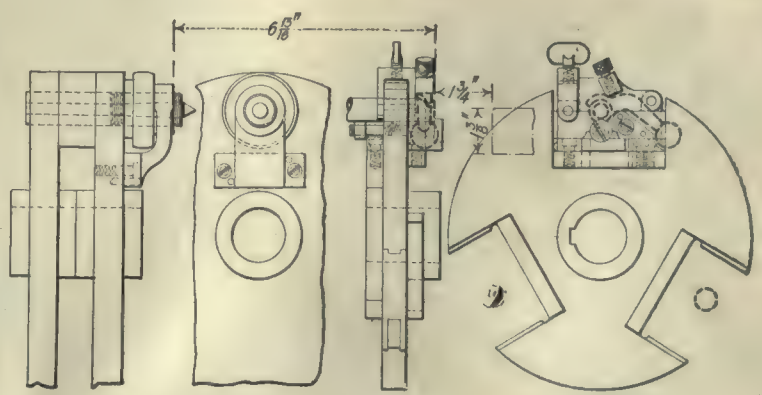


FIG. 697

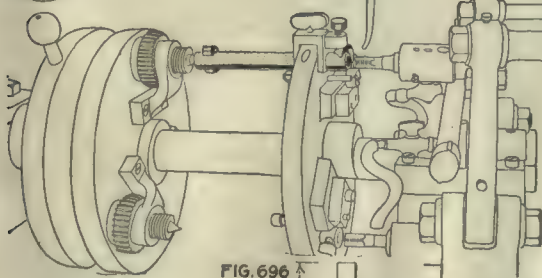


FIG. 696

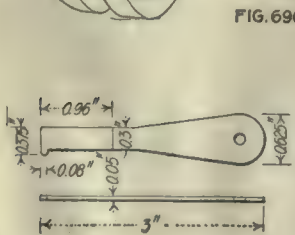


FIG. 699

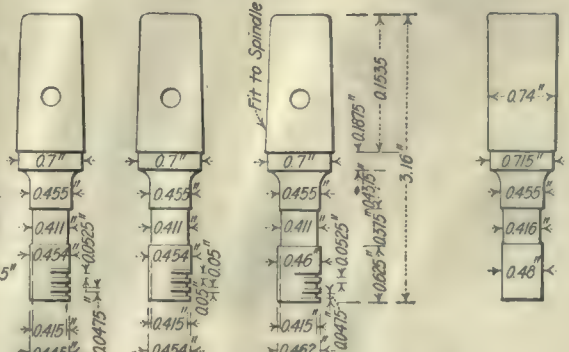
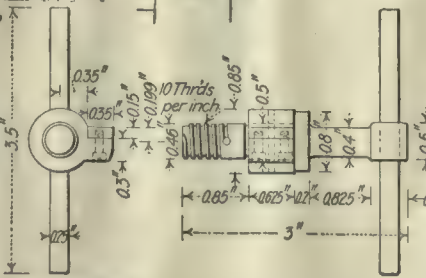


FIG. 698

end motion being due to the cam slot shown at the left end. The end movement can only take place as the piece is rotated by means of the handle on the other trunnion, and the amount of this movement is limited by suitable stops at the bottom of the lever.

The predominance of millers is very noticeable, and on these machines are performed some operations that we should be apt to consider lathe work. A case in point is the milling of the front ends of the bolt, as shown in

way where a piece is to be finished all over, as in most rifle parts. Usually, the hand or rotary file is the only tool that can be used, but an exception is found in operations 40 and 41, where a special file comes into play, as in Fig. 724-C. This is held in the hand, the bolt body is slipped into the opening, and a few twists of the hands clear away the burrs left in milling the ejector slot.

The length of the bolt is very important, as the front end holds the cartridge in the chamber and there must be

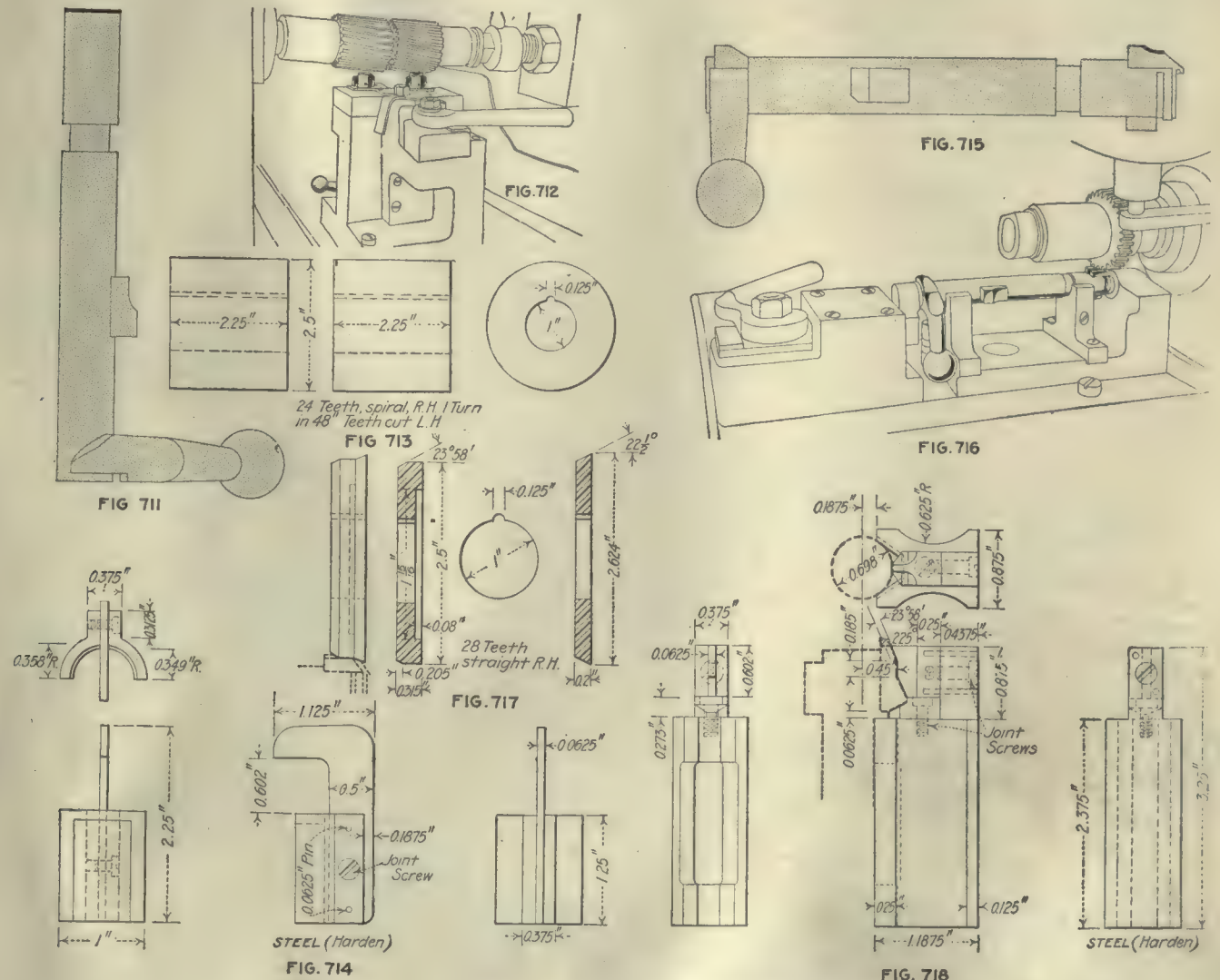


FIG. 711, 712, 713, 714 OP. 39 - FIG. 715, 716, 717, 718 OP. 44

OPERATION 39. MILLING TO REMOVE STOCK, FRONT
END; RUN WITH OPERATIONS 20 AND 46

Transformation—Fig. 711. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Machines per Operator—One. Work-Holding Devices—Work clamped to angle plate in upright position, Fig. 712; two at one setting. Tool-Holding Devices—Standard arbor. Cutting Tools—Two cutters, Fig. 713. Number of Cuts—One. Cut Data—Speed, 50 r.p.m.; $\frac{5}{8}$ -in. feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—1,500 pieces. Gages—Fig. 714. Production—50 per hr. Note—this is run with operation 46.

OPERATION 44. HAND MILLING TOP OF UPPER LOCKING LUG

Transformation—Fig. 715. Machine Used—Garvin No. 3 hand miller. Number of Operators per Machine—One. Work-Holding Devices—Held on forms, clamped at ends, Fig. 716. Tool-Holding Devices—Taper-shank arbor. Cutting Tools—Form cutters, Fig. 717. Number of Cuts—One. Cut Data—Speed, 150 r.p.m.; hand feed. Coolant—Cutting oil, $\frac{1}{8}$ -in. steam. Average Life of Tool Between Grindings—2,000 pieces. Gages—Fig. 718, shape and height from body. Production—100 per hr. Note—Working points, body and ends.

Fig. 712. This, together with the turning of the body of the bolt, as previously shown, would probably be considered lathe jobs in most places. Yet the fact that gun and similar shops are more plentifully supplied with millers than lathes is probably largely responsible for this apparent preference.

Burrs are one of the things that are always in evidence after a machine operation, and they are always in the

no room for it to be forced back against the bolt. The "head space" is one of the vital points, this holding the cartridge firmly in place against the recoil of the discharge. The counterboring of this head space is therefore divided into a roughing and a finishing operation, the first being done on a vertical drilling machine or miller and the latter in a special fixture with a hand facing tool. The latter has a stop that can be very easily adjusted.



FIG. 719

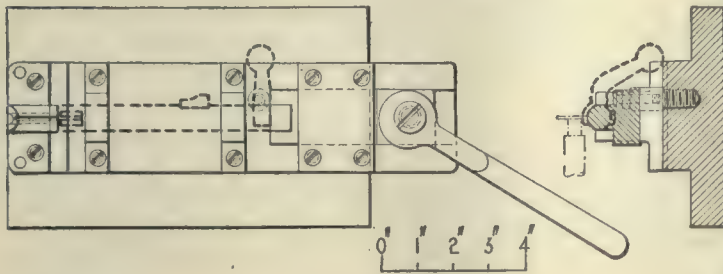


FIG. 720

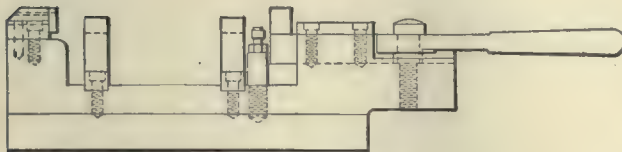


FIG. 721

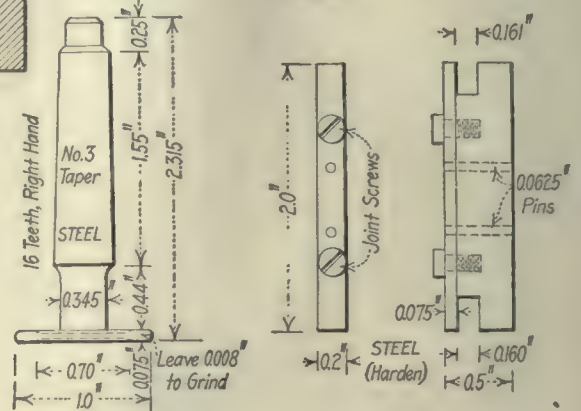


FIG. 722

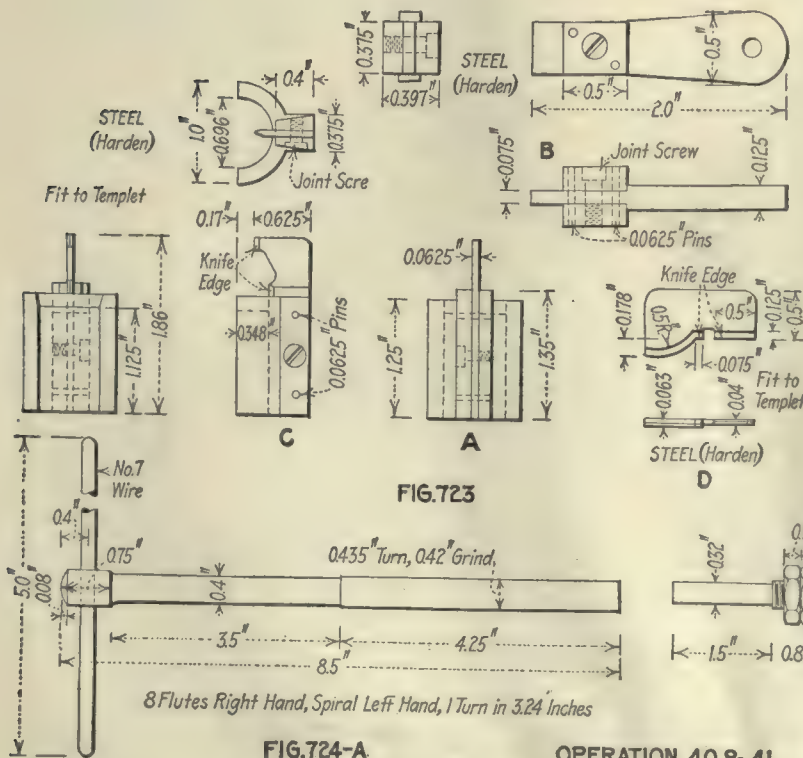


FIG. 723

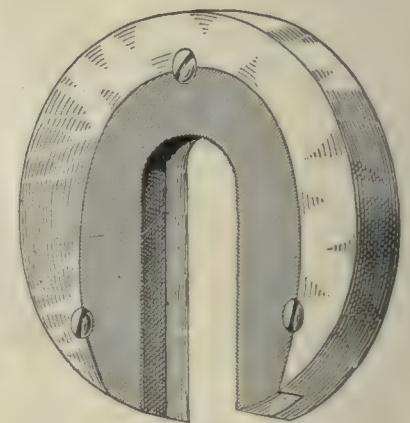


FIG. 724-C

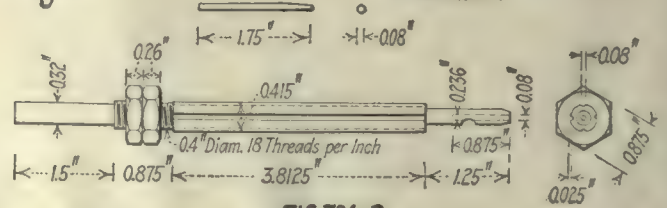


FIG. 724-B

FIG. 724-A

OPERATION 40 & 41

OPERATIONS 40 AND 41. HAND MILLING EJECTOR SLOT, TOP AND BOTTOM

Transformation—Fig. 719. Machine Used—Whitney Manufacturing Co. hand miller, Fig. 720, form and roller used. Number of Operators per Machine—One. Work-Holding Devices—Held on forms, clamped at end, Fig. 721; form below the roller guides cutter to proper contour. Tool-Holding Devices—Taper shank. Cutting Tools— $\frac{1}{8}$ -in. slotting cutter, Fig. 722. Number of Cuts—One. Cut Data—Speed, 500 r.p.m.; hand feed. Coolant—Cutting oil, $\frac{1}{16}$ -in. stream. Average Life of Tool Between Grindings—1,000 pieces. Gages—Fig. 723: A, location from side; B, width of slot; C, location with barrel; D, contour of slot. Production—75 per hr. Note—Work-holding points, body and ends.

The gage is practically a receiver with the addition of an adjustable stop that locates the distance from the bottom of the hand space to the back end, Fig. 730-A.

OPERATION LL. REMOVING BURRS FROM WELL WITH REAMER

Number of Operators—One. Description of Operation—Removing burrs from well. Apparatus and Equipment Used—Hand reamer, Fig. 724-A; firing-pin reamer, Fig. 724-B. Production—300 per hr.

OPERATION 44½. REMOVING BURRS WITH HAND TOOL, REAR OF FRONT LUG

Number of Operators—One. Description of Operation—Removing burrs thrown up by operation 14. The special C-shaped file is held in one hand and the bolt in the other and turned in opposite direction. Apparatus and Equipment Used—Fig. 724-C. Production—175 per hr.

This method of using as a gage a piece into which the part fits, or a duplicate of it, is quite common here and has much to recommend it for general shop practice.

The thread in the bolt is the only one in the whole rifle in which the male screw turns while the rifle is in use. The sleeve is held from turning as the bolt is rolled up a quarter turn, and brought back for loading and cocking. This gives a quarter turn of the sleeve screw in the bolt each time the bolt mechanism is operated and puts more or less wear on the bolt thread in both the bolt and sleeve.

moves a quarter turn in its groove during the action of the bolt. This holds the front end of the cartridge extractor to the bolt and allows the bolt to turn while the extractor slides back in its groove.

In all work of this kind where close fits are demanded and where only very small variations can be tolerated, we see the great difficulty in getting away from the final

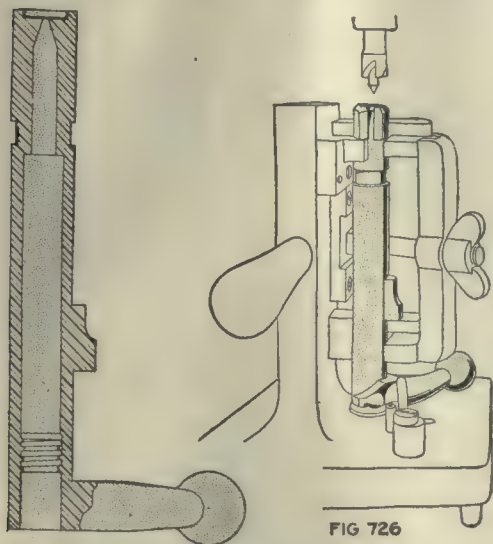


FIG. 725

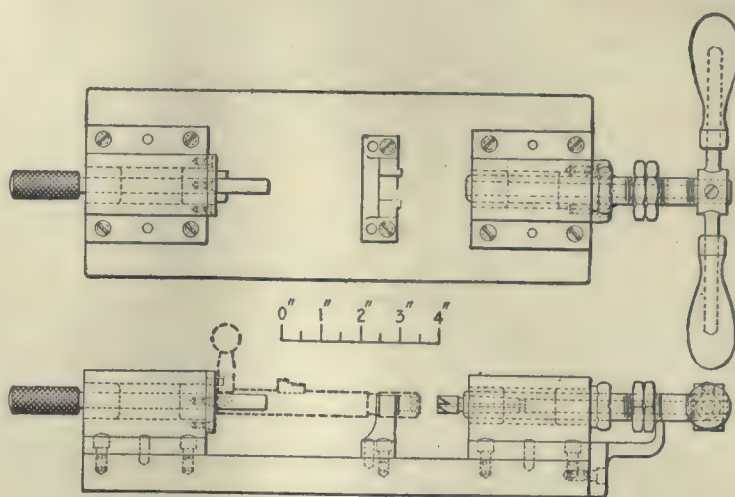


FIG. 728

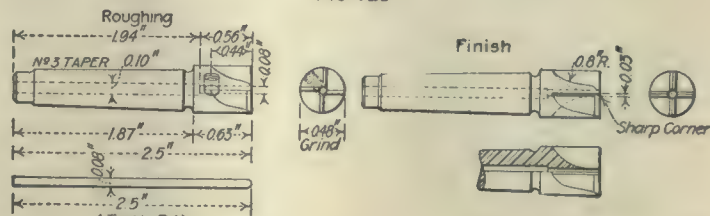


FIG. 729

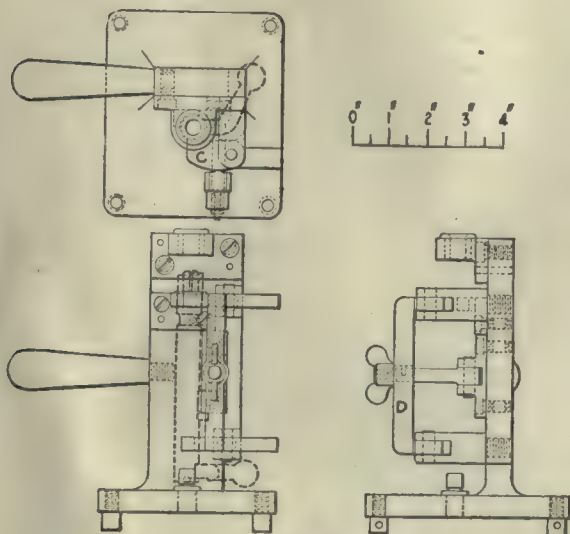


FIG. 727

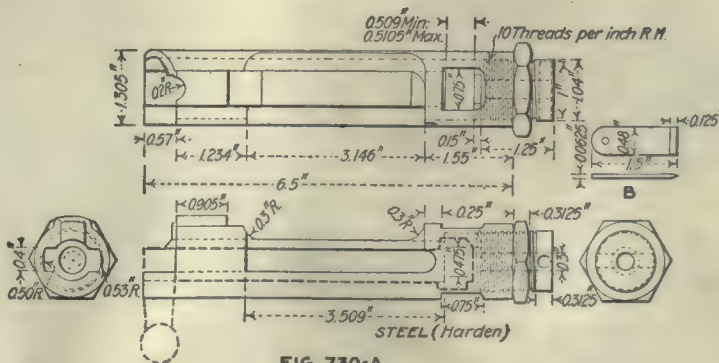


FIG. 730-A

OPERATION 45 & 45½

OPERATIONS 45 AND 45½. COUNTERBORING FOR HEAD SPACE, ROUGH AND FINISH

Transformation—Fig. 725. Machine Used—Pratt & Whitney 14-in. upright three-spindle drilling machine. Number of Operators per Machine—One. Work—Holding Devices—Drill jig, Fig. 726; bolt handle stops against a stop, while clamps are drawn down on body by an equalizer bar; details in Fig. 727; final finishing is done in hand fixture, Fig. 728. Tool—

Holding Devices—Taper shank. Cutting Tools—Two counter-borers with pilot, Fig. 729. Number of Cuts—Two. Cut Data—Roughing speed, 260 r.p.m.; hand feed; finishing cut at 85 r.p.m. Coolant—Cutting oil, ½-in. stream. Average Life of Tool Between Grindings—1,000 pieces. Gages—Fig. 730; A, total length from bottom of counterbore to back end; B, diameter of counterbore and concentricity with hole, also acts as a straight-edge across end. Production—80 per hr. Note—Lower end of bolt is centered by fixed plug.

This is why the thread in this case is so much deeper than the thread by which the receiver and barrel are fastened together. It is also a fairly long thread, so as to distribute the wear as much as possible. The amount of work done, however, is so slight that the wear is almost negligible, the only pressure on the thread being due to compressing the main spring.

In a similar way the extractor collar which encircles the bolt, in the special shallow groove provided for it,

hand-finishing touches. These are noticeable where all the close-fitting operations come together, such as the barrel and the receiver, the sleeve and the bolt, the final length of the bolt when locked in place, the projection of the firing pin and other similar places. Here, too, is where the value of actual experience in handling this work counts, as many have found to their sorrow. Long experience with any fine mechanism gives a familiarity and an ability that it is extremely difficult to duplicate.

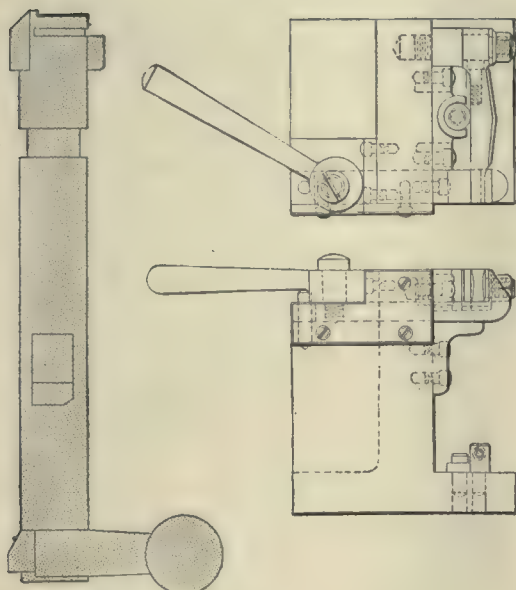


FIG. 731

FIG. 733

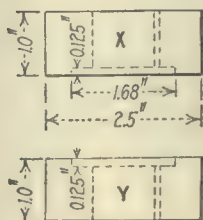
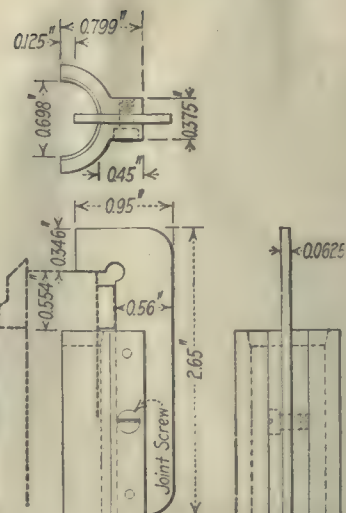


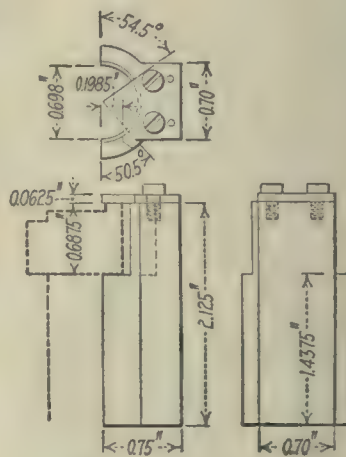
FIG. 734

X-Cut 28 Teeth, Spiral Left Hand, 1 Turn in 48 Inches, Teeth cut Left Hand on Face and Right Side
Y-Cut 28 Teeth, Spiral Right Hand, 1 Turn in 48 Inches, Teeth cut Right Hand on Face and Left Side



STEEL (Harden)

A



B

FIG. 735

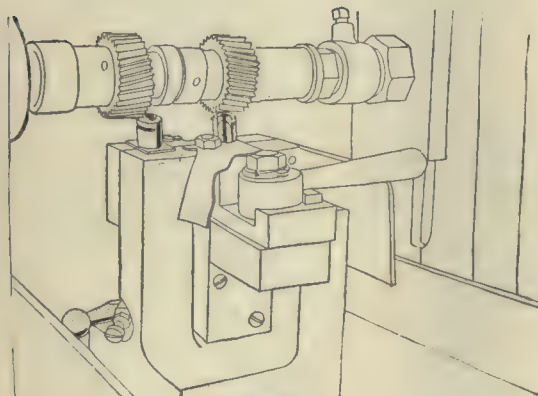


FIG. 732

OPERATION 46

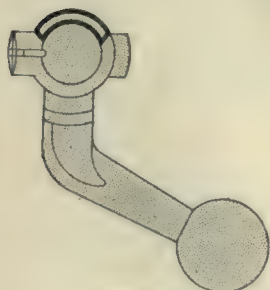


FIG. 736

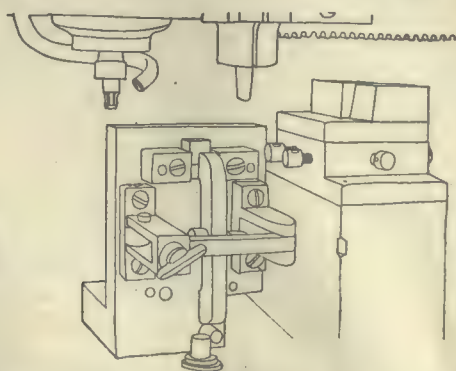


FIG. 737

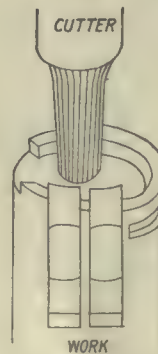


FIG. 737-A

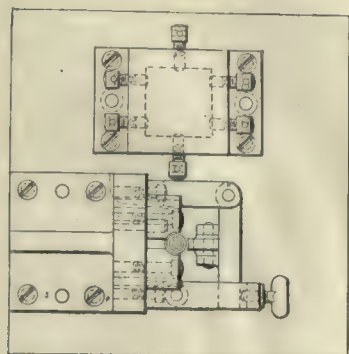
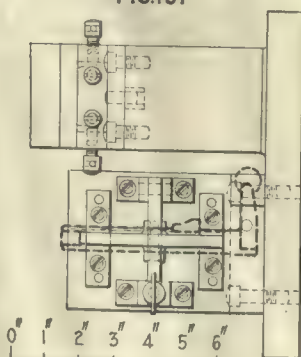


FIG. 738



OPERATION 47

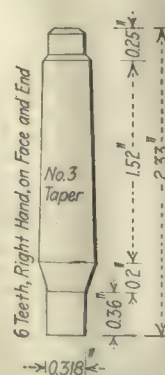


FIG. 739

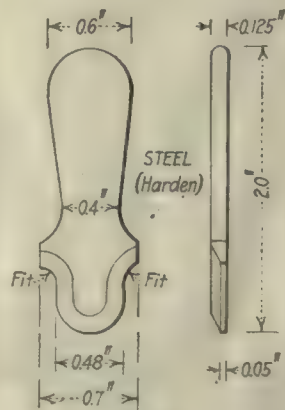


FIG. 740

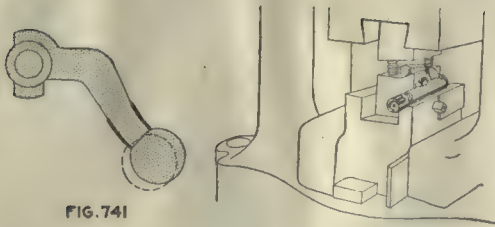
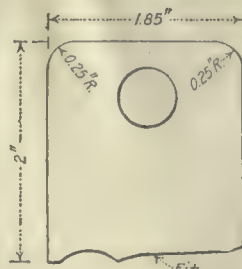


FIG. 741

FIG. 742A



STEEL (Harden)

FIG. 743

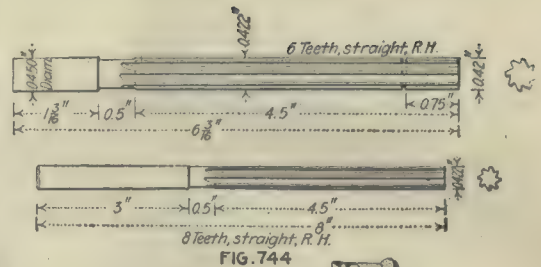


FIG. 744

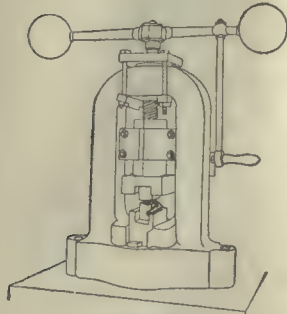


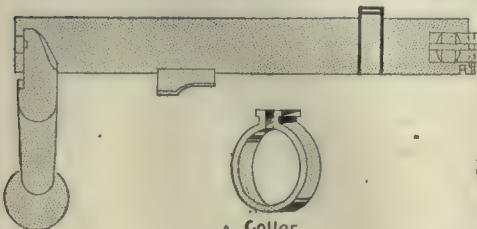
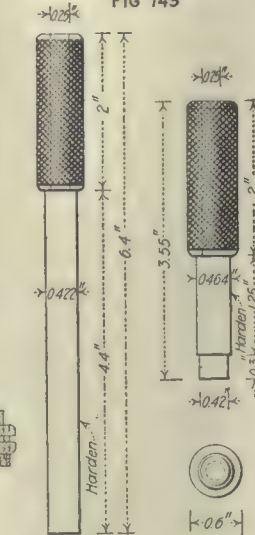
FIG. 742



FIG. 746A



FIG. 746B

Collar
FIG. 747

STEEL

FIG. 745

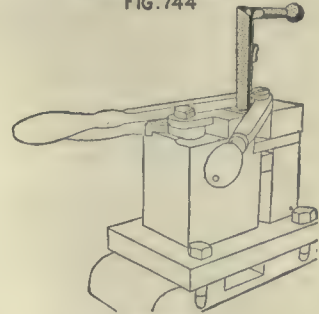


FIG. 748

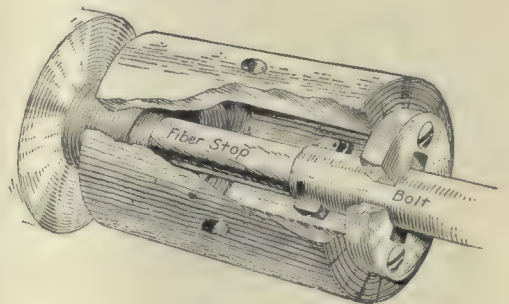


FIG. 748A

FIG. 741, 742, 743 OP. 58—FIG. 744, 745 OP. 59—FIG. 746 OP. 64
FIG. 747, 748 OP. 54—FIG. 748A OP. 55

OPERATION 46. MILLING FRONT END TO FINISH; RUN WITH OPERATIONS 20 AND 39

Transformation—Fig. 731. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Machines per Operator—One. Work-Holding Devices—Work clamped upright on fixture, Fig. 732; details in Fig. 733. Tool-Holding Devices—Standard arbor. Cutting Tools—Two milling cutters, Fig. 734. Cut Data—Speed, 50 r.p.m.; $\frac{1}{8}$ -in. feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—1,000 pieces. Gages—Fig. 735; A and B gage the long and short ends. Production—50 per hr.

OPERATION KK. REMOVING BURRS LEFT BY OPERATION 46, WITH HAND TOOL

Number of Operators—One. Description of Operation—Removing burrs thrown up by operation 46. Apparatus and Equipment Used—Hand tool used, similar to Fig. 729, but has a handle. Production—500 per hr.

OPERATION 47. PROFILING TO FINISH (MATCHING HEAD AND SPACE)

Transformation—Fig. 736. Machine Used—Pratt & Whitney No. 2 profiler. Number of Operators per Machine—One. Work-Holding Devices—Held upright on fixture shown in Fig. 737; details in Fig. 738; machining diagram, Fig. 737-A. Tool-Holding Devices—Taper shank. Cutting Tools—End mill, Fig. 739. Number of Cuts—One. Cut Data—Speed, 600 r.p.m.; hand feed. Coolant—Compound, $\frac{1}{8}$ -in. stream. Average Life of Tool Between Grindings—400 pieces. Gages—Fig. 740, contour. Production—40 per hr.

OPERATION 58. BENDING HANDLE

Transformation—Fig. 741. Machine Used—Hoe hand screw press, Fig. 742. Number of Operators per Machine—One. Punches and Punch Holders—Bending dies, Fig. 742-A. Dies and Die Holders—Square-shank punch holder, form-bending die. Gages—Fig. 743, contour. Production—120 per hr. Note—Bolt handle heated in lead pot to cherry red and offset in press shown.

OPERATION 59. REAMING FIRING-PIN HOLE

Number of Operators—One. Description of Operation—Reaming firing-pin hole. Apparatus and Equipment Used—Speed lathe and reamer, Fig. 744. Gages—Fig. 745, diameter. Production—125 pieces per hr. Note—Work held in hand on center in tailstock.

OPERATION 64. FILING CAM, FITTING TO RECEIVER

Number of Operators—One. Description of Operation—Filing and fitting cam, and cornering. Apparatus and Equipment Used—File. Production—8 per hr. Gages—746-A and B.

OPERATION 53. CASEHARDENING

Number of Operators—One. Description of Operation—Heat to 780 deg. C. (1,436 deg. F.) for $2\frac{1}{2}$ to 3 hr.; quench in oil; pack with $\frac{3}{4}$ bone and $\frac{1}{4}$ leather. Apparatus and Equipment Used—Same as for receiver.

OPERATION 54. ASSEMBLING WITH EXTRACTOR COLLAR

Transformation—Fig. 747. Number of Operators—One. Description of Operation—Bending and assembling collar to bolt; collar is heated to cherry red before bending. Apparatus and Equipment Used—Rockwell oil-burning forge; stand fixture for closing in collar, Fig. 748. Production—200 per hr.

OPERATION 55. FREEING EXTRACTOR COLLAR IN SPEED LATHE

Machine Used—Machine built at Hill shops. Number of Operators per Machine—One. Work-Holding Devices—In hand. Tool-Holding Devices—Round wooden holder on spindle of machine, Fig. 748-A; brass plate on front catches extractor-collar lugs and turns collar on bolt, which is held in the hand; a loose belt on pulley allows the operator to stop spindle by placing hand on outside of holder to change work. Cut Data—450 r.p.m. Coolant—None. Production—400 per hr.

OPERATION 56. FILING EARS ON EXTRACTOR COLLAR

Number of Operators—One. Description of Operation—Filing the top, sides of ears to fit extractor, and cornering. Apparatus and Equipment Used—File. Production—80 per hr.

OPERATION 52. POLISHING SURFACE

Number of Operators—One. Description of Operation—Polishing outside surface of bolt. Apparatus and Equipment Used—Wheel and polishing jack. Production—70 per hr.

OPERATION 57. BURRING BOLT-STOP NOTCHES, WITH OILSTONE

Number of Operators—One. Description of Operation—Burring stop notches. Apparatus and Equipment Used—Oilstone. Production—300 per hr.

OPERATION 65. BROWNING

Number of Operators—One. Description of Operation—Same as with barrel. Apparatus and Equipment Used—Same as with barrel.

TABLE OF SCREWS AND TAP DRILLS IN INCHES AND MILLIMETERS

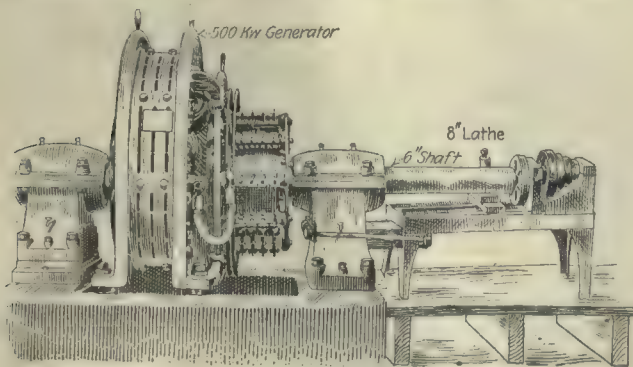
Size	Threads	Dia. of Screw			V Thread			U. S. S. Thread			Dia. of Screw			V Thread			U. S. S. Thread									
		In.	M/M	No. of Drill	In.	M/M	No. of Drill	In.	M/M	No. of Drill	In.	M/M	No. of Drill	In.	M/M	No. of Drill	In.	M/M	No. of Drill							
No. 1...	56	0.071	1.805	55	0.052	1.32	55	0.052	1.32	No. 9	24	0.1763	4.477	30	0.1285	3.263	No. 19	16	0.3078	7.818	A	0.234	A	0.228	5.791	
No. 1...	64	0.071	1.805	54	0.055	1.397	54	0.055	1.397	No. 9	28	0.1763	4.477	29	0.136	3.454	No. 19	18	0.3078	7.818	C	0.242	B	0.238	6.045	
No. 1...	72	0.071	1.805	54	0.055	1.397	54	0.055	1.397	No. 9	30	0.1763	4.477	28	0.1405	3.568	No. 19	20	0.3078	7.818		0.250	D	0.246	6.248	
No. 1...	56	0.0781	1.984	53	0.0595	1.511	54	0.055	1.397	No. 9	32	0.1763	4.477	28	0.1405	3.568	1/2-in.	16	0.3125	7.937	B	0.238	A	0.234	5.943	
No. 1...	64	0.0781	1.984	52	0.0635	1.612	53	0.0595	1.511	1/2-in.	24	1.875	4.762	28	0.1405	3.568	1/2-in.	18	0.3125	7.937	D	0.246	C	0.242	6.146	
No. 1...	72	0.0781	1.984	52	0.0635	1.612	52	0.0635	1.612	1/2-in.	32	1.875	4.762	24	0.152	3.86	25	0.1495	3.797	1/2-in.	20	0.3215	7.937	F	0.257	6.35
No. 2...	48	0.0842	2.14	52	0.0635	1.612	53	0.0595	1.511	No. 10	24	0.1894	4.81	28	0.1405	3.568	No. 20	16	0.321	8.153	D	0.246	C	0.242	6.146	
No. 2...	56	0.0842	2.14	52	0.0635	1.612	52	0.0635	1.612	No. 10	28	0.1894	4.81	25	0.1405	3.568	No. 20	18	0.321	8.153	F	0.257	6.35			
No. 2...	64	0.0842	2.14	51	0.067	1.701	51	0.067	1.701	No. 10	32	0.1894	4.81	23	0.154	3.911	24	0.152	3.86	1/2-in.	18	0.3437	8.731	J	0.277	6.908
No. 2...	50	0.0937	2.381	49	0.073	1.854	50	0.070	1.778	No. 11	24	0.2026	5.145	23	0.154	3.911	24	0.152	3.86	No. 22	16	0.3473	8.821	I	0.272	6.908
No. 2...	56	0.0937	2.381	48	0.076	1.93	49	0.073	1.854	No. 11	28	0.2026	5.145	20	0.161	4.089	21	0.159	4.038	No. 22	18	0.3473	8.821	1/2	0.277	7.037
No. 2...	60	0.0937	2.381	48	0.076	1.93	48	0.076	1.93	No. 11	30	0.2026	5.145	19	0.166	4.216	20	0.161	4.089	No. 24	14	0.3738	9.489	L	0.290	7.366
No. 3...	40	0.0973	2.472	50	0.070	1.778	51	0.067	1.701	1/2-in.	24	0.2031	5.159	23	0.154	3.911	24	0.152	3.86	No. 24	16	0.3738	9.489	M	0.302	7.493
No. 3...	48	0.0973	2.472	48	0.076	1.93	49	0.073	1.854	1/2-in.	32	0.2031	5.159	18	0.1695	4.305	19	0.166	4.216	No. 24	18	0.3738	9.489	1/2	0.3125	7.937
No. 3...	56	0.0973	2.472	47	0.0785	1.993	48	0.076	1.93	No. 12	20	0.2158	5.48	22	0.157	3.987	23	0.154	3.911	1/2-in.	16	0.375	9.525	N	0.302	7.67
No. 3...	48	0.1093	2.778	44	0.086	2.184	44	0.086	2.184	No. 12	24	0.2158	5.48	18	0.1695	4.305	19	0.166	4.216	1/2-in.	20	0.375	9.525	O	0.316	8.026
No. 3...	56	0.1093	2.778	43	0.089	2.26	43	0.089	2.26	No. 12	32	0.2158	5.48	15	0.180	4.572	16	0.177	4.50	1/2-in.	24	0.375	9.525	P	0.323	8.204
No. 4...	32	0.1105	2.81	48	0.076	1.93	49	0.073	1.854	1/2-in.	24	0.2187	5.556	17	0.173	4.394	19	0.166	4.216	No. 26	14	0.400	10.16	O	0.316	8.026
No. 4...	36	0.1105	2.81	46	0.081	2.057	48	0.0765	1.93	1/2-in.	28	0.2187	5.556	16	0.177	4.50	17	0.173	4.394	No. 26	16	0.400	10.16	1/2	0.3281	8.334
No. 4...	40	0.1105	2.81	44	0.086	2.184	46	0.081	2.057	1/2-in.	32	0.2187	5.556	14	0.182	4.622	15	0.180	4.572	1/2-in.	16	0.4062	10.32	Q	0.332	8.432
No. 4...	32	0.1236	3.14	43	0.089	2.26	44	0.086	2.184	No. 13	22	0.2289	5.815	16	0.177	4.50	17	0.173	4.394	No. 28	14	0.4263	10.82	1/2	0.3437	8.731
No. 5...	36	0.1236	3.14	42	0.0935	2.374	43	0.089	2.26	No. 13	24	0.2289	5.815	15	0.180	4.572	16	0.177	4.50	No. 28	16	0.4263	10.82	1/2	0.3593	9.128
No. 5...	40	0.1236	3.14	41	0.096	2.438	42	0.0935	2.374	No. 13	32	0.2289	5.815	10	0.1935	4.914	12	0.189	4.80	1/2-in.	14	0.4375	11.11	1/2	0.348	8.838
No. 5...	32	0.125	3.175	43	0.089	2.26	44	0.086	2.184	1/2-in.	24	0.2343	5.953	13	0.185	4.699	14	0.182	4.622	1/2-in.	20	0.4375	11.11	V	0.377	9.575
No. 5...	36	0.125	3.175	42	0.0935	2.374	42	0.0935	2.374	1/2-in.	28	0.2343	5.953	10	0.1935	4.914	12	0.189	4.80	No. 30	14	0.4526	11.49	U	0.368	9.347
No. 5...	40	0.125	3.175	41	0.096	2.438	42	0.0935	2.374	1/2-in.	32	0.2343	5.953	8	0.199	5.054	9	0.196	4.978	No. 30	16	0.4526	11.49	V	0.377	9.575
No. 5...	48	0.125	3.175	38	0.1015	2.578	39	0.0995	2.527	No. 14	18	0.242	6.146	16	0.177	4.50	17	0.173	4.394	1/2-in.	14	0.4085	11.90	V	0.377	9.575
No. 6...	30	0.1368	3.475	40	0.098	2.489	41	0.096	2.438	No. 14	20	0.242	6.146	14	0.182	4.622	15	0.180	4.572	1/2-in.	12	0.500	12.70	X	0.397	10.08
No. 6...	32	0.1368	3.475	38	0.1015	2.578	40	0.098	2.489	No. 14	24	0.242	6.146	10	0.1935	4.914	12	0.189	4.80	1/2-in.	13	0.500	12.70	1/2	0.4062	10.31
No. 6...	36	0.1368	3.475	37	0.104	2.641	37	0.104	2.641	1/2-in.	20	0.250	6.35	11	0.191	4.851	12	0.189	4.80	1/2-in.	20	0.500	12.70	1/2	0.4375	11.11
No. 6...	40	0.1368	3.475	35	0.110	2.794	36	0.1065	2.705	1/2-in.	24	0.250	6.35	7	0.201	5.105	9	0.196	4.978	1/2-in.	12	0.5625	14.28	1/2	0.4531	11.50
No. 6...	32	0.1406	3.571	37	0.104	2.641	38	0.1015	2.578	1/2-in.	32	0.250	6.35	3	0.213	5.37	3	0.213	5.37	1/2-in.	14	0.5625	14.28	1/2	0.4687	11.90
No. 6...	36	0.1406	3.571	35	0.110	2.794	36	0.1065	2.705	No. 15	18	0.2552	6.482	12	0.196	4.80	13	0.185	4.689	1/2-in.	18	0.5625	14.28	1/2	0.4843	12.30
No. 6...	40	0.1406	3.571	34	0.111	2.819	35	0.110	2.794	No. 15	20	0.2552	6.482	9	0.196	4.978	11	0.191	4.851	1/2-in.	18	0.5625	14.28	1/2	0.500	12.70
No. 7...	28	0.150	3.81	35	0.110	2.794	36	0.1065	2.705	No. 15	24	0.2552	6.482	5	0.2055	5.219	6	0.204	5.181	1/2-in.	12	0.625	15.87	1/2	0.5156	13.09
No. 7...	32	0.150	3.81	33	0.113	2.87	34	0.111	2.819	No. 16	16	0.2684	6.817	10	0.1935	4.914	12	0.189	4.80	1/2-in.	11	0.6875	17.46	1/2	0.5781	14.68
No. 7...	40	0.150	3.81	31	0.120	3.048	31	0.120	3.048	No. 16	18	0.2684	6.817	6	0.204	5.181	8	0.199	5.054	1/2-in.	12	0.6875	17.46	1/2	0.5781	14.68
No. 7...	30	0.1562	3.968	31	0.120	3.048	32	0.116	2.946	No. 16	20	0.2684	6.817	4	0.209	5.308	6	0.204	5.181	1/2-in.	10	0.730	19.05	1/2	0.625	15.87
No. 7...	32	0.1562	3.968	31	0.120	3.048	31	0.120	3.048	1/2-in.	18	0.2812	7.143	2	0.221	5.613	3	0.213	5.37	1/2-in.	12	0.730	19.05	1/2	0.6406	16.27
No. 7...	36	0.1562	3.968	30	0.1285	3.263	30	0.1285	3.263	1/2-in.	20	0.2812	7.143	2	0.221	5.613	2	0.221	5.613	1/2-in.	12	0.8125	20.63	1/2	0.6875	17.46
No. 7...	40	0.1562	3.968	30	0.1285	3.263	30	0.1285	3.263	1/2-in.	24	0.2812	7.143	A	0.234	5.943	2	0.231	5.613	1/2-in.	10	0.8125	20.63	1/2	0.6875	17.46
No. 8...	24	0.1631	4.14	32	0.116	2.946	34	0.111	2.819	No. 17	16	0.2815	7.15	4	0.209	5.308	7	0.201	5.105	1/2-in.	9	0.875	22.22	1/2	0.7031	17.85
No. 8...	30	0.1631	4.14	30	0.1285	3.263	30	0.1285	3.263	No. 17	18	0.2815	7.15	2	0.221	5.613	3	0.213	5.37	1/2-in.	12	0.875	22.22	1/2	0.7343	18.65
No. 8...	32	0.1631	4.14	30	0.1285	3.263	30	0.1285	3.263	No. 17	20	0.2815	7.15	2	0.221	5.613	3	0.213	5.37	1/2-in.	12	0.875	22.22	1/2	0.7636	19.44
No. 8...	40	0.1631	4.14	29	0.136	3.454	29	0.136	3.454	No. 18	16	0.2947	7.485	2	0.221	5.613	2	0.221	5.613	1/2-in.	9	0.9375	23.81	1/2	0.7968	20.24
No. 8...	32	0.1718	4.365	29	0.136	3.454	29	0.136	3.454	No. 18	18	0.2947	7.485	1	0.228	5.791	1	0.228	5.791	1/2-in.	12	0.9375	23.81	1/2	0.8281	21.03
No. 8...	36	0.1718	4.365	28	0.1405	3.568	28	0.1405	3.568	No. 18	20	0.2947	7.485	B	0.238	6.045	A	0.234	5.943	1/2-in.	8	1.000	25.4	1/2	0.8437	21.43
No. 8...	40	0.1718	4.365	28	0.1405	3.568	28	0.1405	3.568	No. 18	20	0.2947	7.485								12	1.000	25.4	1/2	0.8906	22.62

Letters from Practical Men

Taking the Small Lathe to the Big Job

The illustration shows what happened when I was called upon to turn up the end of a generator shaft. The machine was out in the country and weighed many tons, and there was no lathe in town big enough to take in the job; so instead of putting the job in the lathe I put the lathe in the job.

The lathe I used was a small one and was clamped to the generator. The center in the shaft was put on the



HOW THE SHAFT WAS TURNED

lathe center, and the lathe was then lined up with the job. I drilled the end of the shaft and put in a capscrew through the face plate to hold the center in the center of the shaft.

The generator had to be turned by hand as power would have been too fast, but six hours did the job and two laborers took turns rotating the generator shaft. Instead of the work costing about \$100, it cost only about \$10.

North Yakima, Wash.

J. K. ARROWSMITH.

Too Much Efficiency

A certain shop in New England prides itself on its efficiency. From the office boy to the general manager, all believe that they are the last word in system and that overworked term "efficiency." In one of the departments are several gas heaters for melting paraffin, operated by boys.

These paraffin pots had been the cause of several small fires at different times and should have been a lesson to the management and taught it the value of preparedness. A few weeks ago one of the pots of paraffin caught fire and boiled over, dripping liquid flames on a quantity of waste and other inflammable material. The whole mass was soon blazing merrily, which would have meant a serious conflagration had it not been for quick work on the part of a few employees who neatly mastered the situation with the aid of fire extinguishers. The fire was well under control, with but a small loss, before the factory fire brigade arrived.

A few days later a fire that again broke out at the same place, and from the same cause, came near gaining

the upper hand and cleaning out the entire room. It took the fire brigade over half an hour of hard work to quench the flames, which caused a loss of about \$70 from fire and water.

The second fire could have been put out as quickly as the first, had there been an extinguisher at hand, but there was not an extinguisher in the room; they had all been used for the fire that occurred a few days before and had never been recharged. The hooks where the extinguishers usually hung were empty, and the extinguishers were underneath a bench in the plumbers' room waiting to be refilled. I presume there was an authorization order somewhere on the way, provided it hadn't been lost in transit, which after being signed, countersigned and O. K.'d by the different department heads, would in due time reach the man in charge of the refilling. This worthy, however, was deaf to all the pleadings of the paraffin-department foreman, and would not touch the much-wanted extinguishers without the necessary clearance papers.

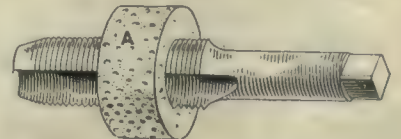
HARRY B. STILLMAN.

Plainville, Conn.

Simple Depth Gage for Tapping

A blind hole is very hard to tap unless the machine has an attachment that will reverse automatically. If a few holes have to be tapped to various depths, the attachment is useless. If one tries to machine tap the hole by guesswork, the tap is apt to be broken. The cork *A* is adjusted to approximately the right depth; and when it touches the surface of the work, the machine is reversed. The cork being flexible, if the tap goes in a thread more than intended no harm is done, as there is nothing to break.

Springfield, Mass.



THE TAPPING GAGE

Plate Patterns

The manufacturer of today who uses a number of small castings and who does not insist on having his castings made from plate patterns is in a number of ways losing cash that would go far toward paying a good dividend on his stock. The cost of an aluminum plate of patterns is low, amounting on an average to about \$75 for a simple pattern for first-class equipment.

The advantages of such a plate pattern are many. Uniform castings true to pattern are a great saving in the cost of finishing and assembling. There is no danger of the patterns becoming loose and lost, bent or out of shape. There are no pattern repairs to pay for. When the plate is properly made, it is as nearly perfect as a punch and die; and castings should be produced just as accurately from the pattern plate in the foundry as from the press room. The sprue will be uniform and will eliminate excessive grinding.

A few months ago a case came to my notice where a well-known manufacturer was using 50,000 small castings a month from a certain kind of gated patterns. He could not see where there was any advantage in having plate patterns made. He did not realize that his castings were coming to him each weighing, on an average, 2 oz. more than the weight of his patterns. That is a small matter on a single casting. However, it makes an aggregate of 100,000 oz. a month, or 6,250 lb. That amount of gray iron at 4½¢. per lb. represents \$281.25 a month. This overweight was caused by rapping the pattern in the foundry, which is eliminated on plate patterns.

Another great advantage is the increased production by the molder, due to the fact that he has no heavy match to handle and no repairs to wait for. The customer is more sure of getting castings free from sand holes, owing to a perfect match plate doing away with the old sand patch.

In making plate patterns, small patterns can often be so arranged that more can be produced in a mold than with gated patterns, and at the same time poured with the same sprue, which is a great saving and gives the foundry a chance to cut cost of production. The size of gates on plated patterns can also be reduced, as one large enough to run the castings successfully is all that is required.

In gated patterns it is frequently necessary to use a heavy gate to keep the patterns in shape. Another advantage is the elimination of complaints between the manufacturer and the foundry, because of imperfect castings.

A. E. HOLADAY.

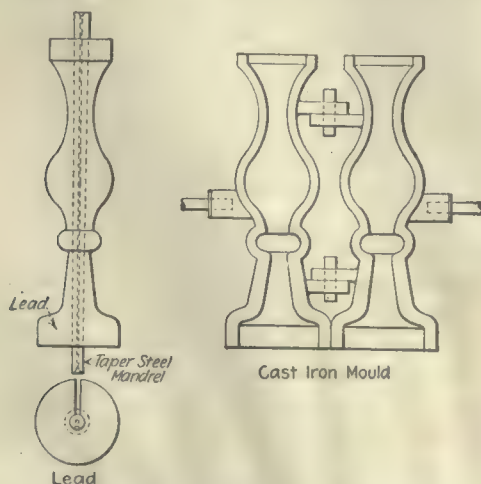
Naugatuck, Conn.

✱

Finishing Glass Molds Inside

The illustration shows a cast-iron mold for blowing glass. This and similar ones are difficult to make true inside so that the glass can be turned at the same time that it is blown. The casting is usually out of round.

The mold is first faced off and then clamped together to drill the hinge holes. A tapered steel mandrel is placed



FINISHING GLASS MOLDS INSIDE

inside the mold, into which lead is poured. After cooling, the mandrel is taken out and a slot is milled through the lead to the steel mandrel. The latter is then placed in the lathe, and with oil and emery on the inside of the mold it is clamped on the revolving mandrel, using judgment not

to clamp too tight as soon as the mandrel wears small. When this occurs, the lead is driven up on the tapered mandrel and grinding is continued until the mold is smooth inside.

This is a good and quick way to smooth the inside of work of this kind, where the neck is too small to admit a boring tool.

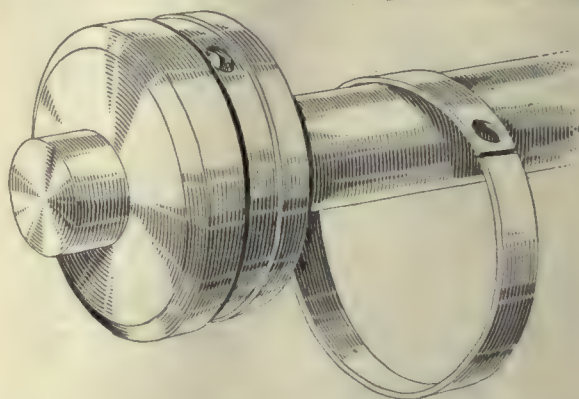
GEORGE B. FAIRMAN.

Wellsboro, Penn.

✱

Safety Collar

An easily made safety collar that can be used on the end of shafting, etc., is shown in the accompanying illustration. It consists of a round cast-iron collar having a groove in the center, in which is placed a loose-fitting



THE SAFETY COLLAR

flat steel spring. A hole is made in the spring through which to insert a screwdriver. The hole is turned away from the screw after the screw is tightened. The spring serves as a guard for the screw, and at the same time it will instantly stop if anything comes in contact with it.

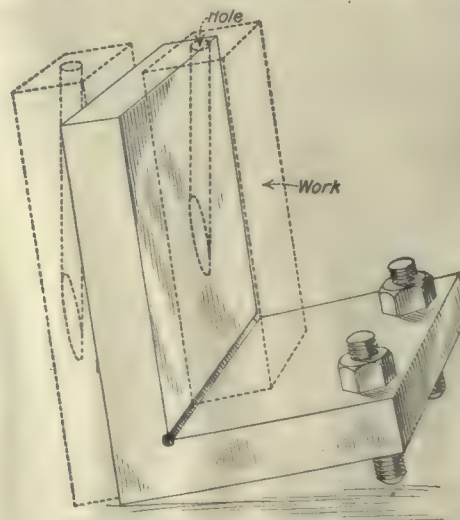
Hartford, Conn.

J. E. COOLEY.

✱

Simple Adjustable Angle Plate

The accompanying illustration shows a tool that we find quite handy on the drilling machine for drilling holes



Table

SIMPLE ADJUSTABLE ANGLE PLATE

at various angles. It will be noticed that the adjustment is secured very simply by means of the two studs and clamping nuts.

Springfield, Vt.

WILLIS ROBBINS.

Discussion of Previous Question

Annealing Stampings Made of Sheet Steel

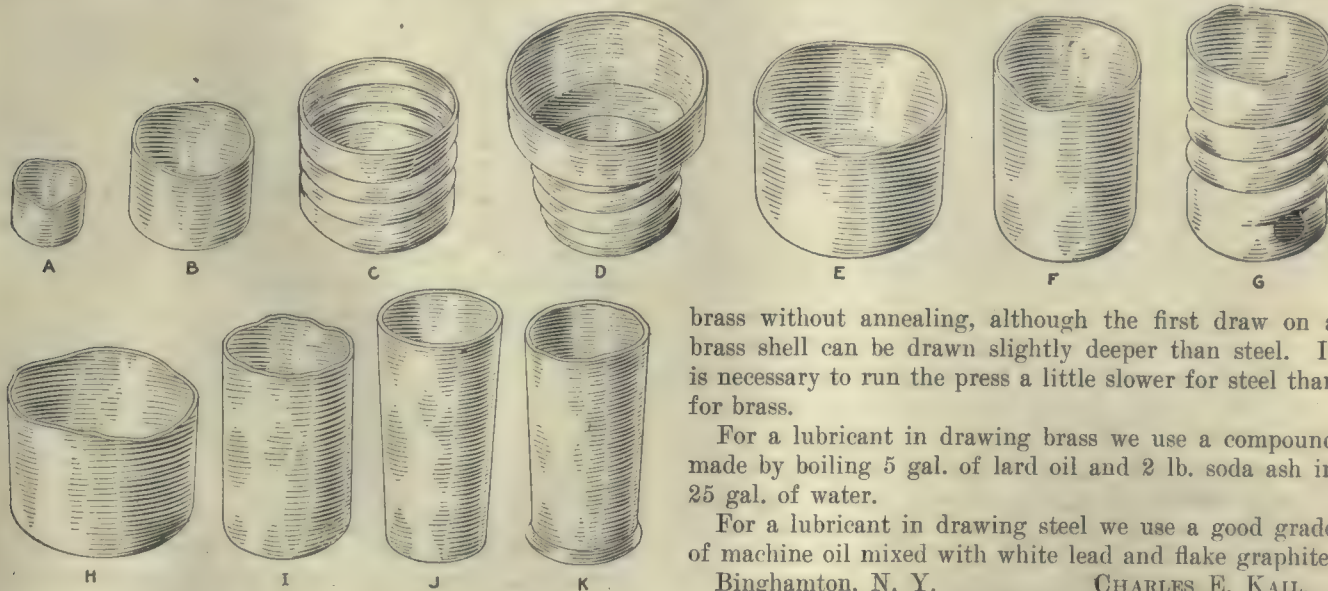
On page 571 F. E. Olsen has opened a subject on which I would like to give some of my experience. I would also like to hear from others.

What Mr. Olsen says about the annealing of steel stampings is fairly well known, but I cannot see any economy or any reason for brass-plating the parts to be annealed. As it is necessary to have a box of some kind

shown the three operations necessary to make the piece from 0.018-in. cold-rolled steel. There are two draws followed by rolling the thread, but there is no annealing between operations.

From *H* to *K* are shown the successive steps in making a screw driver ferrule of 0.030-in. cold-rolled steel. This is also made without annealing, but if it were made of brass it would be necessary to anneal it at least once.

My experience has been that in cupping and deep-drawing sheet metal, steel can be drawn deeper than



STEEL SHELLS DRAWN WITHOUT ANNEALING

to do the annealing in, it might just as well be one that can be made air-tight, as brass-plating the articles will cost nearly one cent per pound. I should say to save this cost by having the right kind of box for the annealing.

Mr. Olsen says that in cupping a small steel shell $\frac{7}{16}$ in. in diameter, $\frac{3}{8}$ in. deep, made of 0.018-in. sheet steel, it is necessary to anneal. On a shell of this size I would not expect to do any annealing. In fact I would expect to make it in one operation, unless the corners had to be made sharp in the bottom of the cup. As proof of this the accompanying illustration shows a few samples of shells that we are making in large quantities.

At *A* and *B* are shown shells which we make in one operation. Those marked *C* and *D* require two draws, although at times we have had material from which we were able to make them in one draw. But since the steel mills are so far behind in deliveries it is hard to get good drawing steel, and we are using two draws on all shells that have a length equal to the diameter. The largest of these shells we have always made in two draws. After trimming they are threaded, but there is no annealing between operations. I am quite positive that if this shell were made of brass it would be necessary to anneal it after the first operation. At *E*, *F* and *G* are

brass without annealing, although the first draw on a brass shell can be drawn slightly deeper than steel. It is necessary to run the press a little slower for steel than for brass.

For a lubricant in drawing brass we use a compound made by boiling 5 gal. of lard oil and 2 lb. soda ash in 25 gal. of water.

For a lubricant in drawing steel we use a good grade of machine oil mixed with white lead and flake graphite.

Binghamton, N. Y.

CHARLES E. KAIL.

Inspecting High-Grade Gears-- An Analysis

Under the title of "Inspecting High-Grade Gears," on page 580, Mr. Younger discussed the desirability of putting limits on gear drawings. In doing so he showed incidentally that gearing is going through the same stages of evolution that all other machined parts have to undergo before they are put on a manufacturing basis.

While I am in complete sympathy with Mr. Younger's plea for "limits on gear drawings," a knowledge of the human inertia that will retard such a necessary development leads me to believe that its application will not be an easy matter in any establishment.

Let us consider the various stages in limit fixing; and in going over them, let us try to see in what way they affect the fixing of limits for gearing. In considering the working of any mechanism with a view to interchangeable manufacture we have: (1) To consider what allowance is necessary between any two parts to make them function properly. This makes for efficient working. (2) Weigh carefully what tolerance, from a basis figure, can be allowed on each individual piece, and the cumulative effect. These tolerances should be the maximum that is consistent with the efficient working of the various pieces. This assists production. (3) Finally, we have to consider

the human elements concerned. This is our most unstable factor. Here we have A, those in authority who should determine the limits, and B, those who later on will have to work to the limits when fixed. This naturally involves the consideration of methods of production and gaging—that is, testing.

When we come to consider these three points we shall find that they are so interrelated that we cannot entirely separate them, but must consider each in its relation to the others.

With gearing, our first difficulty would come when we want to fix an allowance that will permit the pieces to run properly. Everyone concerned will fiddle about with the gears and say they are “too easy” or “too tight.” But this is not what we want. We require something definite, stated in thousandths of an inch. Who will define it?

As Mr. Younger says, clearances and tolerances in gears are a matter of taste; that is, the question is one of opinion and not one of fact. It must therefore be decided by the management in consultation with the others concerned.

The probable decision will be that no “backlash” will be allowed. This is of course no decision at all, because unless the gears are ground accurately, the tolerances on the center distances and the pitch-line diameters of the gears must be unduly fine. With fine tolerances and selective assembling we may, however, achieve such a result if the tolerances are crossed. If, however, we desire real interchangeability, then the tolerances must not cross.

Having made up our minds on this point, we must fix the tolerance for the center distance of the two shafts. Here we are up against something we cannot dodge. When we are boring two pairs of holes parallel to each other, say in the gear box of an automobile, there is no known method that will consistently produce such holes to an exact center distance. This is a broad statement, but I will stand by it.

Many adopt certain methods of doing this kind of work and will swear to the accuracy of the result, but they never measure it or they would know differently. Here is where we get the inertia effect in full. “Dead accurate center distances,” “absolutely accurate gears,” etc., may be excellent talking points for a salesman, but they are meaningless in the shop. If we can hold the center distances of two holes to plus or minus 0.001 in., we are doing particularly well. Speaking quite generally, there would be a high percentage of scrap in most plants if limits of twice that amount were rigidly enforced.

Now we come to the gears, and we must decide the process of manufacture before we can decide the limits. For gears with ground teeth, we should naturally expect to keep closer to a basic size than with machine-cut gears. Many are under the impression that if gear teeth are ground, then the result is so fine that “limits” are superfluous.

Gear-grinding firms, however, have no delusions on this point. They know how close they can work commercially, and express this in their guarantee. One firm of gear-grinding specialists says, under the heading “Requirements for Gear-Box Work”:

A. Center distance not to exceed 0.0005 in. under size or 0.001 in. over size.

B. Alignment error not to exceed 0.001 in. in 12 in. in either direction.

C. Holes in gears to be ground out not less than standard size and not more than 0.0005 in. over standard.

Guarantee—With center distance standard gears ground and paired by Gear Grinding Co., Ltd., backlash not to exceed 0.004 in. Smooth roll guaranteed. Gears to be mounted in box as paired by gear-grinding company.

If we intend to have our gears ground, we can take the limits laid down by the firm that will grind them and insert them on the drawing. If, on the other hand, we are going to cut the gears ourselves by means of a method that is far less accurate than grinding, we shall probably figure up the drawing to a much finer limit, knowing full well that these limits will not be rigidly adhered to. This kind of self-deception is quite common in some plants.

Once having fixed the limits, we must consider the method of inspection to keep the gears within these limits. Mr. Younger suggests two methods of testing—either with a “master gear” or a “master rack.” Unless the gear has to run with a rack, I think we can dismiss the latter, because a gear might run with a rack and stick, or have backlash when run with a gear.

No doubt the only safe way to test gears that have to be interchangeable within close limits is to test each with a master gear representing its mating gear. This test should take place on a testing fixture with fixed center distance. Any other kind of testing fixture is open to distrust. If limits are decided on, then two sets of plugs may be provided, each pair representing on the same block a “go” and a “not go.” This can be arranged either with the three plugs in one line or, preferably, with each plug representing the corner of a triangle.

As we have said, the fixing of the limits will be the trouble. Once the limits are fixed the tool designer will soon provide means for checking the work. The only real difficulty lies in getting the “master gears” made to size. Many methods have been described for determining the exact size of a gear wheel, but nearly all depend on the accuracy of the tooth curve taken in conjunction with cylinders. Considered geometrically, such solutions are all right; but knowing that the tooth curve is doubtful, it seems like trying to get accurate results from an inaccurate basis.

I would suggest the following as being absolutely certain: Make a testing fixture suitable for each master gear. Next cut three gears, each of which will run with each of the others without backlash. This will give exact results, as it is based on Whitworth's surface-plate theory. The best way would be to get a gear-grinding firm to grind three that will run as described.

One of these can then be kept as a reference, one used for testing the gears, and the other one kept as a spare. Owing to the expense of originating master gears, it seems preferable to have the limit on the fixture and not on the masters. It may be argued that by bringing the center distance of the fixture in to form a “not go” test, we are altering the conditions under which the gears will be run. As the test is a “not go” one, there must not be any running, otherwise we must reject the gear. Apart from this, there will, as we have mentioned before, be some variation in the center distances of the shafts on which the gears will work.

Another point about gear-testing fixtures that is worth watching is that they should never be made exactly to the center distance given on the drawing. There are sure to be small variations in the diameter of the holes in the gears. The plugs on the testing fixture must be made to take the smallest hole; consequently, when gears are ground near to the maximum in the hole, they will run

on the fixture when they are large on the pitch line. This, if not watched, would give the same result as "crossed limits." We would also get similar results when testing, say gear-box centers, with test bars and bushes in conjunction with limit test disks. That is, we must watch for any slackness, either of the bushes or test disks, on the test bar.

There is one point that has seldom received any attention, and that is the heat factor. This applies more particularly to worm gears; but where the closest of work is required it may affect the accuracy of spur gearing. For instance, take the case of an aluminum gear box for an automobile. These are bored quickly, and the change in temperature during the operation can easily be felt by hand. If such a box is finish-bored while still warm, then there would be an error corresponding to the change in temperature. No doubt this is as a rule small.

While there is not much heat generated in spur gearing when in action, this is not the case with worm gears. Here we have a considerable rise in temperature. Take the case of a bronze worm wheel, say 5 in. in diameter. Assume that the rise in temperature of the worm wheel under load is 50 deg. F. more than that of the casing that contains it.

Then, if we assume 0.00001 as the coefficient of expansion for bronze, we have an increase in the pitch-line diameter of $50 \times 15 \times 0.00001 = 0.0075$. What is to become of this? Are we to allow for it in the limits, or shall we trust to some defect in the worm contact to take care of this and give us the necessary clearance by abrasion when tested?

The whole subject of limits for gearing is of absorbing interest and is worthy of much discussion.

As I see it, at present, the unit of interchangeability is not the single gear, but any pair of gears. This means selective assembling and is not in the strictest sense absolute interchangeability. It has the merit, however, of giving good gearing at a fraction of the cost of "interchangeability of each gear."

WALTER G. GROOCKOCK.

Guilford, England.

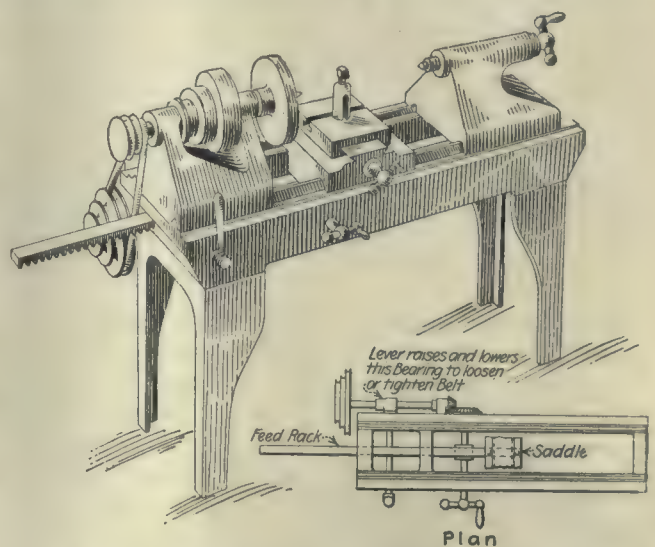
A Country Repair Shop

The recent articles describing the equipment and some of the older employees of the Douglas pump shop at Middletown, Conn., pp. 529 and 591, has called to mind another interesting shop, though a small one, situated in the same locality. It is some twenty miles farther down the Connecticut River, in the village of Deep River, and for forty years past—possibly a great deal longer—it has been the center toward which all the machine repair work of the lower section of the county has gravitated.

The presiding genius of the shop, and since its establishment its sole proprietor and oftentimes its sole employee, is Charles Doane, always referred to by contemporaries as "Charlie" Doane, a mechanic still in fair health and in the possession of his skill as a workman, though approaching his 84th birthday. He is in every sense a typical Yankee mechanic of the old school who all his life has been put up against jobs for the accomplishment of which he possessed few tools and no adequate equipment, but always making good by the exercise of that inborn ingenuity which in these oldtime mechanics was sharpened to a remarkable degree by the very necessity of accomplishing hereculean tasks with practically nothing to work with.

My earliest recollection of both the man and shop dates back into the 80's, when as a boy I was sent by my father to get a broken part of his sawmill repaired. I found the shop, but no evidence of life or activity. Inquiring at his house, nearby, I was informed that he was probably hoeing corn in the field near the shop, but if not there had "gone over to town." I found him, among the rows of corn, and told him I had a rush job—that a feed shaft on my father's sawmill had broken, and the hands would be idle until my return. He replied that as soon as he "hoed to the end of the row" he would look at it, an answer that in a few words characterized both the man and the whole school of master mechanics to which he belongs. Deliberation was the natural legacy of being continually forced to tackle jobs for which they had no tools but their brains.

The hoeing completed, we went over to the shop, a machine room of perhaps 30x60 ft., with a lean-to boiler house



OLD ENGINE LATHE WITH RACK FEED

at one end. At that time he had, besides the small two-cylinder vertical engine that furnished power, an equipment consisting of three lathes, a planer and a shaper; but it is my belief that in earlier years he had fewer tools, and possibly started with only the lathe, around which my recollections of the shop center. How old this lathe was, he himself did not know, but he did know that it was purchased second-hand and had seen considerable service in the year 1840. Judging from its design it would be surprising if it did not antedate the equipment described in the Middletown shop. Of the design of the bed and the head and tailstocks on this lathe I have only the haziest of recollections, but that the carriage had "power feed," and the peculiar manner in which this power feed was secured and controlled, I recall quite clearly, and in the illustration have shown the essential features of the feed mechanism.

It will be noted that there is no lead screw used, and no apron to the carriage. The carriage travel was obtained by a wheel and pinion attached to the bed and meshing into a long rack attached to the under side of the carriage. This pinion shaft extended through the back side of the bed and ended in a bevel gear. Along the back of the lathe will be noted a longitudinal shaft connecting to the crossfeed shaft by a bevel pinion, and driven from the lathe spindle by a round belt. Three cutting

speeds were obtained from the three-step cone for the feed belt. The method of throwing the feed in and out consisted of tightening or slackening the feed belt by raising or lowering the cone end of the back-feed shaft with a cone and lever. But the feature of this lathe most easily recalled is the rack. When the carriage was near the headstock, this rack projected from the head end of the lathe about three feet, and had a habit of catching the unwary in the region of the belt line, with a prod that was long to be remembered.

The shop had no milling machine, but the genius of the man had overcome this difficulty by devising two attachments by which he converted his shaper into a miller. He removed the tool slide from the ram, and bolted on a milling head which was belt-driven from a special jack-shaft put up for the purpose, plumb over the average working position of the milling spindle. The second attachment was a screw feed device, bolted to the bed and to the ram, by means of which he fed the ram and milling head at the proper cutting speed. The work was then clamped to the shaper table or in the vise, and almost any milling job that came to hand in such a shop could be done. It is not probable that this man was the first to convert a shaper into a miller, but the idea of doing it and the method of accomplishing it in that particular shop were original products of his brain and entitle him to full credit, even though somewhere else and unknown to him another man did the same thing at an earlier period.

Not the least interesting thing in this shop is the steam engine. It is of the tandem, vertical type, with crankshaft at the top, the bearings being supported on rod columns, with the driving pulley between bearings and the disk cranks at the outer ends. The remarkable thing about this engine is that it was built complete down to the most minute detail, in that shop and by Mr. Doane and his oldest son, then a boy just starting his apprenticeship. The old relic that had furnished power up to that time (about 1885) had gone back on them of a sudden, and the greater part of the work on this new engine was done by hand, father and son taking turns on "pulling the belt" for all the machine operations.

A modern mechanic could spend days in this shop, listening to the old man relate his experiences in accomplishing things where others had failed, and in going over the collection of "special tools" accumulated from sixty-five years of experience—a "bunch of junk" to the casual observer, but of absorbing interest to the man who appreciates the ingenuity they represent.

None the less interesting would be a record of the men who at one time and another have passed under the tutelage of "Charlie" Doane. The writer knows perhaps a dozen now scattered all over southern New England, but that knowledge is limited to only a few years, whereas the shop and the man have been a source of mechanical education in that section for three generations.

W. Philadelphia, Penn.

F. H. BOGART.

The Actual Sizes of Drills

Mr. Shirley, on page 777, wants to know what size a drill should be, to the nearest $1/10000$ in. Twist drills, as a rule, are made tapering, being very nearly exact size near the shank and several thousandths over size at the point, varying of course according to size. For instance,

a $1\frac{1}{2}$ -in. drill often comes two thousandths over size at the point, while a 2-in. drill often comes four or five thousandths over size.

As for measuring drills in ten thousandths, I do not consider it important enough to go to the extra trouble. Neither do the makers, probably, as the drills soon get smaller with use until they are several thousandths under size. As to Mr. Shirley's second query, "What size hole should it drill in tool steel or cast iron?" I will say that it will invariably drill over size in either metal, even though a small lead hole has been drilled.

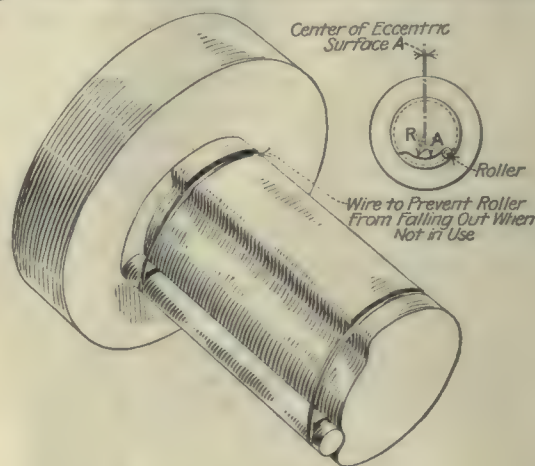
Replying to the third query, if Mr. Shirley wishes a correct finish he will have to use two drills before he uses the reamer. For example, if a $3/4$ -in. reamed hole is desired, drill first with an $1\frac{1}{8}$ drill, follow with a $47/64$ -in. drill, and the result will be a good straight hole that will give the reamer a decent chance to do good work.

Janesville, Wis.

J. A. RAUGHT.

Arbor for Machining Rollers

In the article by Donald A. Hampson, on page 244, the arbor illustrated is not suitable for work of larger size, although it may hold where the cut is light or for filing. The reason for this is that when the work is put



HOW TO SHAPE THE ARBOR

on the arbor and twisted, the rod has a tendency to climb up or bind. The angle is too great; and when the pressure of the cut is applied, will slip around the work. The accompanying illustration shows how this difficulty can be avoided.

WALTER JORGENSEN.

Davenport, Iowa.

How Would You Produce This Casting?

The casting shown on page 318 can be molded in two ways—using green sand and a two-piece flask. I have had similar castings made, differing only in dimensions.

The casting illustrated can be molded by making the bosses loose pieces. This is the way a jobbing or repair shop would tackle a few pieces in emergency jobs with skilled molders. The second method is to use a core for the inside of the casting. This is the quickest way and does not require much skill in molding. The item of expense is the core box and core. This last method I have seen successfully practiced for many years.

Brooklyn, N. Y.

G. STROM.

Editorials

Seventeen-Million Dollar Tax on Intelligence

Yes, you have read the title correctly—a *tax*, not a premium. Not on our daily physical necessities, nor on our more or less dispensable luxuries, but on information—the one thing that is essential to the development of the mind. And this is proposed in the Congress of the United States of America in the year A. D. 1916.

✽

The greatness of a nation may be measured by the extent to which it fosters the enlightenment of its citizens. No statesman, even of present-day average caliber, would be foolhardy enough to oppose the public-school system. A stand in favor of restricting the teaching of reading, writing and arithmetic would be unthought of by the most unthinking politician. It would have the deserved effect of terminating his public life as abruptly as a well-aimed hand grenade would blot him out physically.

Yet reading, writing and arithmetic are merely the tools one uses to acquire the further information that is to be of use to himself, to the community and to the state. The three R's never built a railroad, or ran one. Beyond the education given in public schools must come acquirement of the knowledge of how to do things—that is the basis of material prosperity; and the knowledge of how to think—which is the basis of culture. A small percentage of our population obtains this additional knowledge in universities; another small percentage absorbs it from personal experience, but the great majority of us must get it by reading educational books and periodicals.

✽

The more one sees of the limited vision of some present-day politicians the more he admires the wise and far-seeing statesmanship of past generations that led to the unification of our country in ideals and ideas. They were men who could look a deficit in the face without becoming hysterical, provided the deficit was of such a nature as to be a tremendous national asset in disguise. They were men who in days of depleted national revenue could formulate the wise policy of exempting schools and colleges from taxation, thereby placing a premium on intelligence. And not stopping with educational institutions, but realizing that knowledge and information are sought as often in the pages of periodicals as in the classroom, they took a step toward encouraging those who were ambitious to read and keep informed, by boldly cutting in half the Governmental postal revenue upon these periodicals.

Bear in mind that this was at a time when the stage-coach and pony express still carried a large portion of the mail to the remote parts of our country. It was at the time when the Post Office Department was confronted with a heavy deficit at the close of each fiscal year—not such a time as the present when it earns a surplus, as reported by Postmaster-General Burleson within the last few days!

And now comes the tax on intelligence that will add a burden of \$17,000,000 upon those who are ambitious enough to keep themselves informed on current events or to possess themselves of up-to-the-minute information on developments in the arts, professions or trades.

On Dec. 9 the House Committee on Post Offices voted to include as a legislative rider on the Post Office Bill an amendment fathered by Representative Randall of California, applying the zone system, as applied to parcel post, to all second-class mail matter. Instead of the present flat rate of 1c. per lb., or an increased rate of 1½c. per lb., as advocated by Mr. Burleson, this committee makes the unthinkable proposal to discriminate against those American citizens who live remote from publication centers by taxing them as high as 6c. per lb. postage on all of their magazines, periodicals and newspapers. And this in spite of the fact that the Postmaster-General had recommended that the question be postponed until it could be ascertained what effect the change would have on the spread of educational periodicals.

✽

The *American Machinist* has no quarrel with honest and intelligent postal reform. Nor, we are sure, have our readers any desire to defraud the Government of what justly belongs to it. But neither you nor we should sit idly by and permit a few unthinking representatives who can see no further than next year's budget to upset the broad-minded policies set down by wise and far-seeing statesmen. Just *two days* after the Post Office Bill was reported, this ridiculous rider was jammed through the committee. Two days to reflect upon a measure that will take \$17,000,000 out of the pockets of the people who subscribe to periodicals! Hurrah, boys, hurrah; down with the cost of living and up with the cost of learning! Off with the tax on drinkables and on with the tax on thinkables! Let's give Shoats Corners, Wash., \$500,000 for a marble post office and soak Tom Jones, who goes there to get his *American Machinist* every week, \$5 a year extra for postage on his favorite paper!

✽

We have not exaggerated this case a particle. The zone system as proposed for all periodicals proposes an increasing rate similar to the parcel post, culminating in 6c. per lb. for a distance of 1,800 mi. or over. The present rate is a flat one of 1c. per lb. anywhere in the United States. The weight of the Dec. 7 issue of the *American Machinist* was 33 oz. The average in November was 1.7 lb. Readers who live 1,800 mi. or more distant from New York are to be penalized approximately \$5 each per year for being ambitious enough to desire to keep posted on machine-shop practice, because apparently of their bad taste in not picking out a publication center as a place of residence.

The revenue last year on 1c. postage was in round numbers \$11,500,000. Mr. Randall, the author of this (headless) rider, estimates that the *average* second-class rate as proposed will amount to 2½c. per lb. Here is a net in-

crease of \$17,225,000. Bearing in mind that the Post Office Department earned a surplus last year, compare this boost of 150 per cent. with the cut of 50 per cent. made by the statesmen of 1885. Either we must be getting too much intelligence, or certain politicians must be having too little of it!

If the Congressmen of the United States really desire to institute postal reform, let them begin at home. There is a golden opportunity for reform in the franking privilege under which grand pianos and household furniture have been sent *by mail*, and through which every voter in the country is prior to election deluged with personal propaganda concerning the merits and achievements of the representative from his district. "To him who hath shall be given" is biblical, and true; but why should the fellow who is lucky enough to be in office avoid the postage incidental to reelection, while his more unfortunate rival who is looking for the job is forced to attach a 2c. stamp to every letter that he sends in search of votes?

The Post Office Department seems to be the most obliging department of the Government. It is not enough that the Agricultural Department sees fit to distribute free seeds through Congressmen to Tom, Dick and Harry—but our post office must also carry the seeds gratis. Possibly if the recipients wanted them badly enough to pay postage, there would not be so many of these gifts thrown away, to say nothing of the increased postal revenue that would result. The idea, of course, is to improve the agricultural art—no one will find fault with this ambition, even with potatoes at \$2 a bushel and a Ford on every farm. But why, since we are a mechanical and manufacturing as well as an agricultural people, make the machine-shop man and the readers of other instructive periodicals pay the postage on Farmer Jones' seeds?

§

That this rider is not a sincere effort justly to apportion expense is undeniably manifested in that it specifies the retention of the free-in-county distribution of periodicals. In other words, the Government will undertake to distribute free of charge through its postal system the circulation of any newspaper unimportant enough not to go outside of the county in which it is published. And this distribution is in large part through the most expensive branch of the postal service—the rural free delivery. A goodly portion of that \$5 annual tax that Tom Jones will be asked to pay in extra postage on his *American Machinist* will go toward carrying, free of charge, the *Bugville Bugle* to Farmer Perkins, who lives 10 mi. from town on a free-delivery route! What with the free postage on seeds and the free postage on county newspapers, it looks as if we industrialists should be able to learn something about scientific management from the agriculturists.

Legislation that is rushed through a committee in two days cannot be discriminating, and discrimination is essential to just enactments. It would be idle to say that there are no abuses of the second-class mail rate, but it would be unjust if educational periodicals are compelled to suffer for the sins of others. We recognize the justice of taxing theatrical property and exempting school property—why not distinguish similarly between periodicals which instruct and those which amuse? Why place obstacles in the way of the circulation of reputable technical, trade and religious periodicals because certain unscrupulous

publications parade their self advertising at second-class rates under the cloak of a nominal subscription price?

It is argued that trade publications should suffer this unjust discrimination because of the advertising that they carry. You cannot separate the advertising from the editorial pages of a trade or technical publication and say: "These pages are educational because editorial; and these pages are not, because they are advertising." Advertising pages in a technical paper are informative. They do not correspond with the unrelated advertisements in the popular magazines, which have nothing in common with their editorial contents. Advertisements in technical papers are localized news items, invaluable to the man in the profession. All new developments in the mechanical line, when developed and proved successful, are considered to be fit for description in the editorial columns *once*. After that, they go into the advertising section. But to the man who has not had the issue in which they were described editorially, they are bona fide items of news and information, no matter in what part of the paper they are published.

And do not forget that the second-class mail matter is the inspiration that calls into existence a large part of the first-class mail. Ten thousand inquiries have been known to originate from a single page of advertising matter—inquiries that took ten thousand 2c. stamps to send to their destinations, and ten thousand more for the first reply.

§

We are not stating these facts because we are publishers of technical papers; but because, being publishers of technical papers, we see perhaps more clearly than others would see it the gross injustice that this proposed rider attempts to perpetrate upon the reading public who must ultimately pay the bill.

We object to the narrow-minded class legislation that would penalize the man who must get his education largely through reading.

We object to the unjust sectionalism that divides this country into a ring of zones, each ring imposing an additional handicap on the spread of information.

We object to the distinction that makes the mechanic pay the farmer's bill for postage.

We object to the step backward that we will take as a nation if we discourage intelligence.

§

And you, Mr. Randall—do you, as the father of this proposal to tax intelligence, realize its consequences to the people of your own state? Do you realize that you are doubling the cost of nine-tenths of the reading matter that goes to the citizens of California—that you are placing a serious obstacle in the path of the mechanics in California's shops, the civil engineers who build California's bridges, the mining engineers who develop California's mineral resources?

You, and the *county weekly that you own* and that the Government circulates to your subscribers free of charge, will not be hurt by this bill, Mr. Randall: but the men in your state who are interested in things that occur outside of *your* county will be hurt, and we venture to say that they outnumber you a million to one.

§

And you, Mr. Reader, make it a point, as a patriotic citizen, to write your Congressman that you heartily disapprove of the Randall tax on intelligence.

Shop Equipment News

Collapsible Taps for Unlimited Thread Depths

The collapsible tap shown is one of the line that has been designed and put on the market by the National Acme Manufacturing Co., Cleveland, Ohio. The body and shank of this tap are of no greater dimensions than the cutting diameter of its chasers. Since the extreme diameter is the cutting size of the tap, there is no limit of

depth to which the work can be tapped except the length of the shank, which can be made as long as necessary.

The chasers are supported through their entire length during the cutting. The operation of these taps is similar to that of the self-opening dies made by the same company. They may be used on either drilling machines or chucking machines. Where the depth of the hole from a front surface varies, an outside trip may be furnished, the use of which insures collapsing at a given depth. This line of taps is known as the Namco and is made in 13 sizes ranging from 1 in. to $6\frac{1}{4}$ in. in capacity.

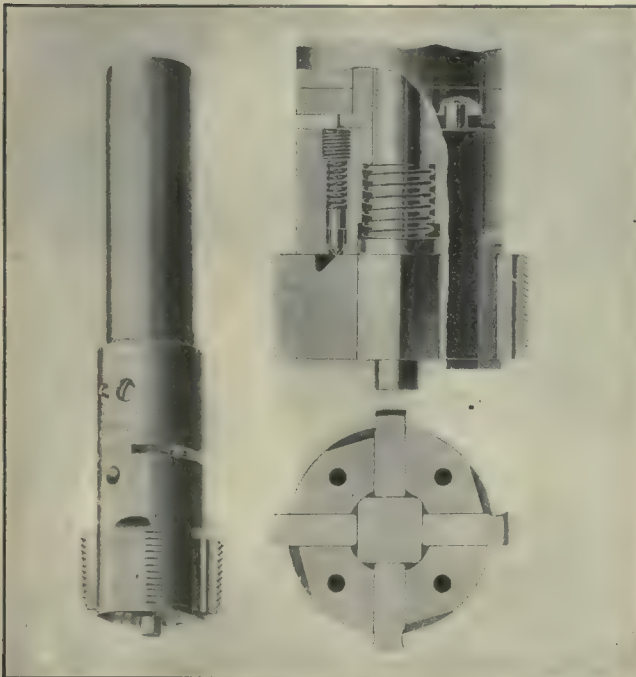
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Heavy Turret Lathe for Chuck and Bar Work

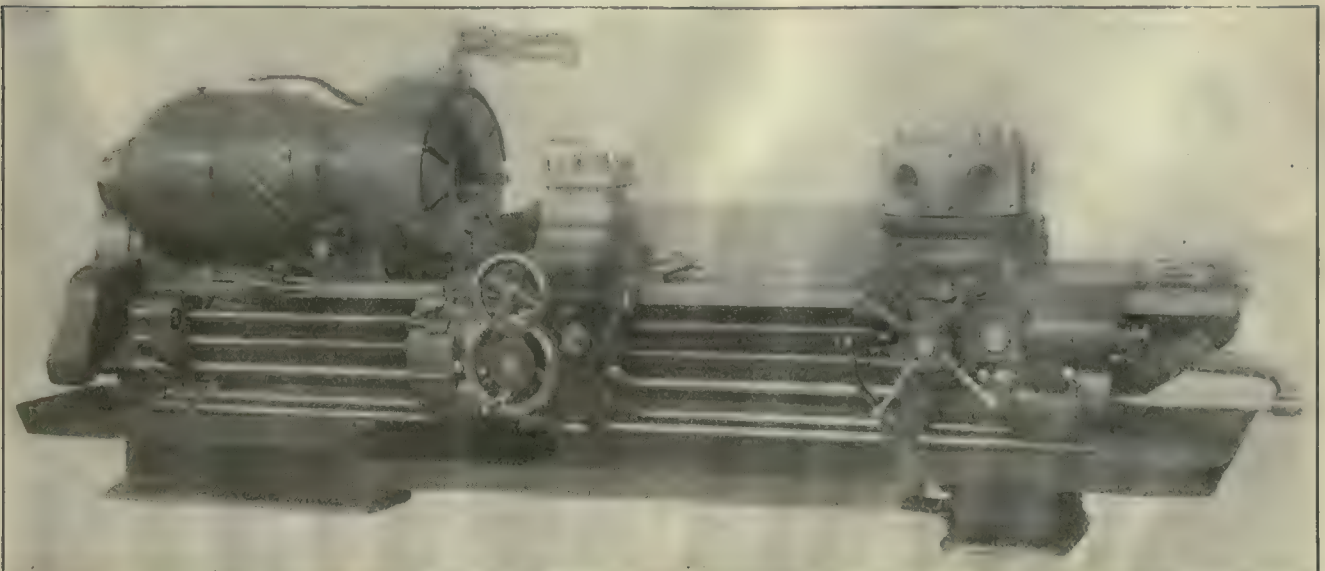
The illustration represents the latest addition to the line of Libby turret lathes manufactured by the International Machine Tool Co., of Indianapolis, Ind.

This is a 26-in. all-gear drive turret lathe adapted for both bar and chucking work. The two gears that drive the spindle are located one on either side of and close to the front main belt. The chuck ring gear is 22 in. in diameter, 4 in. face and is keyed and bolted solidly to an 11-in. flange forged on the spindle. All headstock bearings are of phosphor bronze.

The machine is built with two sizes of spindle bore— $4\frac{1}{2}$ and $7\frac{1}{2}$ in. The latter is especially designed for heavy bar work, such as locomotive crosshead and knuckle-joint pins, shrapnel, automobile transmission gears and the like. This machine has a single pulley drive operating through an all-gear headstock with eight speed changes through gears and frictions. Power rapid traverse is provided for both turret and toolpost carriages operating at the rate of 35 ft. per min.



SIDE VIEW AND SECTIONAL VIEW OF THE NAMCO COLLAPSIBLE TAP.



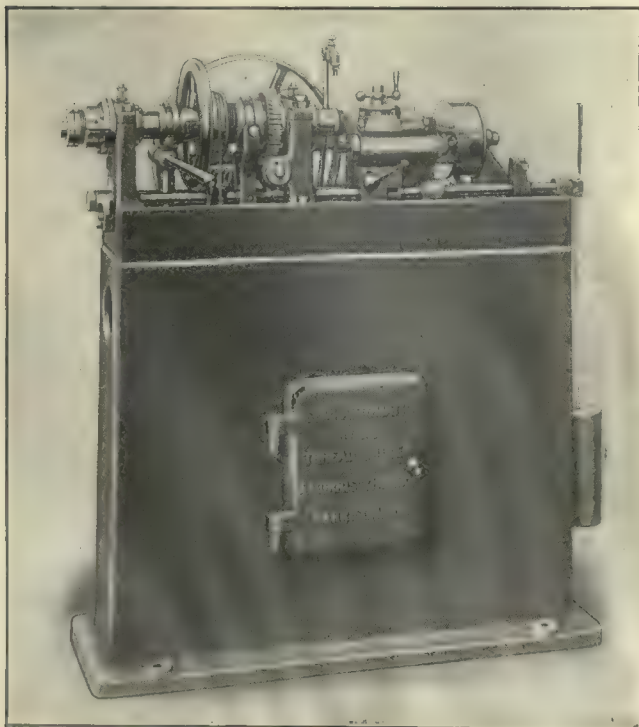
HIGH-POWER 26-IN. HEAVY TURRET LATHE

Swing over ways, 26 in.; swing over carriage, 24 in.; travel of turret carriage, 72 in.; travel of toolpost carriage, 72 in.; holes in turret, $4\frac{1}{2}$ in.; diameter of driving pulley, 18 in.; width of driving belt, 6 in.; extreme floor space, 6x17 ft. by 57 in. radius sweep of bar; net weight, 12,000 lb.

Semi-Automatic Thread Miller

The machine shown in the illustration was designed for milling threads on rifle barrels, fuse bodies and similar pieces, and is adapted for milling threads on any piece up to 2 in. in diameter if short (as for instance a fuse body) or to $1\frac{1}{4}$ in. if long (as a rifle barrel). The work is held in a collet chuck operated by a hand lever, as in a screw machine. The cutter is set in a vertical head and is adjusted for depth of cut by a screw with micrometer dial. It is advanced into the work by a cam operated by a hand lever and is withdrawn automatically when the thread is completed. This arrangement in practice is found to give uniformity in the size of thread and is fast, as the operator does not have to give any thought to the depth of the cut once the correct adjustment has been obtained. The work spindle is rotated by a worm and wheel acting through a clutch. This clutch is engaged by the same lever that advances the cutter into the work, thus saving a movement on the part of the operator. On completion of a revolution of the work spindle the thread is completed, and the cutter is automatically withdrawn and the work spindle stopped. This spindle is returned, by a weight, to its initial starting position, here again saving the operator a movement. Bronze primers having 14 pitch threads $1\frac{3}{16}$ in. in diameter and $\frac{1}{2}$ in. long can be cut at the rate of 120 per hr., and equally good time can be made on aluminum alloy fuse bodies $2\frac{1}{2}$ in. by 14 threads Whitworth.

In the reservoir the fine cuttings are automatically



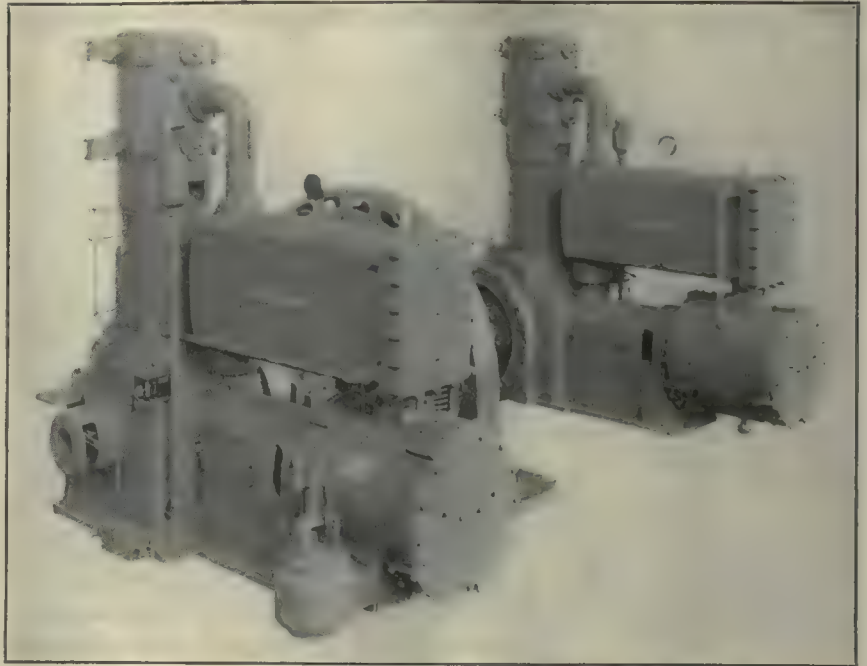
SEMI-AUTOMATIC THREAD MILLER

separated from the liquid and kept from the pump. The machine weighs 1,000 lb. It is one of a line built by the T. C. M. Manufacturing Co., Harrison, N. J.

✱

Twin-Angle Compound Air Compressor

As the name implies, the Twin-Angle compound air compressor consists of two complete compressors of the angle compound type set side by side on a common found-



TWIN-ANGLE COMPRESSOR FOR VARIABLE CAPACITY

dation and driven by a common shaft. This shaft is provided with couplings at each end, so that either compressor may be cut out in case the amount of air needed over a considerable period is less than one-half the total capacity of the compressor.

This machine is arranged to be driven by either motor or belt and is a product of the Sullivan Machinery Co., Chicago, Ill. It is equipped with a novel type of plate valve.

✱

Knurling Brake-Lever Tubes for a Forced Fit

BY W. THOMPSON

Our former practice of assembling brake levers on automobile rear-axle brake tubes was to key lever and tube, assemble and braze. This produced a permanent job, but caused a great amount of trouble in removing flux from the bore of the tube and cleaning the tube and lever, a drawback that caused serious inconvenience and delay and ran up the cost of manufacture to a point that called for decided action.

To overcome this trouble we resorted to knurling the tubes with a $\frac{3}{16}$ -in. pitch straight knurl $\frac{1}{2}$ in. wide. This method insured the lever being a good drive fit on the tube, which assisted by the key proved to be just as satisfactory as the brazed job at one-half the expense. Up to date we have produced nearly 100,000 tubes in this manner and have had no rejections.

New York Industrial Congress-- A Meeting of Pioneers

By L. P. ALFORD

SYNOPSIS—The first congress held under the auspices of the Industrial Commission of the State of New York devoted four days to a discussion of accident prevention and health preservation. The spirit exhibited throughout was that of the pioneer—one who bravely and vigorously attacks a great problem of human suffering and economic waste.

Everyone admires the courage of the pioneer. The frontier—his home—is dear to every American. Its dangers are well known, and the brave spirit that dares to face them belongs only to those who deserve to conquer.

Accident, privation and disease are a part of the daily hazards of the pioneer. To him the unbridged river is a menace, the mountain cliff is a spot of danger, the overhanging ledge holds the possibility of sudden death, the untracked forest promises little except starvation. To a very great degree these hardships have disappeared in our country. But in their place has come to our industrial people a new set of hazards. Think what such figures as these mean!

Each year 35,000 men lose their lives in American industry. Each year 2,000,000 workers are seriously injured. In the State of New York alone during the year 1916 there will have occurred the great total of 60,000 industrial accidents. Of this number 1,500 will have produced death. The number of persons permanently and totally disabled will be 120. The number who will be partly and permanently disabled will be 6,180. The daily cost of these accidents is \$40,000. The yearly cost of compensation will reach the huge total of \$11,500,000.

The forces of Nature that were once faced single-handed by the pioneer have been chained for industry, but have also become a Frankenstein. Every year Nature's power, but partly controlled, breaks over man's bonds and takes a huge toll of human life.

The force of a river torrent that the pioneer bravely dared at his crossing, is harnessed to supply power to drive trains and move machinery. And these same trains and machines kill men—it is the force of the river exerted in another way. The same force of gravity that pulled the pioneer from the top of the cliff to death on the mountain side, also pulls the workman down the elevator shaft, or from the edge of the roof, or from the scaffolding. The same force that brought down a boulder from the overhanging ledge upon the unfortunate settler below brings down the countershaft or heavy casting in the shop, or the brick or piece of timber from the top of the building.

Man faces hazards today, as he has always faced them. The dangers of the early days have largely disappeared as our wild continent has been subdued. In their place are the dangers of industry. Can we not truly call the men who are leading the safety-first movement the pioneers of today?

This thought was brought out in the sessions of the New York State Industrial Congress held in Syracuse, N. Y.,

Dec. 11 to 14. It was the first meeting of its kind ever held in the Empire State. This fact may have contributed to the spirit shown. But the viewpoint of the pioneer came out in another way.

The man who is putting his life into the safety-first movement, remembering that his father was killed on a railroad and his uncle crushed in a rolling mill, feels something as did the early settler who bridged a torrent where a friend was washed away, or who cut a road along a mountain cliff where a relative slipped to his death. A bit of the feeling of the crusader is in the man who is working to safeguard industrial conditions and who cannot forget that his youthful sweetheart walked through the unlocked doors of an elevator and was killed at the bottom of the shaft.

Safety experts, employers and employees all showed the same enthusiasm in discussing the results already obtained, and planning for the future. Coöperation has been established between the industrial commissions of three great states, New York, Pennsylvania and New Jersey. The object sought is the unifying and standardizing of methods and devices. This of itself is an accomplishment. And in private plants concrete results of the greatest significance have already been recorded.

The United States Steel Corporation estimates that since 1906 its safety work has saved the lives of over 14,000 men and a million dollars in money. Those 14,000 wage earners and their families mean a city of 70,000 persons. Is it not a result worthy of the pioneer spirit to have conserved the homes and well-being of a community of that size?

During the last five years the president of every great railroad in the United States has backed the safety-first movement with his influence and the funds of his road. The State of Wisconsin has reduced the number of accidents to its industrial workers by 61 per cent. during the same period. A great smelting plant in the West has reduced its lost time to one-tenth of what it formerly was. One of the largest paper mills in the country has gone for twelve months without a single accident causing disability for 24 hours. During the past year, eight establishments in the State of New York have reduced the number of their accidents by from 30 to 62 per cent. through observing modern safety methods. One firm in the same state has reduced its hazards and accidents by 75 per cent. during the same period.

Are not these revealing facts!

They show what has been accomplished, what can be achieved. But they give no hint of the suffering and misery that has been prevented. This is the greatest result of all. Only by a thoughtful study of the statistics can one begin to visualize in a slight degree how much pain and anguish industrial accidents bring to workers and their dependents. There is probably no daylight hour which does not see a mourning group around some newly dug grave, whose occupant was killed in industry. No moment of day or night is free from human pain caused by some industrial accident. And the pity of it all is that many of these injuries are preventable.

American Institute of Weights and Measures

The assembling of engineers and manufacturers in New York City to attend the annual meeting of the American Society of Mechanical Engineers was taken advantage of to perfect the organization of a new association to deal with matters relating to weights and measures. This meeting for organization was held on Friday afternoon, Dec. 8.

The objects of the society, its membership, their dues and the number and duties of its officers are set forth in the brief constitution of the institute. This is quoted in full below:

Article I, Name—The name of this association shall be the American Institute of Weights and Measures.

Article II, Objects—The objects of the institute shall be:

Section 1. The maintenance and improvement of our present (English) system of weights and measures, for the good of our commerce and industry and the well-being of our country.

Sec. 2. The education of the people with respect to the importance of our weights and measures, through the dissemination of correct information with respect to them and to the danger inherent in changes of our basic standards of measurement.

Sec. 3. The improvement of old and the development of additional standards as they may be needed by reason of new conditions in commerce, industry, science and engineering.

Sec. 4. The promotion of wise legislation for the conservation of our basic English units of weight and measure, and opposition to hasty and ill-considered legislation involving changes from our fundamental English standards.

These objects shall be promoted:

Sec. 5. By the investigation of weights and measures in all their applications, including their actual use in foreign countries.

Sec. 6. By the publication, as occasion may require, of an official bulletin giving the results of these investigations and other pertinent information, the bulletin to be distributed to members of the institute, manufacturers, engineers, members of Congress, and Federal, state, municipal and other officials in charge of weights and measures, and to the public.

Sec. 7. By the collection, classification and custody of records relating to weights and measures, and by placing such records in permanent and accessible form.

Sec. 8. By the delivery of lectures and addresses, and by participation in discussions before scientific, educational, engineering, manufacturing and other public organizations.

Sec. 9. By the preparation of pertinent articles for publication in periodicals and the public press.

Sec. 10. By correspondence with newspapers, and especially by preparing answers to all published articles which are antagonistic to the purposes of the institute.

Sec. 11. By the scrutiny and analysis of proposed legislation relating to weights and measures, both Federal and state; by the presentation of relevant facts and arguments to legislators, to legislative committees and to the public; and by the scrutiny of acts and policies of government officials with respect to weights and measures.

Sec. 12. By coöperation with other associations having similar objects, in this and other countries.

Sec. 13. By such other means as may from time to time appear expedient.

Article III, Membership—There shall be three grades of membership: Association, Corporation and Individual.

Manufacturing, commercial, agricultural, transportation, engineering and other societies or associations in sympathy with the objects of the institute shall be eligible to Association membership.

Manufacturing, commercial, agricultural, transportation and other corporations and firms in sympathy with the objects of the institute shall be eligible to Corporation membership.

Individuals in sympathy with the objects of the institute shall be eligible to Individual membership.

Association and Corporation members may each designate an individual to represent them in the affairs of the institute, and such representative shall be eligible to election as a member of the council.

All classes of members shall have equal privileges and voting powers. Foreign associations, corporations, firms and individuals shall be eligible to membership on the same terms and shall have the same privileges as American associations, corporations, firms and individuals.

Article IV, Dues—The annual dues of Association members shall be \$100 for associations which are national in scope, and \$25 for all others.

The annual dues of Corporation members employing less than 500 employees shall be \$25, and of those employing more than 500 and less than 1,000 employees shall be \$50, and shall then increase at the rate of \$25 for each additional thousand employees or fraction thereof up to a maximum of \$500.

The annual dues of Individual members shall be \$5.

Article V, Officers—Section 1. The affairs of the Institute shall be managed by a council of 15 members, or representatives of Association and Corporation members, to be elected annually through a ballot by mail. The council shall elect from its membership a president, one or more vice-presidents and a treasurer. From the council the president shall appoint an executive committee of five members, of which he shall be one, which shall have supervisory charge of the affairs and management of the institute.

Sec. 2. The council may employ a commissioner and also an associate commissioner, who, under the president and the executive committee, shall have charge of the offices and activities of the institute, and shall speak, write and otherwise act for the institute as its authorized representatives. The commissioner shall also act as secretary and shall have authority, under the executive committee, to employ such office staff as may be necessary.

Sec. 3. There shall be prepared and sent to all members quarterly reports, giving a summary of the activities of the institute and of the results accomplished by it, to the end that the members may be kept in touch with its work.

Sec. 4. Vacancies in the council arising through disability, death or resignation may be filled for the unexpired term by the remaining members of the council.

Article VI, Meetings—The annual meeting of the institute shall be held in the month of December, as may be designated by the council.

Article VII, Amendments—Amendments to this constitution may be made on the initiative of the council, or of any 10 members acting in concert through a written communication to the council. Such amendments, when passed by a three-fourths vote of the council and sent by mail to the members through the bulletin or otherwise, shall become immediately effective.

Trade Catalogs

Musco Solidified Oil Lubricant. Sun Co., Toledo, Ohio.

Portable Tool Holder. Jackson, Schmitz & Shanks Engineering Co., Chicago, Ill.

Hand-Operated Traveling Cranes. Victor R. Browning & Co., Cleveland, Ohio. Pp. 4; 6x9 in.; illustrated.

Horton Chucks. The E. Horton & Son Co., Windsor Locks, Conn. Catalog No. 16. Pp. 42; 4x7 in.; illustrated.

Electric Welding. Wilson Welder and Metals Co., Inc., New York City. Catalog No. 1. Pp. 64; 6x9 in.; illustrated.

W. & B. Boring and Grinding Attachment. John Gibson, 210 Drumm St., San Francisco, Calif. Pp. 11; 3x6 in.; illustrated.

Forthcoming Meetings

Society of Automobile Engineers. Annual meeting, Jan. 9-11. United Engineers Building, New York City. Colver F. Clarkson, secretary, 29 West 39th St., New York City.

American Society of Mechanical Engineers. Monthly meeting, first Tuesday. Calvin W. Rice, secretary, 29 West 39th St., New York City.

Boston Branch National Metal Trades Association. Monthly meeting on first Wednesday of each month, Young's Hotel. W. W. Poole, secretary, 40 Central St., Boston, Mass.

Providence Association of Mechanical Engineers. Monthly meeting, fourth Wednesday of each month. J. A. Brooks, secretary, Brown University, Providence, R. I.

New England Foundrymen's Association. Regular meeting, second Wednesday of each month, Exchange Club, Boston, Mass. Fred F. Stockwell, 205 Broadway, Cambridgeport, Mass.

Engineers' Society of Western Pennsylvania. Monthly meeting, third Tuesday; section meeting, first Tuesday. Elmer K. Hiles, secretary, Oliver Building, Pittsburgh, Penn.

Rochester Society of Technical Draftsmen. Monthly meeting, last Thursday. O. L. Angevine, Jr., secretary, 857 Genesee St., Rochester, N. Y.

Superintendents' and Foremen's Club of Cleveland. Monthly meeting, third Saturday. Philip Frankel, secretary, 310 New England Building, Cleveland, Ohio.

Western Society of Engineers, Chicago, Ill. Regular meeting, first Wednesday evening of each month, excepting July and August. J. H. Warder, secretary, 1785 Monadnock Block, Chicago, Ill.

Philadelphia Foundrymen's Association. Meetings first Wednesday of each month, Manufacturers' Club, Philadelphia, Penn. Howard Evans, secretary, Pier 45 North, Philadelphia, Penn.

Technical League of America. Regular meeting, second Friday of each month. Oscar S. Teale, secretary, 35 Broadway, New York City.

Building Laundry Machinery

By FRANK A. STANLEY

SYNOPSIS—The work considered in this article includes among other things the drilling of steam-drier ends to receive the studs for holding the heads, two special supports with roller rests being utilized to permit free indexing of the castings in front of the horizontal drilling spindle; also the machining of small brass castings, brackets and the like with simple chucking fixtures.

In an earlier article a detailed description was given of an improved type of laundry mangle or flat-work ironer, built by the Watts Laundry Machinery Co., Willi-

Watts type of ironer two steam cylinders are used, and in the larger-sized machine they are 30 in. in diameter by 120 in. long.

Such driers are built up of a plain cylindrical casting suitably ribbed inside for additional strength, bored out at the ends to receive the heads, which have long necks turned up to form journals upon which the cylinder may rotate. The heads are secured in position on the cylinder by studs and nuts in the same way that steam-engine cylinder heads are customarily attached.

One of these driers is shown in the lathe in Fig. 1, mounted upon its own journals and turned—ready for polishing. The method of steadying the job in the lathe



FIG. 1. LAUNDRY-MANGLE DRIER ON THE LATHE

mantic, Conn. The accompanying illustrations represent some further operations recently seen in this shop and also touch upon certain unusual features of design intimately connected with apparatus of this character seldom seen in establishments building other classes of machinery.

All mangles or clothes ironers have a cast-iron drier of some kind or other, usually a cylinder in form, that carries steam pressure up to 75 or 100 lb. per sq.in. In the

with special bearing blocks carried upon plain fixtures spanning the ways will be apparent upon inspection of the photograph. A group of these driers will be noticed at the far end of the room, and a set of heads for three different cylinders may be seen resting against the front of the lathe bed. Although as a rule these cylinders are somewhat smaller in diameter than the drier commonly found in paper machines, they are in character practically the same. Their service is also similar in that they are

required to dry a damp material passed over their surface by an endless belt, or apron, of canvas.

It is necessary that such steam cylinders, carrying the pressure they do, should be sound. After machining they are tested hydrostatically to about 200 lb. pressure, in order that any imperfection in the casting, any blowholes or defects may be revealed by the leakage of water. This test also shows whether the fitting of the heads in place is properly done and whether there are any defects in the heads themselves or in the necks that constitute the bearing journals, through one of which in the case of each drier the steam pipe passes. The neck in that instance is of course bored out for stuffing-box and glands.

Owing to the length of these castings, they are somewhat awkward to handle in the process of drilling the holes for the head-holding studs. In the shop referred to, it is the practice to place the drier cylinder upon horses, as shown in Fig. 2, these being located at the end of a horizontal drilling and boring machine, which has already been illustrated in connection with special boring opera-

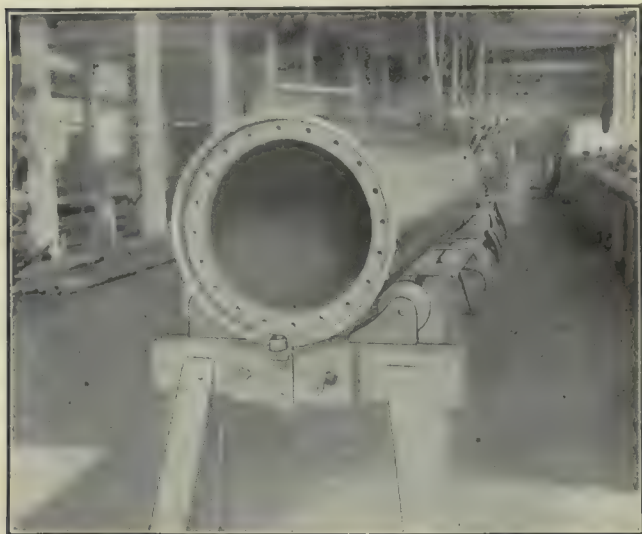


FIG. 2. DRILLING AND TAPPING DRIER-CYLINDER ENDS FOR THE HEADS

tions upon the frames and housings for this type of laundry ironer.

These horses are each provided with a pair of rolls upon which the cylindrical casting is free to rotate. Further, an end thrust roll is placed at the outer end, as seen in Fig. 2. Upon these horses the work is held level and securely for the drilling and tapping of each hole, the drill being guided through a templet or circular jig, fitting nicely in the chamber in the end of the cylinder just as the head is afterward put in place.

These seats at either end for the head and against which the drill jigs are placed are machined originally in the lathe by mounting the whole casting upon an arbor in the form of a spider that controls the work from the interior, at the same time leaving the outer ends free to receive the boring and facing tools necessary to machine the head seat. While the casting is held on this spider, the outside is turned. The assembling of the heads in the cylinder and then mounting the cylinder in the lathe, as in Fig. 1, upon its own journals in suitable bearing boxes, enables the final cut to be taken on the outside, bringing the casting into proper condition for the polishing of the exterior surface.

Reference has been made in a previous article to the pressure rolls and other rolls carrying the aprons for this ironing machine. These rolls are customarily made of heavy seamless drawn tubing, fitted with cast-iron heads at each end, the heads themselves being cast in the mold with steel journals, or gudgeons as they are commonly termed in the shops making such work. A set of such rolls is shown in Fig. 3, where 23 in number are represented in outline with their respective diameters and the number of each

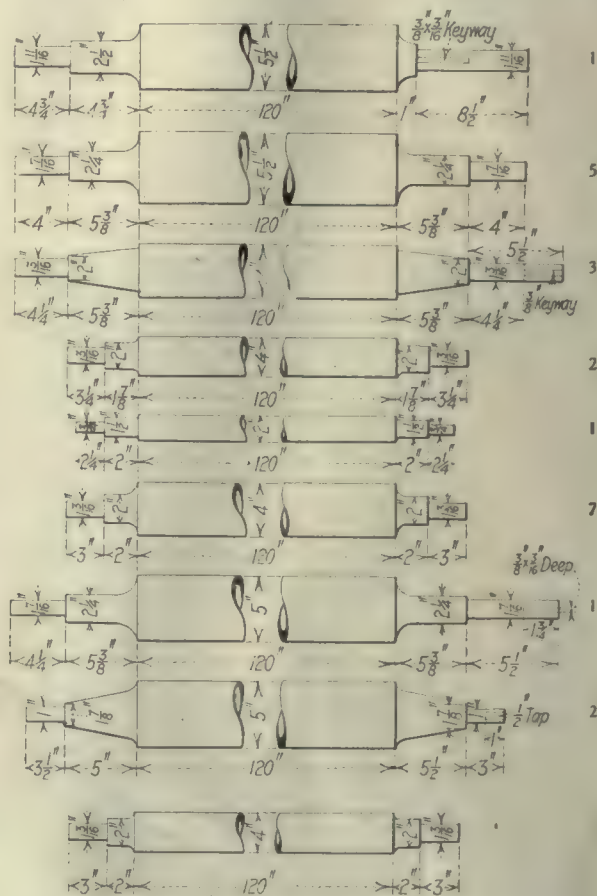


FIG. 3. SET OF ROLLS FOR CLOTHES IRONER

diameter required for the 120-in. machine referred to. Five of the tubes are numbered 1, 2, 3, 4, 5, and marked extra heavy; these are the five pressure tubes used over the top of the cylinder in the mangle for pressing the work against the drying surface of the steam cylinder. The other tubes are used mainly as idler rolls and tighteners for carrying the endless belt, known as the apron, around in contact with the surface of the drier cylinder.

The heads of these rolls are of the general form illustrated in Fig. 4. This is a typical head, the body of which is made to suit the inner diameter of the respective tube where it is to be used, the gudgeon or spindle for which is shown as $1\frac{3}{16}$ in. in diameter, although it may be even smaller or larger, the sizes usually being 1 in., $1\frac{3}{16}$ in., $1\frac{7}{16}$ in. and $1\frac{11}{16}$ in. The overall length of the head is about $10\frac{1}{4}$ in., and the diameter of the main portion of the body is about $2\frac{1}{4}$ in.

The gudgeon is a piece of steel turned with the roughest feed possible in the lathe, giving a deep scoring effect. $\frac{1}{8}$ or $\frac{3}{16}$ in. per turn. The portions that come immediately under the enlarged diameters on the roll head are scored to form an anchoring channel, as indicated by the dotted lines in the sketch. This gudgeon is placed in the

mold, where it is supported in seats formed by corresponding core prints on the pattern. Owing to its rough surface and scores, it is held securely in the casting when the latter is poured. Upon coming from the mold it is centered, squared off on the ends, placed on lathe centers, the outer end of the neck at the flange machined and the large diameters of the body turned for a shrink fit in the ends of the roll. The roll itself, made of tubing, is expanded by heating to admit the roll head, then allowed to cool and grip it tight. The tubing is usually about $\frac{1}{8}$ in. thick, although in some cases somewhat heavier than this. After the heads are both in place, the tube is finished upon the centers by grinding and polishing. There are a number of peculiarly shaped brackets and boxes on this type of machinery, and a bearing of this kind for roll No. 6 is illustrated in Fig. 5. This is an open box placed with the slot for the roll journal at an

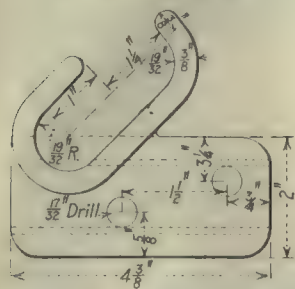


FIG. 5. BEARING FOR ROLL

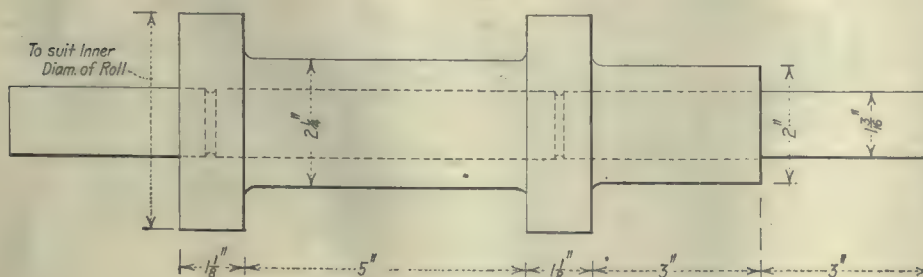


FIG. 4. CAST-IRON HEAD WITH STEEL SPINDLE OR GUDGEON FOR ROLLS

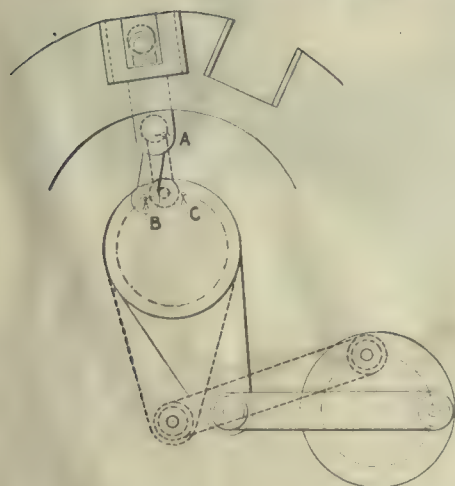


FIG. 7. DIAGRAM OF LAYOUT FOR OPERATING LINK CENTERS ON ROLL BOXES

angle of about 45 deg. and so proportioned that the roll may be easily dropped into place, but cannot then be pulled out until released by slackening its apron. This is an awkward piece to machine, and the work is accomplished by having it cast with a curved temporary wall approximating the curvature of the end of the casting itself, as indicated by the dotted line. This is set up on a fixture on the miller and the vertical spindle fitted with a cutter which is run down into the end of the job and

fed out to cut out the wall. There are several other brackets and boxes of similar nature where temporary walls cast in the work are cut out in machining operations in preference to having the metal entirely solid or to having the rough scale to remove on one or both sides of the part.

Fig. 6 illustrates a small part cast of brass, which has to be turned all over. The head must be closely sized and faced up to the body and a pipe thread cut on the opposite end. There is a hole about $\frac{3}{8}$ in. cored the whole length of the body.

Originally in making these it was a common practice to turn up the end taper and apply a pipe die, use a special dog threaded to fit the pipe thread on the casting, place this in a lathe, shove the tail center against the flanged end of the work, square up the flange and then turn down behind the inner face of the flanged end of the body. This was something of a nuisance, as in reaching down behind the flange some time was always lost and usually the tool needed resetting when changing from the squaring-down cut to the turning of the body.

To get around this, a change was made as follows: A drift is now shoved into the hole at the flanged end of the

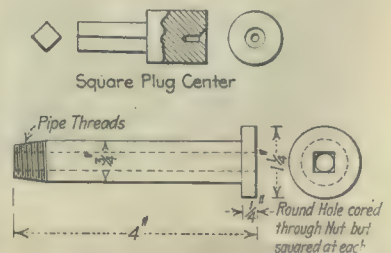


FIG. 6. CYLINDRICAL PIECE MADE FROM BRASS CASTING

casting to produce a square opening, as indicated. A piece of steel about an inch in length, but provided with a good-sized center, is then pressed into the hole to serve as a center and an arbor for the driving dog and thus act in the same way as a regular arbor except for being square. In this way the casting is turned from the threaded end straight up to the flange and there is now no working behind blind surfaces or setting around of the cutting tools in doing what turning is necessary. The center as used in the squared end of the hole and as shown in Fig. 6 is sufficiently large to allow the dog to grip properly. After turning the work, the square center is removed by knocking out from the open end of the casting.

In the first article on this shop, reference was made to the system of operating links for actuating the pressure roll boxes to lift the rolls or drop them into position on the drier. There are five of these boxes at each end of the machine, carried in slots in the top of the main frame. To actuate them uniformly, the stud holes in the operating disks for carrying the lower end of the link must be correctly positioned.

The method of locating the center for each link is indi-

Small Jigs Used in Machining Automobile Elements

BY ROBERT MAWSON

SYNOPSIS—In this article are shown jigs used in machining some of the smaller parts for automobiles. On those pieces having circular bosses a sliding V-block and a fixed V-block are employed as locating mediums. On some of these jigs the bushings are carried in the cover; in others the bushings are part of the jig body. Some of the tools are provided with a spring latch that enables the cover to be quickly held in place.

On pages 1018 and 1019 were illustrated some of the special tools, jigs and fixtures used by the International

Motor Co., Mack Works, Allentown, Penn., in machining parts for commercial vehicles. In this article are shown other similar tools at the same factory. The jigs here described are mostly used on small parts, but have been found to give satisfaction in service. The spring latch provided on some of the jigs for holding the cover in place greatly reduces the time required for the workman to insert the rough part.

A careful reading of this article as well as the previous ones in the series will suggest valuable ideas in special tool design not only for automobile work, but for other machine manufacturing where jigs and fixtures are necessary in securing interchangeability of parts.

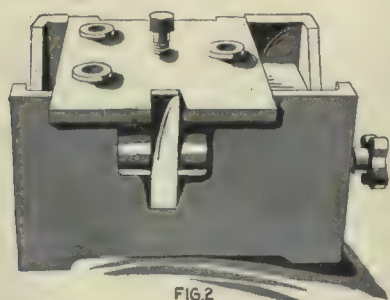


FIG. 2

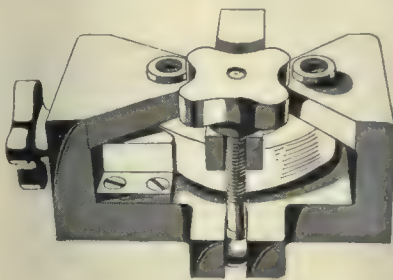


FIG. 4

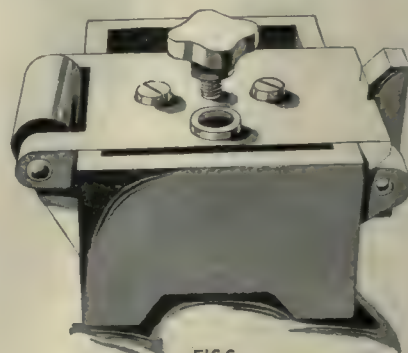


FIG. 6

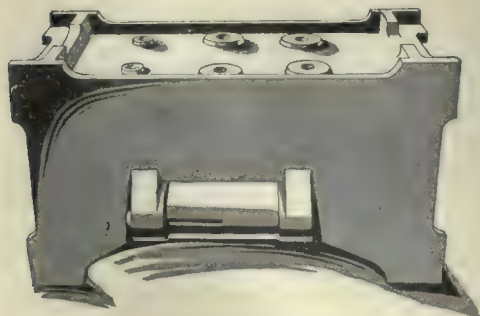


FIG. 8

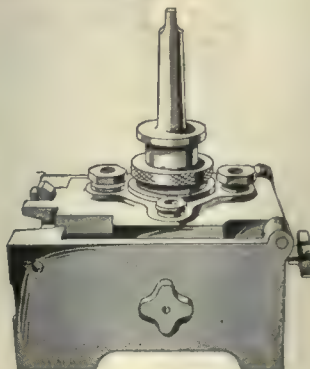


FIG. 10

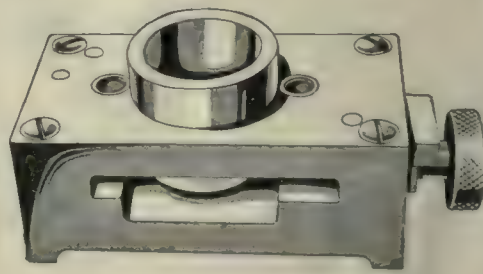


FIG. 12

JIGS AND FIXTURES FOR MACHINING AUTOMOBILE PARTS, SHOWING THE WORK IN POSITION

FIGS. 2 AND 2-A

Operation—Drilling motor front-support frame bracket, Fig. 1. The milled casting is located at one end against fixed stops. A sliding V-block operated by a knob-headed screw at the other end of the jig locates this end and forces the casting back against the stops. The cover is then dropped down, being held by a latch. A screw through the cover is tightened on the piece and holds it securely.

Holes Machined—Three $\frac{33}{64}$ -in. drilled.

FIGS. 4 AND 4-A

Operation—Drilling gear-shifter crank ball cap, Fig. 3. The casting, which has been previously bored, is placed on a machined plug. A sliding V-block operated by a knob-headed screw is then tightened against the casting to locate it. The cover, which is afterward dropped down and held with a knob nut, is provided with an equalizing strap that allows it to accommodate any inequality in the casting.

Holes Machined—Two $\frac{25}{64}$ -in. drilled.

FIGS. 6 AND 6-A

Operation—Drilling gear-shifter lever ball cap, Fig. 5. The casting is located in a similar manner to the tool, Fig. 4. The cover is then dropped down, and the knob-headed screw through the cover holds the casting securely.

Holes Machined—Two $\frac{25}{64}$ -in. drilled.

FIGS. 8 AND 8-A

Operation—Drilling and reaming dumper shifter-rod casting, Fig. 7. The casting, which has been previously ground on the base, is located by two sliding V-blocks operated by knob-headed screws through the cover, which is held down with a latch.

Holes Machined—Six $\frac{25}{64}$ -in. drilled, one $1\frac{1}{4}$ -in. and one $1\frac{1}{2}$ -in. spot drilled and reamed.

FIGS. 10 AND 10-A

Operation—Drilling and boring steering-gear frame bracket, Fig. 9. The casting, which has been previously milled, is located against stop pins at the rear and one side, knob-headed screws being employed to force the piece against them. The cover is then dropped down and held with a spring latch.

Holes Machined—Three $\frac{5}{16}$ -in. drilled and one 3-in. bored $2\frac{1}{2}$ in. deep.

FIGS. 12 AND 12-A

Operation—Drilling pipe flange, Fig. 11. The forging is located in a fixed V-block at one end and by a sliding V-block at the other end. Motion for the sliding member is obtained by a knurled-head screw that controls a slide attached to the V-block.

Holes Machined—Two $\frac{25}{64}$ -in. and one $1\frac{3}{4}$ -in. drilled.

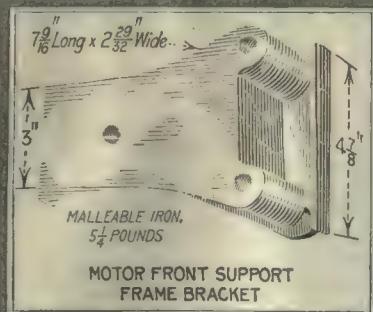


FIG 1

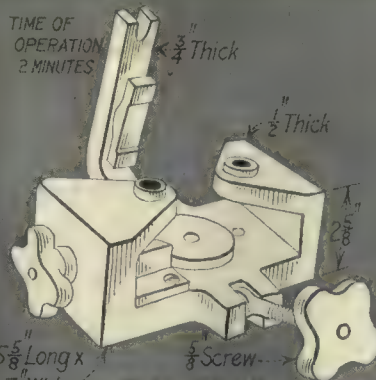


FIG 4-A

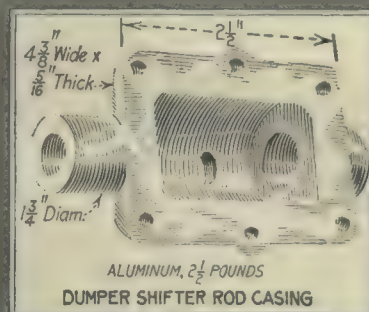


FIG 7

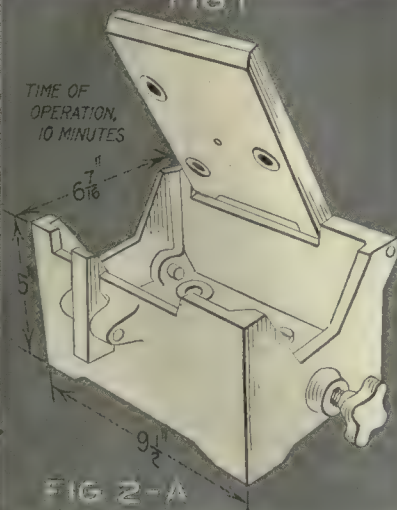


FIG 2-A

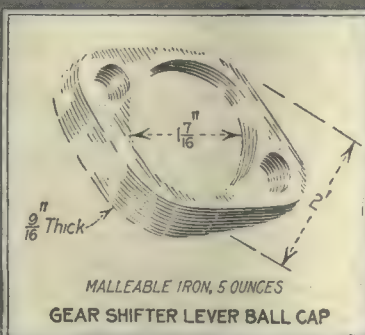


FIG 3

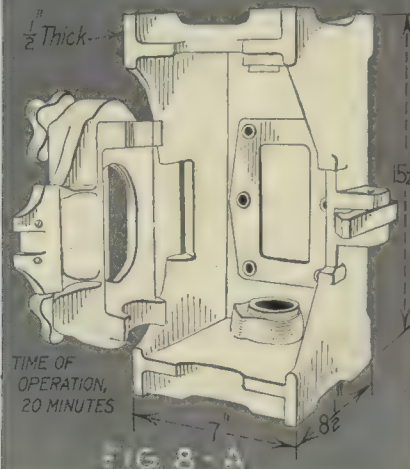


FIG 8-A

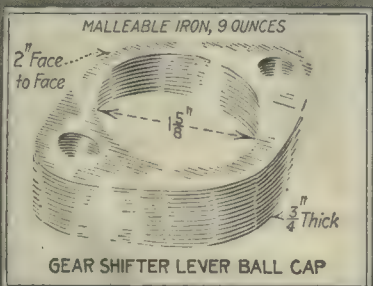


FIG 5

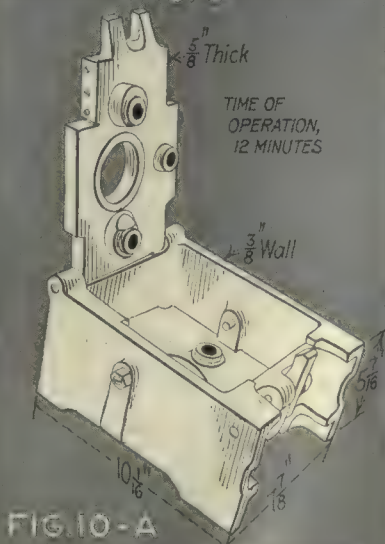


FIG 10-A

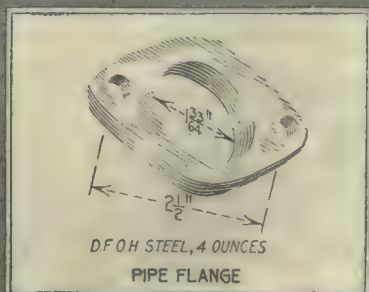


FIG 11

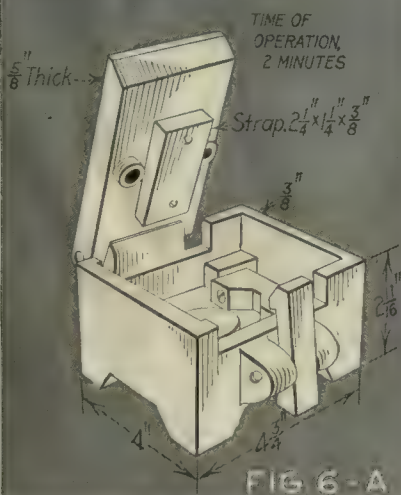


FIG 6-A

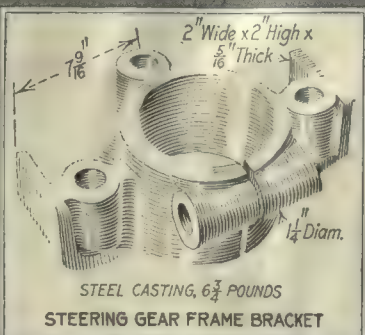


FIG 9

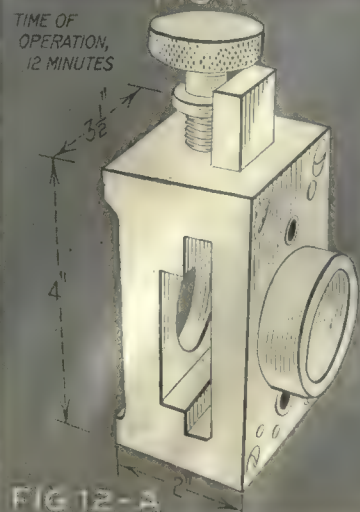


FIG 12-A

ALL BUSHINGS USED FOR GUIDING TOOLS ARE BLACKENED. ALL JIG AND FIXTURE BODIES ARE CAST IRON. STRAPS AND FASTENINGS, MACHINERY STEEL; GUIDE BUSHINGS ARE TOOL STEEL, HARDENED AND GROUND

Production Gages

By F. H. BOGART

A practice which is beginning to have many advocates in American shops is the use of two distinct sets of tolerances and limit gages in the manufacture of every component. The master set, or inspection gages, are made with the full tolerance allowed on the working drawing, and in common practice are held to a maximum error of two-tenths of a thousandth from the absolute dimension. The second set, or duplicate sets, are made for use in the production of the components in the factory, and are plainly marked in a manner to distinguish them from the inspection gages. On the production gages the full tolerance is reduced by about 20 per cent., and the limiting dimensions established accordingly. Moreover, in their manufacture the permissible error is increased to one-half a thousandth, and many manufacturers use the gages soft or with the wearing points surface-hardened.

EXAMPLE APPLIED TO MUNITION WORK

The first example of this that came under my observation was in a plant manufacturing 3-in. cartridge cases for the French commission. The commission had their own resident inspector, who had come provided with two duplicate sets of gages, one for his own use, and one for reference use by the contractor. The manufacturer had had numerous duplicates made of the various gages, all of them dimensioned in millimeters and to the full tolerance allowed by the master set. I observed, soon after becoming connected with this organization, that there was continual bickering between the French inspector and the various supervisors and the company inspectors as to whether certain machined parts were within the limits specified. Repeated trials of several supposedly duplicate gages usually produced more and more heated arguments, which ended by getting out the official millimeter micrometer and actually measuring the dimension. In some cases it would be half a hundredth of a millimeter over the specified limit, in other cases slightly under; but no matter which side won out, they were usually disputing again in a few minutes.

THE SOURCES OF THE TROUBLE

I carefully investigated this annoying condition, and traced its cause to two sources. One was the fact that few of the American shops that were making the production gages for this company had been able to secure millimeter micrometers, and had converted the figures on the drawings furnished them to inches, in some cases carrying the conversion to only three decimal places. The fact that the unit of French mechanical measurement is a hundredth of a millimeter, or only about four-tenths the length of our thousandth of an inch, led them in many instances into a considerable error from the specified limits, and these errors proved a continual source of trouble in production. The other cause was the difference in "feel" of the men who happened to be doing the gaging. Theoretically, any dimension measuring exactly to the maximum or minimum is as good as can be made; but so much as one-tenth of a hundredth beyond either limit will cause the French inspector to shake his head and exclaim, "That eez not satisfactory." An experienced mechanic will appreciate that this condition gives oppor-

tunity for a wide difference of opinion as to what is right and what is wrong, due to the slight difference in the feel of a gage on parts varying from each other by such infinitesimal measurements.

As a means of overcoming this whole difficulty, it was suggested to the manufacturers that on all the more important dimensions they make up gages marked "For Use on Production Only," and reduce the tolerance allowed by them sufficiently to offset both the slight errors in the gages themselves and the difference in feel. This suggestion was carried out, the production gages being dimensioned in inches, and the limiting dimensions being reduced a half-thousandth where the theoretical tolerance was for 0.002 to 0.004 in., and a thousandth where it was greater than 0.004 in. In other words, the tolerances were reduced 0.001 and 0.002 in. respectively.

RESULTS OF THE IMPROVEMENT

The improvement brought about by this revision of gage limits was very marked. On the diameter of the rim and barrel of the cartridge cases—two dimensions that had been a constant bugbear to the machine-department foreman and his inspector—arguments disappeared, and rejections were cut to one-tenth what they had been. The manufacturers were not able to apply the revision completely, as it would have meant the scrapping of all their gages and the making of several new sets, which they could not afford nor had they time to do.

This experience convinced me that in limit-gage production the practice of using gages on the machines with less tolerance than on those used for inspection has sufficient merit to warrant very careful consideration. Certain drawbacks developed, however, which should indicate that it would be advisable to go slow before adopting the method in a large manufacturing plant. The first difficulty was the confusion caused by having two sets of gages and practically two standards for every operation. This could be overcome by careful control of the use of the gages and of their disposition when not in use.

CAUTION IN THE USE OF DOUBLE LIMITS

The second difficulty was that, as soon as the operators on the machines learned there was a wider tolerance than that allowed by their gages, they were inclined to take advantage of it. In other words, they were not so particular to keep inside their gages, because if they went outside a little they guessed it would be all right, knowing there was a wider limit farther on. The best cure for this trouble would be to keep it a shop secret that any other tolerance existed than that on the gages furnished the operators. But to preserve secrets of this nature in the average factory organization is no easy task, as any manufacturer knows from experience.

VARYING PROBABILITIES OF SUCCESS OF THE PLAN

To what extent this system of using a double standard in gaging interchangeable work will be generally adopted, only more time and experience can determine. While it has much in theory to recommend it, the objections just cited might under certain circumstances offset every advantage, and it is probable that it will work out with varying degrees of success in different plants, owing to more favorable conditions in one than in another.

Forging-Hammer Foundations

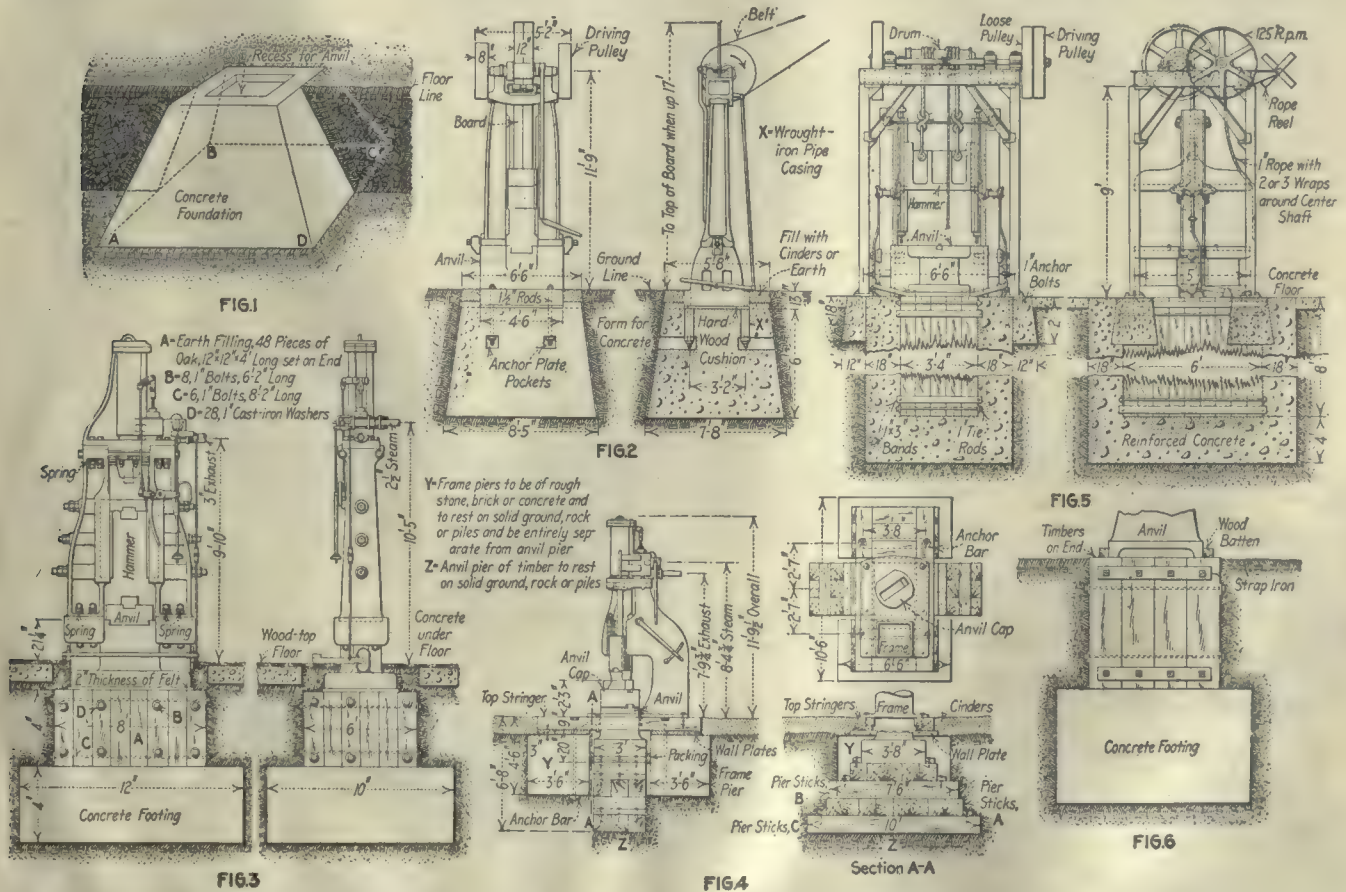
BY TERRELL CROFT

SYNOPSIS—This article reviews modern practice. The different methods which have been and are now commonly used are considered, and the advantages, disadvantages and applications of each of the different types of construction are pointed out.

The functions of a foundation for a drop or a steam hammer are to furnish a footing of sufficient area to prevent the machine from sinking into the soil, to maintain the machine in an upright fixed position and to retain it in alignment with its lineshaft, to insure that the hammer blows will have maximum effectiveness, to assist in

from settling excessively either due to its own dead weight or to downward forces incident to the repeated blows of the hammer. If the anvil of the machine is relatively heavy, the force of the blow will be absorbed by it and will not be transmitted through the foundation to the footing. On the other hand, if the anvil is relatively light, then much of the force of the blow may be transmitted to the footing. In such a case it is possible that the downward force incident to a hammer blow may be greater than that due to the dead weight of the machine. This condition should be given consideration and the area of the footing proportioned accordingly.

It does not appear feasible to specify safe pressures per square foot of bearing area of the foundations on



FIGS. 1 TO 6. A NUMBER OF HAMMER-FOUNDATION INSTALLATIONS

Fig. 1—Typical monolithic drop-hammer foundation construction. Fig. 2—Foundation for a 1,000-lb. broad-lift, gravity drop hammer; E. W. Bliss Co. Fig. 3—Foundation for an arrangement of a 1,500-lb. steam drop hammer; Massillon Foundry and Machine Co. Fig. 4—Foundation and arrangement for a 1,100-lb. single-frame steam forge hammer; Massillon Foundry and Machine Co. Fig. 5—Foundation for an arrangement of a rope-lift, gravity drop hammer; Canton Foundry and Machine Co. Fig. 6—Timbers on end forming pedestal cushion for light anvil hammer

absorbing the jar incident to the blow of the hammer and sometimes to reduce or eliminate noise. A foundation may satisfy one or more of the above and be entirely inadequate as to the others.

Conditions affecting the operation of gravity drop or steam drop hammers may not be wholly identical with those affecting steam forge hammers. This fact must be considered in designing the foundations for each of these two types of machines.

The area of the footing of a hammer foundation, ABCD, Fig. 1, must be sufficient to prevent the machine

different soils, because of the number of uncertain factors involved. Obviously, the bearing area in a loose or weak soil should be greater than that in a solid one. A bed-rock substratum will sustain almost any load that will be imposed upon it. The bearing area to use for a hammer foundation must then be determined largely on the basis of prior experience. A study of the proportions of the examples described later will indicate what unit bearing areas have been found satisfactory in practice under average conditions and what should be avoided as being outside of the limits established by experience.

To maintain the hammer in a vertical position and in alignment the bearing area should be great enough to prevent the foundation from settling along one side or corner. It is possible to have sufficient bearing area to prevent the foundation and machine from sinking as a unit, and yet this area may not be great enough to prevent the foundation from settling unevenly or from "jiggling" or shifting around and getting out of alignment.

If the foundation does not sustain the hammer frame in a vertical position, the guides of a drop hammer or the cylinder of a steam hammer will be thrown out of plumb. Then the hammer head, instead of sliding vertically in its guideway, will press thereon unevenly. Where this occurs the guides of a drop hammer may be strained until broken, or the parts of a steam hammer may be unduly worn. If the foundation does not maintain a belt-driven hammer in alignment, belt slippage and wear are the result. The center line of the machine passing through the anvil from right to left should be parallel with the driving lineshaft.

If the blows are to be most efficient the anvil should yield but little when the hammer strikes. As will be shown, maximum effectiveness cannot in every case be attained by the provision in a foundation of great bearing area or considerable mass. The relative weights of the hammer and the anvil are an important feature in this connection.

The distinction between gravity drop hammers and double-acting steam hammers is this: The hammer or "drop" of an ordinary drop hammer, Fig. 2, acts solely because of its own weight and travels freely in its slides. Hence, after it drops and strikes its blow, it rebounds instantly and does not occasion excessive tensile stresses in the frame or in the guides of the machine. At the instant at which the hammer of a double-acting steam hammer strikes its blow, the steam pressure may be pushing against the piston head. This can introduce tensile strains in the frame of the hammer.

The design of a drop-hammer foundation is determined largely by the ratio of the weight of the anvil to the weight of the hammer. Timbers on end comprise the most satisfactory and economical support for drop hammers having a low ratio of anvil weight to hammer weight, while a concrete foundation provides the most satisfactory and economical base for "high-ratio" hammers.

If the anvil of a drop press is sufficiently heavy, all that is required of its foundation is to prevent settling or shifting. It is possible and commercially feasible to incorporate enough weight in the anvil so that it will absorb nearly all of the effect of the blow.

The desirable ratio between the weight of the anvil and the weight of the hammer for drop hammers is now generally conceded to be at least 15 to 1; that is, for effective economical operation with a 30-in. fall of the hammer the anvil should be at least 15 times as heavy as the hammer. Formerly a 10 to 1 ratio was considered satisfactory, and a hammer designed on this basis will give fairly good service if suitably installed with its anvil on a timber pedestal.

Drop hammers are sometimes made having a ratio of anvil weight to hammer weight greater than 15 to 1 merely to insure a blow of maximum effectiveness. In other instances these high ratios have been adopted because it was not feasible to construct timber-pedestal foundations of the types essential for good results with

"low-ratio" hammers. High-ratio hammers have the further advantage that foundations of relatively light and simple construction can be used. Little or nothing is gained (at least where the hammer does not drop through a greater distance than 30 in.) by increasing the ratio much above 20 to 1.

High-ratio drop hammers are the more economical because more and better work can be produced with them, because the timber pedestals which are required for supporting low-ratio hammers and which involve expensive maintenance are eliminated, and because breakage and consequent shutdowns are minimized. The extra first cost of the heavier machine is probably offset by these three features, it being assumed that the expense is reckoned on an annual charge basis.

Drop hammers in which the ratio of anvil weight to hammer weight is less than 11 to 1 should be supported on wooden pedestals, Figs. 3 and 5. Where the ratio of anvil weight to hammer weight is low, the anvil will not of itself absorb the blow. It must be supported on a somewhat resilient material which must, however, have considerable mass. If such an anvil is mounted on a rigid base, as a masonry foundation, it will "jump around" or possibly crack the material of the foundation by its constant vibration or introduce, because of the unabsorbed shocks, excessive stresses in the frames of the hammers. These stresses may cause breakages and shutdowns.

The function of the timber pedestal used for supporting a drop hammer of low-ratio design is to act as a semi-rigid cushion that absorbs much of the force of the hammer blow and transmits the remainder to the soil or the masonry footing under it. Timbers placed on end are apparently better for this duty than other materials. Hence a timber pedestal is much better than a solid concrete foundation for low-ratio hammers. Where a high-ratio hammer is mounted on a timber pedestal when the hammer comes down, even with a very heavy press, the shock produced in the supporting timbers can be scarcely detected by the hand.

The disadvantages of a timber-pedestal drop-hammer foundation are that the timbers will ultimately decay. The replacement expense involved may be considerable. Timber-pedestal supports are the most satisfactory and economical for drop hammers in which the ratio of anvil weight to hammer weight is low, because if such hammers are mounted directly on concrete or solid masonry the breakage of the frame of the drop and of the dies will be excessive.

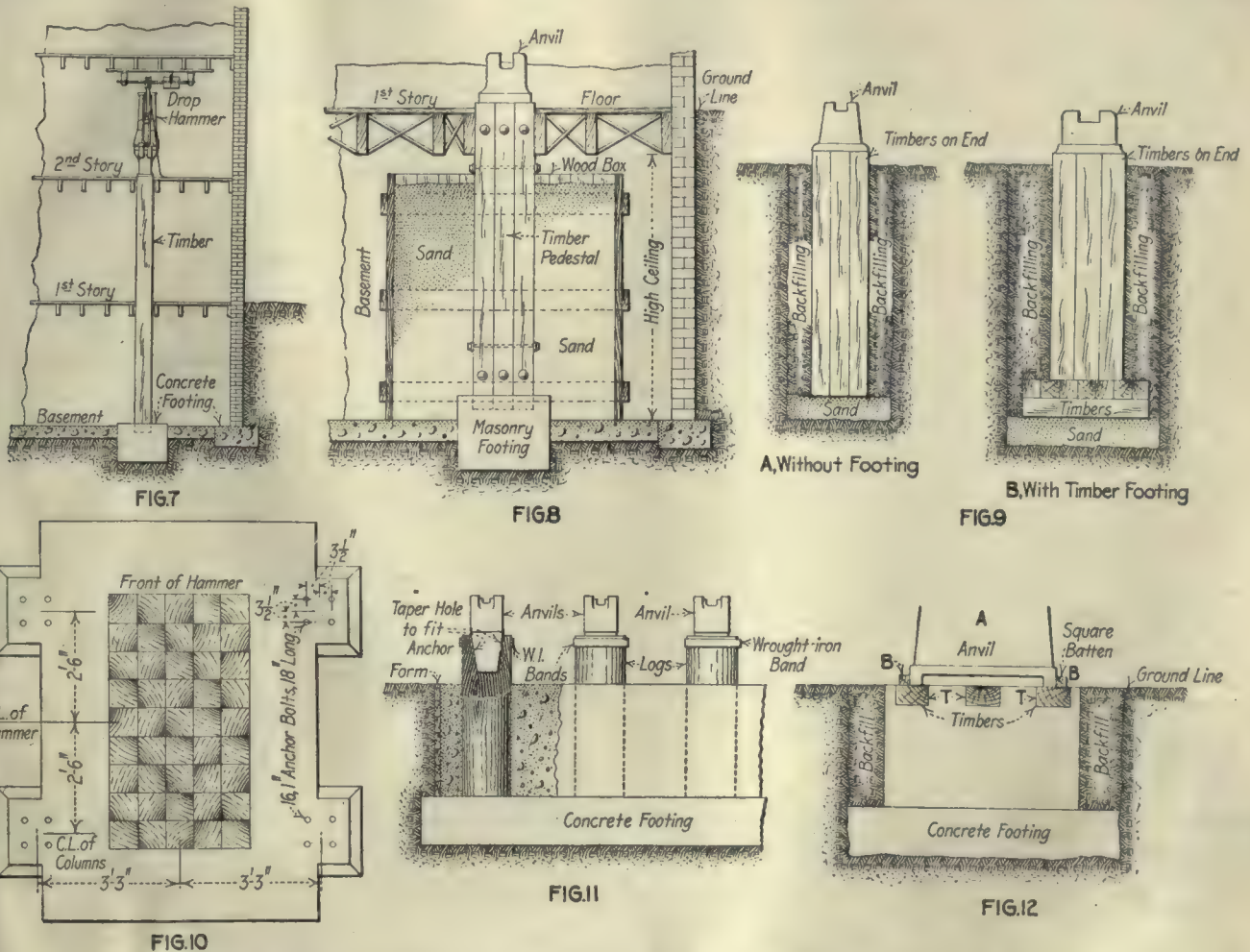
A typical arrangement of a timber-pedestal foundation is shown in Fig. 6. The pedestal comprises one or more timbers on end held together in one unit. The rectangular end of the composite pedestal should be somewhat larger than the lower face of the anvil that is to be supported. Ordinarily, square sticks not smaller than 8x8 in. are used. Where feasible, 12x12-in. sticks should be utilized, because the larger ones require fewer bolts or straps for binding them together. The pedestal should be supported, preferably in a recess cast for its reception, on a monolithic footing, usually of concrete. This footing should have sufficient bearing area so that the unit load on the supporting soil will be well within the safe limit. This will be determined largely by local soil conditions. The footing should be thick enough, possibly three-quarters as thick as it is long, to insure against any possibility of its cracking.

For small low-ratio hammers a single stick set on end may be used for a pedestal, as shown in Fig. 7. A 12x12-in. or a 14x14-in. stick often has sufficient cross-sectional area to sustain a low-ratio anvil. A footing comprising a monolithic block of masonry or concrete should be used under the lower end of the stick to distribute the load imposed on the soil over a safe area.

Cedar or chestnut is preferable because of their long lives when buried in the earth. However, almost any

Cedar, 15 yr.; chestnut, 12 yr.; cypress, 9 yr.; juniper, 8½ yr.; pine, 6½ yr.

The general practice with pedestals for drop hammers of the usual sizes is to make them about 8 ft. long. It is probable that if a pedestal is as high as its width, provided that in no case it is shorter than 5 ft., it will satisfactorily do what is expected of it. Where it is necessary to excavate to a considerable depth to obtain a good bottom for the footing, the pedestal should obviously be long



FIGS. 7 TO 12. ARRANGEMENTS OF VARIOUS TYPES OF TIMBER HAMMER PEDESTALS

Fig. 7—Timber pedestal for drop hammer on upper floor of building. Fig. 8—How transverse yielding of timbers was corrected with a sand box. Fig. 9—Timber pedestals supported on a sand bed. Fig. 10—Plan view of foundation for "Canton" rope-lift hammer, showing anchor-bolt locations. Fig. 11—Battery of drop-hammer anvils supported in taper cavities in logs. Fig. 12—Cushion timbers embedded in top of concrete foundation

sound wood will be satisfactory before decay commences, and the kind of wood to use for timber pedestals must be determined locally. Preservative treatment should be applied to the timbers used for pedestals where these are set in the earth. Creosote, which is a moisture repellent, or a similar preservative can be used. Where the timbers are thus impregnated their lives will probably be at least doubled. If treated timbers cannot be obtained from local dealers they may sometimes be purchased from railroad companies. Treated railroad ties are occasionally utilized. Treated poles may in certain instances be bought from local public-service companies.

The useful life of timber buried in the earth is determined to some extent by the character of, and the amount of moisture in, the soil. Under average conditions the lives of untreated buried timbers are about as follows:

enough to extend to this footing. In special cases timber pedestals must be made very long, as for example, in Fig. 7.

The methods of binding the timber pedestals together are shown in the illustrations. Bolts may be used, as in Figs. 3 and 8; tie-rods and straps, as in Fig. 5; or bolts and straps, as in Fig. 6. The bolt-and-strap method, Fig. 6, though the most expensive, is the best because with it the possibility of shifting or twisting of the timbers due to warping, drying out or swelling is minimized.

For holding the drop-press anvil to the timber pedestal, wood cleats or battens, Fig. 6, held with spikes to the pedestal around the lower edge of the anvil, are sufficient for the larger hammers. Eight lag screws, two on each of the four sides, screwed down into the pedestal are ample for holding the smaller anvils.

Footings or beds of sand for drop-hammer timber pedestals, Fig. 9, are recommended by the Long & Allstatter Co., Hamilton, Ohio. With this method the pedestal is built up of heavy timbers of a size somewhat larger than the drop base and from 6 to 8 ft. in length. The pedestal is supported on a sand foundation, which should be about 6 to 8 ft. thick. After the pedestal is in position the excavation is refilled and the backfilling tamped solidly. Where a masonry or concrete footing is used under the pedestal, it must be quite thick to prevent the possibility of its crumbling or cracking. The sand footing is not, it is claimed, subject to similar difficulties. For the foundation for a certain steam hammer the construction was as follows: The excavation was made 12 ft. deep, Fig. 9-A, and two layers of 15-in. square timbers, assembled crosswise, were bedded on a footing of sand in the bottom of the hole. The buried timbers were 5 ft. long and were held together securely with bolts. The pedestal timbers, bolted together into a compact unit, were then mounted endwise on the base block, as indicated in the illustration.

Long timber pedestals not set in the earth should be supported laterally. If they are not, they may yield sideways and not absorb the effect of the blow as do timber pedestals set in earth. Where the timbers pass through the floors of a building, as in Fig. 7, in case the stories are of not too great a height lateral support can be provided at each floor. One cause of trouble due to insufficient lateral support for a pedestal carrying a 10 to 1 ratio anvil was corrected by G. W. Peck as suggested in Fig. 8. A box was constructed around the pedestal and then filled with sand. Prior to the installation of the sand box the anvil would "jump all around" on the timbers, but after the arrangement of the improvised support no difficulties were encountered.

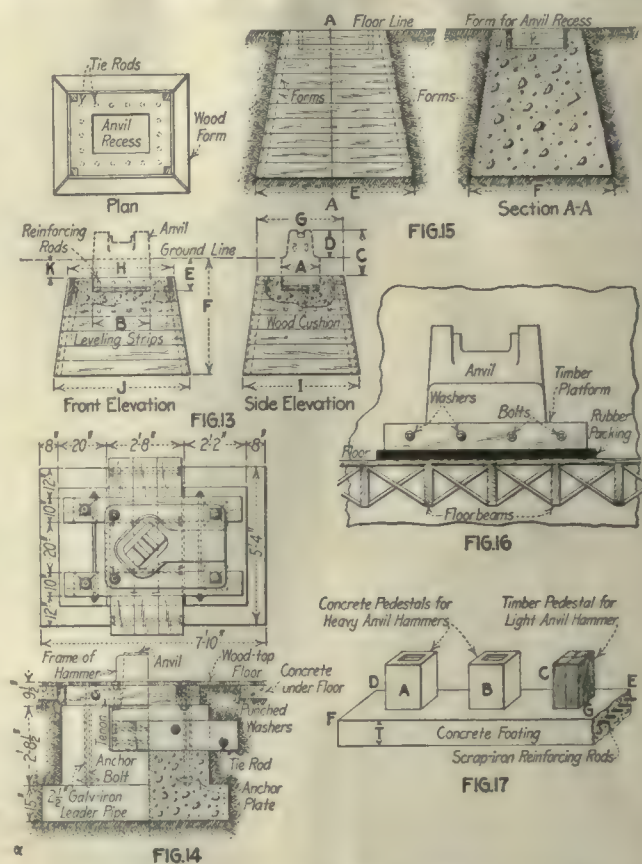
Pedestal timbers should not be set with concrete solid all around them, because their renewal, as they rot out, will be very expensive. Construction similar to that shown in elevation in Fig. 5 and in plan in Fig. 10 is permissible where preserved timbers are used. However, even if the timbers are treated, it is always advisable so to dispose the concrete that the sticks can be readily renewed without dismantling the foundation. This may be accomplished, where the frame of the machine is of construction similar to that of Fig. 5, by casting the anchor bolts in piers and providing a space between the timber pedestal and the piers in a manner somewhat similar to that suggested in Fig. 4.

An installation where low-ratio anvils were set in the ends of logs is illustrated in Fig. 11. In so far as operation was concerned the installation was satisfactory, but in the course of a dozen years the logs rotted and it became necessary to pick them out, which was an expensive process.

The weights of anvils which are too light may be augmented by clamping an additional mass of metal to them. In certain cases the bottom faces of old anvils have been planed off and new sub-bases planed to fit them. Then the original anvil was clamped to the new sub-base with tie-bolts. Sometimes a metal sub-base can be so cast that it has overhanging lips to engage the bottom edges of the old anvil. Then metal wedges can be driven between these lips and the projecting bottom of the anvil. Anvils for large presses are frequently cast in two or more sections. It is essential in such cases that the sec-

tions be firmly tied together so that all of the metal will act as a unit.

For drop hammers having a ratio of anvil weight to hammer weight of 12 to 1 or more a concrete foundation with a relatively thin wood cushion under the anvil comprises the best arrangement. That of Fig. 2 is typical construction for such foundations. They are relatively



FIGS. 13 TO 17. DROP- AND STEAM-HAMMER FOUNDATION PLANS

Fig. 13—Drop-hammer foundation construction as recommended by Billings & Spencer Co. Fig. 14—Foundation with timber cushions for a steam hammer. Fig. 15—Unusual method of making forms. Fig. 16—Timber platform for heavy-anvil hammer on upper floor of buildings. Fig. 17—Arrangement of pedestals or footing for a row of hammers

inexpensive, are readily constructed and will last indefinitely. Concrete provides a base of ample area safely to distribute the load, and the wood cushion directly under the anvil absorbs any minor pounding that may occur. The wood for a cushion should be at least 2 in. thick and may be any tough wood. For example, yellow pine or oak is satisfactory. For the larger hammers it will probably be found desirable to make the wood cushion somewhat thicker than 2 in.

It is inadvisable to cement anvils in solid. The older practice was to set the anvils in a recess in the top of the concrete foundation and to grout them therein with concrete. This made it expensive to chip away the cement in order to remove the anvil, and it was difficult to set the anvil at a new level in case the foundation settled. Uneven sinking throws the machine out of plumb and necessitates releveling it. Where the wood cushion is used under the anvil it can easily be taken out and enough grout placed under the "low" side of the cushion so that its upper surface will be perfectly level.

The most economical and desirable shape for a concrete drop-hammer foundation is probably that of Fig. 12. This design of concrete monolith is better than that

suggested in Fig. 13, because it can be more easily and economically constructed. Furthermore, it requires somewhat less material for a given area of base. With the construction of Fig. 12 the forms are very easy to make, as all of the angles are right angles. In building this foundation the footing is first placed, then the form for the pedestal of the foundation is erected on the footing and the concrete poured into it. Ordinarily no form is required for the footing inasmuch as the sides and bottom of the excavation serve instead. For restraining the anvil a depression like that shown in Fig. 13 is preferable to the method suggested in Fig. 12.

Concrete drop-hammer foundations may be reinforced with old mild-steel rods or rails, placed both vertically and horizontally in the monolith. Frequently the only reinforcing comprises a number of relatively short rods set vertically around the anvil depression, as shown in Fig. 13. The function of these rods is to prevent the breaking off of the upper stratum of the foundation.

The depth to which a concrete drop-hammer foundation should be carried is determined largely by the nature of the soil in which the foundation is to be constructed. Where the top soil is weak or yielding, the foundation should always be carried to a sufficient depth so that its footing bears on a solid stratum.

If "good bottom" cannot be reached without making an excessively deep excavation, satisfactory results may often be obtained by making the footing of such an area that the unit bearing pressure will be very low. The minimum thickness of concrete that should be used under any wood cushion is 4 ft. If a block of less thickness is provided it is liable to crack.

Sand or clay bottoms are objectionable as bearing surfaces for drop-hammer foundations because they are liable to dry out, particularly if the presses are in a forge shop, which is a hot, dry place. This condition is not likely to give trouble unless there are other excavations in the vicinity which will permit the displacement of the dry sand or clay stratum under the first foundation.

With the method of holding anvils on concrete foundations, shown in Figs. 12 and 13, twelve large timber stieks which also act as cushions are embedded in the top of the foundation and flush with it. Battens arranged around the lower edges of the anvil may be spiked to these sticks to prevent movement. Another method of holding a drop-hammer anvil in position is to surround it with heavy timbers held to the concrete foundation with anchor bolts passing through them. The anchor bolts for this purpose are cast in the foundation at the time it is built. These timbers form a fence around the bottom of the anvil.

Anchor bolts are seldom required, although they are sometimes used as shown in Fig. 2. Where bolts serve to hold the anvil down on the foundation, if the nuts are set up tight their heads are apt to be broken off. Anchor bolts, if such are used, are merely to prevent the anvil from shifting laterally, and the nuts are left slack.

In grouting under an anvil, the anvil and cushion are first carefully leveled, the cushion being wedged up against the bottom of the anvil. Then the grout is run in under the wood cushion.

In constructing forms for concrete drop-hammer foundations boards are used as shown in Fig. 15. For large foundations these should be at least $1\frac{1}{2}$ in. thick. Frequently the earth is filled in around the forms to brace

them while the concrete is being poured in, and they are permitted to remain in the ground. A foundation should be allowed to dry out for at least three weeks before the weight of the anvil is imposed on it.

An example of a board-lift drop-hammer foundation constructed in accordance with Billings & Spencer practice is shown in Fig. 13. A 2-in. wood cushion is provided under the anvil, and four anchor bolts, the plates of which are accessible from pockets, are used to prevent lateral shifting.

An example of a foundation for a large rope-lift drop hammer built in accordance with the practice of the Canton Foundry and Machine Co. is shown in Figs. 5 and 10.

Where a hammer of high-ratio design is employed, it will usually operate satisfactorily in the upper story of a building if it is mounted on a bed, composed of timbers bolted together, which rests on a cushion as shown in Fig. 16. The heavy anvil will absorb the effects of the blow. The timber bed will distribute the weight and absorb the minor vibrations, and the cushion will tend to prevent the transmission of noise. Obviously, it is necessary before a drop hammer is arranged as shown in Fig. 16 in the upper story of a building to ascertain definitely that the floor construction is strong enough to carry the dead weight of the hammer. Unless the anvils weigh from 15 to 20 times as much as the hammers, it is impossible to operate them satisfactorily on the upper floor of a building unless a timber pedestal, Fig. 7, is carried up from the ground to support the anvil.

It is claimed that cushions of rubber or hair felt ultimately lose their "life" and springiness. Rubber is deteriorated by oil. Hair felt fills with fine dirt particles and tends to become a compact mass. Roofing felt and pitch cushions have been used successfully in certain instances. In one large plant in the Middle West such cushions are constructed thus: The timbered floor is first coated with roofing pitch, and then successive layers of commercial roofing felt, stuck together with roofing pitch, are applied until the pile is from $1\frac{1}{2}$ to 2 in. thick, according to the weight of the hammer to be supported.

The foundation for a number of hammers arranged in a row can be made as shown in Fig. 17. A long excavation is made down to good bottom and then the concrete footing, which should preferably be reinforced with scrap-iron rods or rails, is poured into the hole. The thickness *T* of the footing *DEFG* must be relatively great or it will be liable to crack under the continued action of the hammer blows. Then, for high-ratio hammers, concrete pedestals can be erected on the footing as shown at *A* and *B*. For low-ratio hammers, timber pedestals can be set as shown at *C*. For small-ratio hammers, one stick of timber or a log on end, Fig. 11, can be used.

The construction of a steam forge hammer foundation must be somewhat different from that used for either a steam or a gravity drop hammer. Fig. 4 shows the construction recommended by the Massillon Foundry and Machine Co. The frame of the hammer is supported on concrete piers which are entirely independent of the built-up timber pedestal upon which the anvil is supported. The effect of the blow of the ram against the anvil introduces vibrations which are absorbed down through the timber pedestal to the footing. Unless a timber pedestal or some similar cushion is provided under the steam-ham-

mer anvil there is liable to be excessive breakage of hammer bases. In other words, it is not good practice to mount the anvil of a steam hammer directly on a non-resilient concrete foundation. Notice also that the frame of the hammer of Fig. 4 is supported on a timber cushion instead of being bolted directly to the foundation top, which provides a very resilient construction. Frequently the construction of Fig. 14, wherein the cushion under the anvil consists merely of a single layer of timbers 6 or 8 in. thick, is used and it appears to be in general satisfactory.

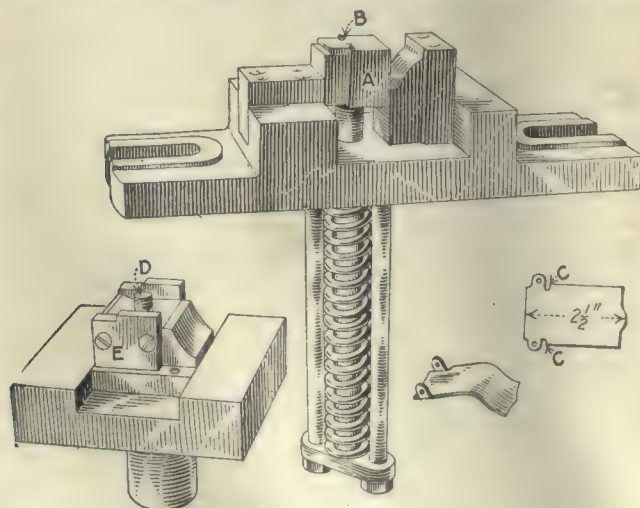
Steam drop hammer foundations for low-ratio machines do not vary materially from timber-pedestal gravity drop hammer foundations. Fig. 3 illustrates the construction recommended by the Massillon Foundry and Machine Co. for a 1,500-lb. steam drop hammer. Observe that springs are placed under the bolts, whereby the frame is clamped to the cylinder to introduce resiliency in the construction. For high-ratio machines concrete foundations similar to those of Figs. 12 and 13 may be used.

Forming Punch and Die

BY A. M. WARD

The piece before and after forming is shown to the right below the die. The material is 0.035 in. half-hard cold-rolled steel.

This tool is of particular interest, because of the long stroke of the spring plunger block *A* shown in the die, and



THE FORMING DIE AND PUNCH

the size of spring required to support this block while the two ears on the blank are being folded over. The pressure is greater than it seems at first sight.

The blank is held in place on the plunger block by two small projections *B*, shown on the top face of the plunger block, that fit into the recesses *C* of the blank. The blank is held down on the plunger block by the spring stripper pin *D* shown in the center of the punch, while the ears are folded over by the side walls *E*, screwed to the sides of the punch. These side walls serve also to hold the blank in place while the rest of the forming is being completed.

This final forming requires a downward stroke of the spring plunger block of $\frac{7}{8}$ in. The plunger spring is $7\frac{1}{4}$ in. long, $1\frac{1}{8}$ in. outside diameter, and is made of $\frac{3}{32}$ -in. wire wound $2\frac{2}{3}$ turns per inch. It is compressed to $6\frac{1}{2}$ in. when the plunger block is in the uppermost position.

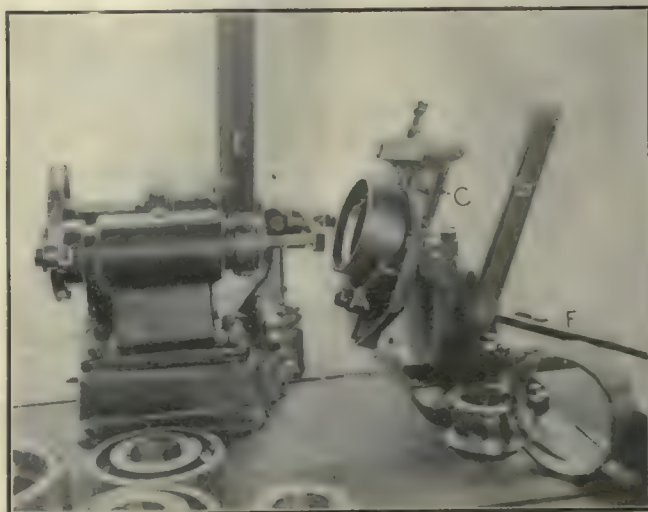
All the parts are of hardened tool steel, except the cold-rolled steel plunger pin and the spring hanger. The die shoe and punch holder are of cast iron.

The plunger pin is turned smaller in diameter where it enters the spring, so as to form a shoulder to hold a thrust collar on top of the spring.

A Grinding Kink in a Ball-Bearing Shop

BY A. TOWLER

The illustration shows the method used by the Hess-Bright Manufacturing Co., Philadelphia, Penn., when grinding the filling notch in a double ball-bearing ring. This notch is used to fill in the balls when assembling this type of bearing. The ring is located by a V-block *A* and held in position with a screw *B*. The handle through which the screw is placed is fitted with a tension spring *C*. By raising the handle the screw is lifted



GRINDING THE NOTCH IN DOUBLE BEARING

and the placing of the ring in position for grinding may be quickly performed.

The fixture is fed in against the revolving wheel with the handle *F*, and the handle *G* is used to raise the sliding element of the fixture by means of a rack and pinion until the notch is ground to the desired depth.

Repairing Brass Plug Cocks

BY JAMES E. NOBLE

Brass plug cocks can often be ground in with flour of emery when they begin to leak. Another way to make them water-tight is to remove the plug, dip it in a strong soldering acid that will make it clean enough to take a tinning over with solder in the usual way. When tinned all over, hold it in a blowtorch or gas flame until the plug becomes hot enough, wipe off all the loose solder and replace in the cock and the job is done.

A plug so treated will usually be liquid tight, but if the cock has been frozen and its shape distorted, it cannot be made tight in this way except in one position. It is obvious that the cock cannot be used for high temperature or pressure steam, but up to 20 or 25 lb. it will remain tight for a long time. Disks made of solder can be used on brass-seated globe valves and swing check valves when the temperature is not too high.

Handling the Material in a Typewriter Factory

By FRANK A. STANLEY

SYNOPSIS—The handling of material is such an important problem that many details can be studied to advantage. This article shows a number of developments in the way of tote boxes, trays and trucks, some of which can easily be adapted to other work.

The handling of small parts about a factory, particularly where precision work or pieces that are partly or completely finished are produced in large quantities and must be shifted frequently from point to point, requires great care. It is essential that some system be utilized for taking care of parts with special tote boxes or trays

piled up promiscuously in any way that might seem handiest to different machine operators. Under the system inaugurated for handling such parts in this plant, each of these top plates is taken care of in a suitable tote box until finally ready for assembling on the typewriter frame.

The form of tote box, or perhaps it might better be called a rack, is well brought out by Fig. 1, which shows a stack of some 35 or 40 such boxes. These are open in form to provide a light construction and can be easily handled and readily stacked up to any necessary height without liability of tipping over.

These boxes are about 18 in. long overall, to hold 10 top plates. Measured at the ends they are about 10x12



FIG. 1. TOTE BOXES FOR TYPEWRITER TOP PLATES

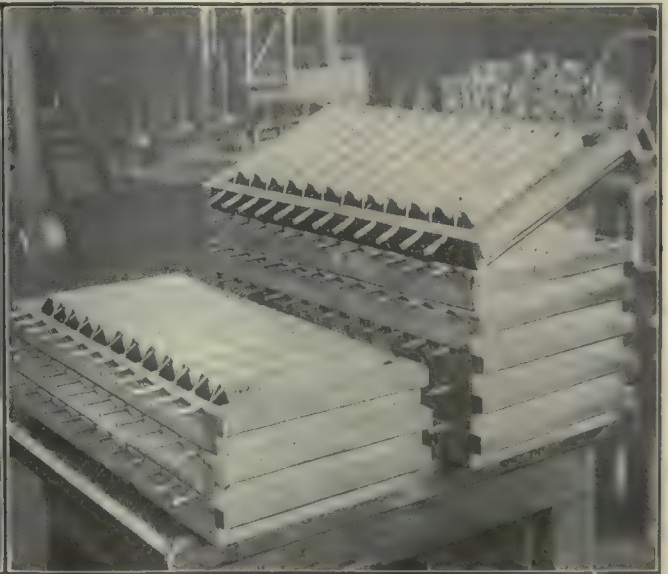


FIG. 2. TRAYS FOR RUBBER ROLLS

so constructed as to minimize the possibility of the pieces injuring one another. Otherwise, there will be a considerable loss of time in correcting damaged articles, and the entire process of transporting materials will constitute an unnecessarily serious and costly problem. This is a matter easily attended to by a little forethought in the design of some simple box or tray system especially adapted to the character of the work to be handled.

At the plant of the Noiseless Typewriter Co., Middletown, Conn., there has been worked out a complete system of special racks, boxes, trays and trucks for simplifying the handling of semifinished and complete typewriter parts through the various departments. A number of illustrations are presented herewith to show certain types of equipment for this purpose.

An earlier article described the most important processes in the machining of typewriter top plates. These are of gray iron, fan shaped, and measure approximately 8x11 in. overall, with a depth at the thickest point of about 1½ in. In the quantities in which these parts are made, they would be awkward pieces to take care of if thrown carelessly into open boxes or trucked about,

in. They are built up of 5/8 pine stock, with two bottom members running longitudinally and measuring perhaps 2½ in. in width each. Across these bottom strips there are fastened two lateral members of wood, against which four upright corner posts are secured, which are again tied at the top around three sides with wood strips of the same dimensions. A further strip is attached at the front and back near the bottom of the corner posts. The entire structure, as will be obvious upon inspection of Fig. 1, is a light but rigid affair, easily lifted by the end cleats. At the same time the base boards have sufficient area to assure the box a firm seat on the floor or bench or upon a stack of similar boxes.

These open tote boxes are designed to hold the typewriter top plates resting on one edge and separated sufficiently to prevent all possibility of their edges coming in contact and marring one another. For this purpose separating cleats are secured to the front board and to the strip at the rear, as clearly shown. This feature, while of importance from the moment that the first operation is accomplished on the plate in that it keeps the profiled surfaces from marring each other, is of still

greater service later on in the process of finishing these plates when they have been enameled and when the slightest contact between adjoining plates would bruise or scratch the coated surfaces.

There is another item of importance in connection with these boxes, and that is the effect upon the men using them. This constant care and attention educate those handling the top plates to a degree of respect and consideration for accurate and carefully finished products

grinding. The trays are skeleton frames with open bottoms with cleats at either end for convenience in carrying and with notches formed in the tops of both longitudinal members to receive the platen spindles.

When the rolls are in place (the trays hold 12 each), they rest with nearly half the diameters above the top line of the tray, as shown. When piled one upon another, the open construction of the tray allows its sides to rest upon the tray below with the framework span-

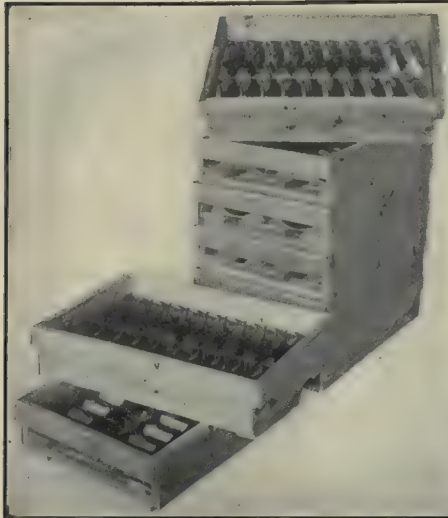


FIG. 3. TOTE BOXES FOR TYPE-BAR TOP PLATE



FIG. 4. TRAY FOR A COMPLETE SET OF KEY LEVERS



FIG. 5. HOLDER FOR TYPE-BAR MECHANISM



FIG. 6. TRUCKS FOR TYPEWRITER FRAMES



FIG. 7. TRUCKS FOR FINISHED TYPEWRITERS

that is not usually developed among mechanics. This is particularly true of those dealing with material that is carelessly thrown about in much the same manner as rough castings are commonly handled.

Another interesting set of carrying trays is illustrated in Fig. 2. These trays are built to hold the rubber rolls, or cylinders, that in the Noiseless typewriter serve as a paper-feeding device, but not for a printing platen. These rolls are made up with steel tubes for cores, in each end of which a cast-iron head is secured to carry a steel spindle. Over the steel tube a length of rubber tube is secured, which is afterward finished to size by

grinding and clearing the tops of the rollers in the tray underneath. They may thus be stacked up like sectional furniture to any convenient height, and the entire series of trays may be moved about the shop as a single unit on a truck. This system provides adequate protection for the finished rubber surfaces, and there is little possibility of the ground spindle becoming injured in any way whatsoever.

A set of tote boxes for top guide plates, which are roughly a quarter-circle in form, is shown in Fig. 3. These boxes hold two rows of parts, 10 in each row, with separating cleats between. These cleats have slop-

ing walls, so that the work rests at an angle and cannot rock in either direction when the boxes are moved about. This position of the work further permits a more shallow construction of box than would be possible otherwise. With the type guide in position as attached to the plate, the under, or important, surface of this guide, is not exposed to possible contact with other parts or to liability of injury through the accidental dropping of some other casting into the box.

The tray in Fig. 4 holds a complete set of key levers, 28 in number and of three different lengths, as required for each typewriter. In this tray the key levers are placed in the same relative position that they will later occupy when assembled in the typewriter frame. They are held right side up in channels formed between separating strips secured to the bottom of the tray, in which they go to the assembling benches, so that the people working in this department can pick the levers up one after another in their right order without sorting them out and hunting for the correct position for each letter.

It will be noticed that the end walls of this open tray are slightly higher than the projecting rear ends of the key levers. As with all the other trays and tote boxes in the establishment, the key-lever containers may be stacked two or three or a half-dozen or more in a pile to suit the convenience of the assembling mechanics.

VERTICAL HOLDER FOR TYPE-BAR MOVEMENTS

A handy holding device for typewriter parts is illustrated in Fig. 5. In appearance this is quite like a desk file for holding papers, commonly known as a stick file, except that here the pointed top is omitted from the spindle. As illustrated, the device is utilized for holding a complete set of toggle movements, 28 in all, for the series of type bars in one typewriter.

Here again this appliance has been developed for the special benefit of the assembling department. As placed on the assembling bench, it allows the workman to pick

up one mechanism after another and place it in the machine without having to go to the bother of fishing the toggle movement with its connecting links from a pile of such parts thrown loose into a tray.

Along with the development of boxes and trays of the character indicated by the illustrations already presented there have been developed a number of wheeled trucks for receiving the heavier parts and for moving them as required from one department to another. One such truck is seen in Fig. 6, as built particularly for holding a large number of typewriter frames.

This truck is built with two sets of sloping shelves whose outer edges are $1\frac{1}{2}$ to 2 in. higher than their backs, so that the frames when placed in their respective sections have a tendency always to rest against the central portion of the truck and never slide outward from their shelves. This sloping arrangement of shelves is obtained by tilting the upright posts in the framework toward the center, so that the structure as a whole tapers toward the top.

There are in all 48 sections on each side of the truck, giving a total capacity for 96 typewriter frames. In spite of this large number the skeleton design of the structure, with light but stiff uprights, struts and shelving, provides a complete truck which with its entire load is still light enough to be moved readily to various places about the plant.

The last illustration, Fig. 7, shows two trucks for complete typewriters that are ready for shipment. One of these trucks, in the background, is shown with no machines in place, in order that the proportions of uprights and platforms may be more clearly seen. The one in front has eight typewriters in position and can carry three times that number when the machines are placed closely together. This type of truck is used extensively in assembly and inspection departments and forms a common medium for handling the typewriters between the final assembly process and the shipping department.

A Book on Looks and Details of Machines--IV

BY JOHN E. SWEET

SYNOPSIS—This fourth installment takes up the design and oiling of sliding surfaces of planers, millers, shapers, punch presses, lathes and engines, applying the principle of equal length for equal wear. In regard to the slide rest of a lathe Professor Sweet writes, "One good guide is better than two poor ones, and short ones in such a case are always poor." The latter portion of the article is devoted to analyses of crank and link motions.

Sliding surfaces and their lubrication do not seem to have received the attention bestowed upon journals, and yet there is always more or less friction and proportionate waste. A true measure of this is the wear. As mentioned with journals, "Wearing surfaces that do not tend to wear out of truth do not wear much" is more evident when investigating slides than journals, and a careful investigation will lead to a careful consideration of proportions.

Iron planers seem to be about the only machine tools where this question of proper proportion has been seriously considered; and after years of use, observation of results has led to making the wearing surfaces of the bed somewhere near one and a half times the length of the table.

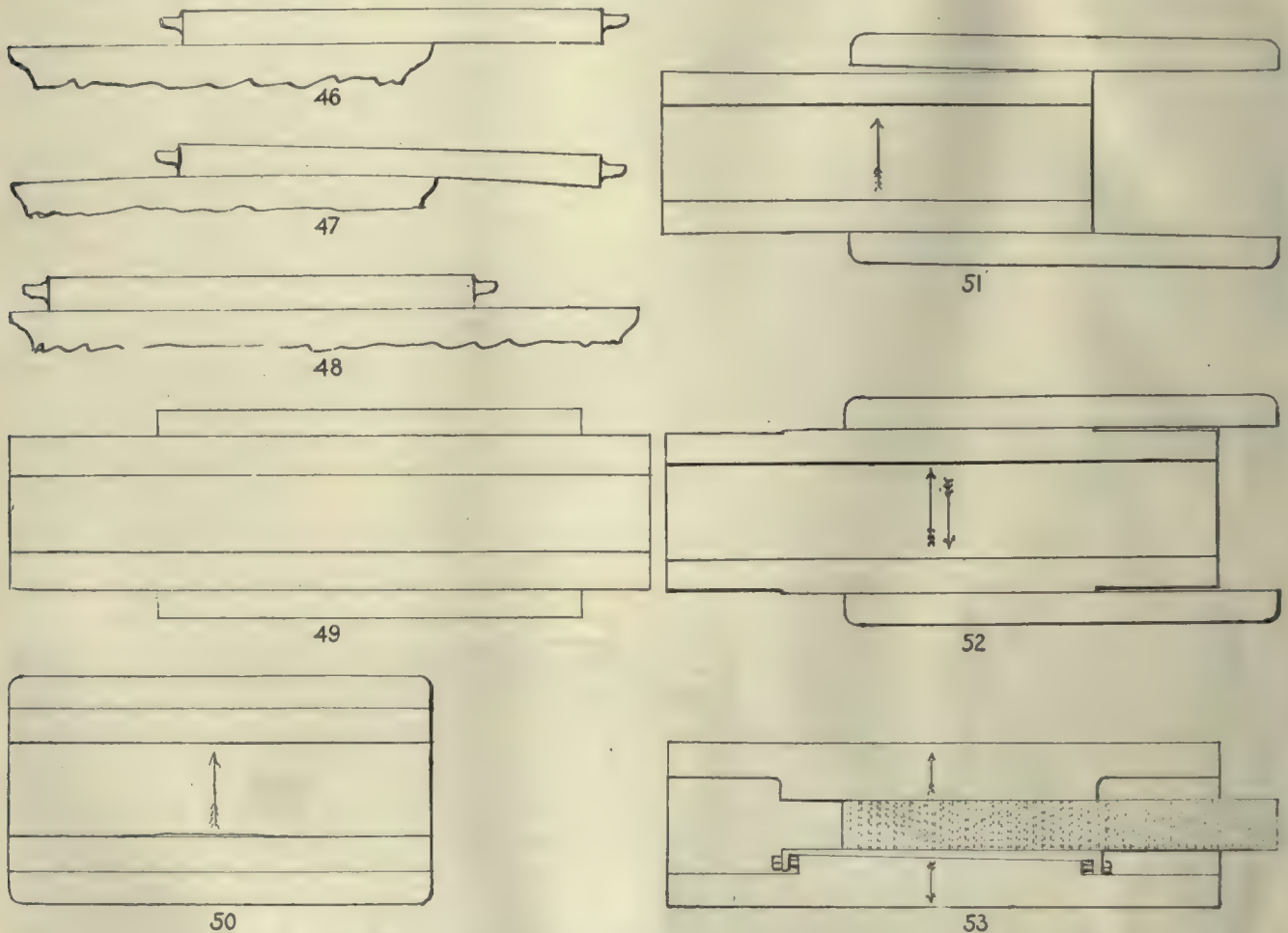
A consideration of the nature of the effect of the load will show why this is necessary and give the keynote of the whole subject, except that in the case of the planer the speed and load are about equal through the travel, whereas in the case of a crosshead of an engine they are variable with varying pressure.

If the bed and table were of the same length when the table was run out either way, the load per square inch of surface would increase more and more on the end of the bed and more and more in the center of the table, Fig. 46. This would tend to wear the bed crowning or convex and the underside of the table concave, Fig. 47. As a result the longer the machine was used the more crowning would the work done on it be. So long ago was this found out

and corrected that planers are built as they are, seemingly, Fig. 48, without the builders ever having a thought about the "why," or at least not enough to comprehend that the whole thing is due to gravity.

As an evidence of this, machines are being built by many builders in all countries where this is not taken into consideration, but followed because it is the practice of

Fig. 52, shorter than the wearing surface on the table. While it is not possible to get it exactly right, owing to the uncertainty of knowing to what extent long or short work will be done, it is plain that it should be shorter. A guess somewhere about two-thirds or three-quarters the length of the table will be about right. As this changes a thing from dead wrong to practically right and as it



FIGS. 46 TO 53. VARIOUS ARRANGEMENTS OF PLANER BEDS AND TABLES

Figs. 46 to 48—Wear of planer beds and tables. Fig. 49—Common arrangement of planer bed and table. Figs. 50 to 53—Arrangements of planer bed and table to insure equal wear

others—that is, with beds nearly one-half longer than the table. Then in the same machine, where the load is carried on flat ways and the side thrust resisted by vertical surfaces, Fig. 49, these are left in the same proportion, which is as wrong as wrong can be—not only because gravity no longer plays a part, but in the case of a planer, traversing or vertical-spindle miller the side pressure is at one point, and that in the center. So to determine the proper proportion in this case a new consideration of the subject comes up.

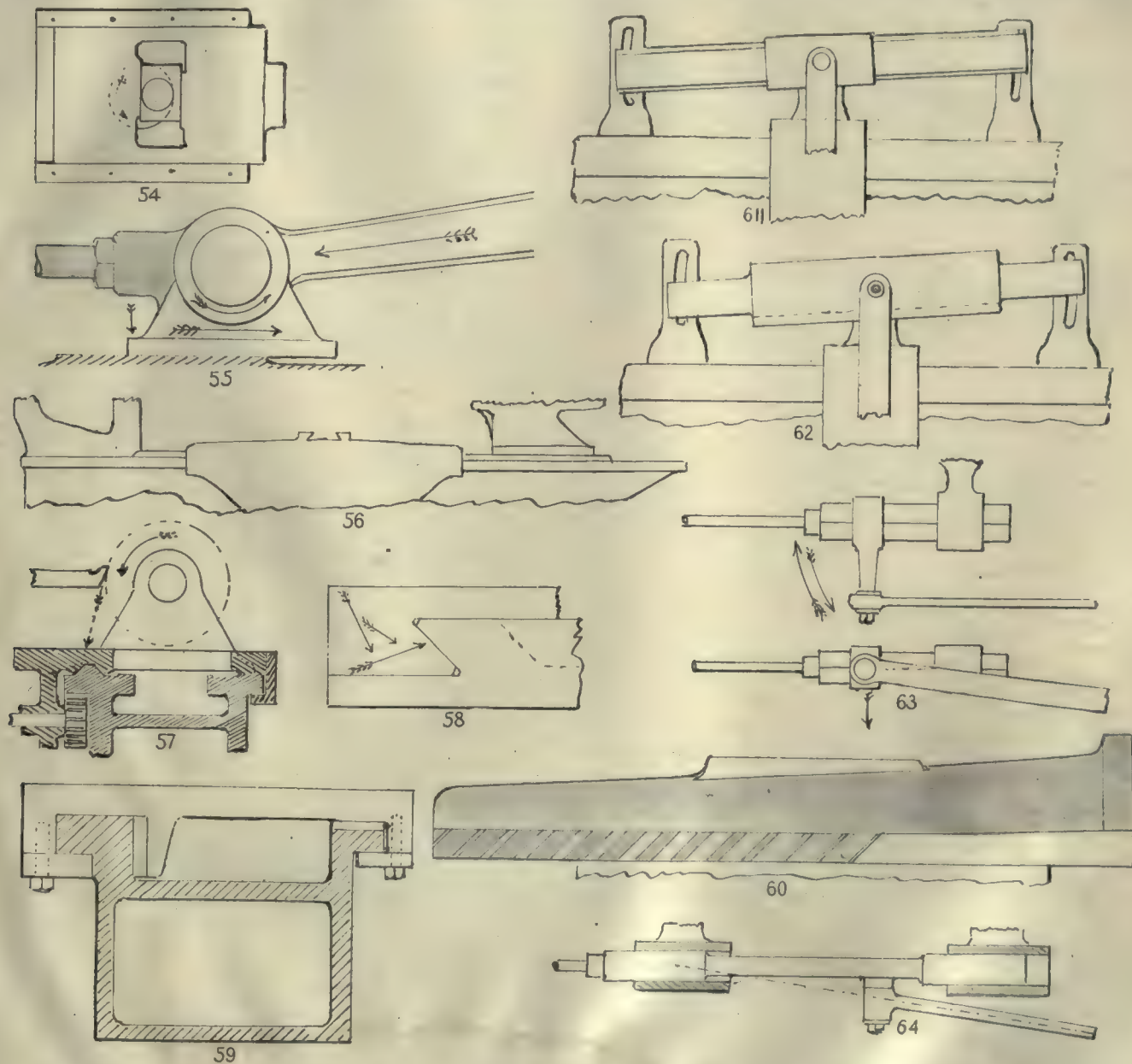
Assume that the two wearing surfaces are even, of equal length, Fig. 50. Then the side pressure of the cut will tend to wear out the middle of the bed guide when doing work at either end of the table, Fig. 51. When doing work at the middle, the wear will be even; but this will have no tendency to compensate for the other wear except to help generate a true curve. This tendency should be provided against in precisely the same way that the unequal horizontal wear was provided against—that is, by making one surface longer than the other—and in the only way possible, by cutting away the wearing surfaces of the bed,

costs less than half the money to make a thing straight that is only half the length, it would not seem necessary to argue the case, Fig. 53. It is better to make the side guides each side of the rack rather than outside the bed, as will be illustrated later.

In the case of a vertical-spindle milling or traversing machine, the bed should not exceed the table in length nearly so much as in the case of a planer, for the reason that in the planer it is a common practice to gang the work—that is, to place a number of small pieces end to end so that it is equivalent to long work—whereas in the case of the vertical-spindle machine there is no gain in time by so doing and the machine is worked a much greater length of time in the middle. In the case of horizontal-spindle millers of the planer type another condition is met with. The action of milling cutters is such that there is a heavy pressure down, so that when doing work at either end of the table and gravity are tending to wear the ways of the bed at the ends, the pressure of the cutter is tending to wear it at the center: so that while a planer may be right with its bed from 30 to 50 per cent. longer

than the table, in the case of the miller from 10 to 12½ per cent. longer is likely to be more nearly correct. In the case of small millers this pressure from the cutter may exceed the weight of the table so that a correct proportion might call for a bed a little shorter than the table, but as usually made they are all wrong. Twenty-four years of constant use of one where both the slide and guides were

because the crosshead is traveling the fastest and receiving the greatest pressure in the middle; in fact, there is no pressure at the ends except the weight of the crosshead in a horizontal engine. In large engines it is impractical to make the crossheads and guides of equal length, but the longer the wearing surface of the crosshead, if thoroughly oiled, the less it will wear; and the longer the crosshead



FIGS. 54 TO 64. DIFFERENT FORMS OF SLIDES AND GUIDES

Fig. 54—Punch-press ram and guides of equal length. Fig. 55—Slipper guide of high-speed engine. Fig. 56—Lathe carriage twice length of headstock. Fig. 57—Lathe rest guided in front. Fig. 58—The dovetail slide. Fig. 59—Right-angle guides. Fig. 60—Wearing surface of shaper ram. Fig. 61—Usual slide of taper attachment. Fig. 62—Better arrangement of slide of taper attachment. Fig. 63—Slide subject to twisting. Fig. 64—Slide subject to twisting and supported by two bearings

of the same length proved in that case that with liberal wearing surface practically no wear took place, as the guides have never been taken up and the table moves with the same freedom from shake as ever.

At about the same time a punching machine was built with a slide with equal-length wearing surfaces, 4x18 in., Fig. 54. The machine is still in use, having punched millions of holes. No provision was made for compensation for wear, and none has been needed.

In the case of a crosshead to an engine there is an additional tendency to wear the guides away in the middle,

the shorter the guides can be cut, and the nearer the two are alike the longer they will remain straight.

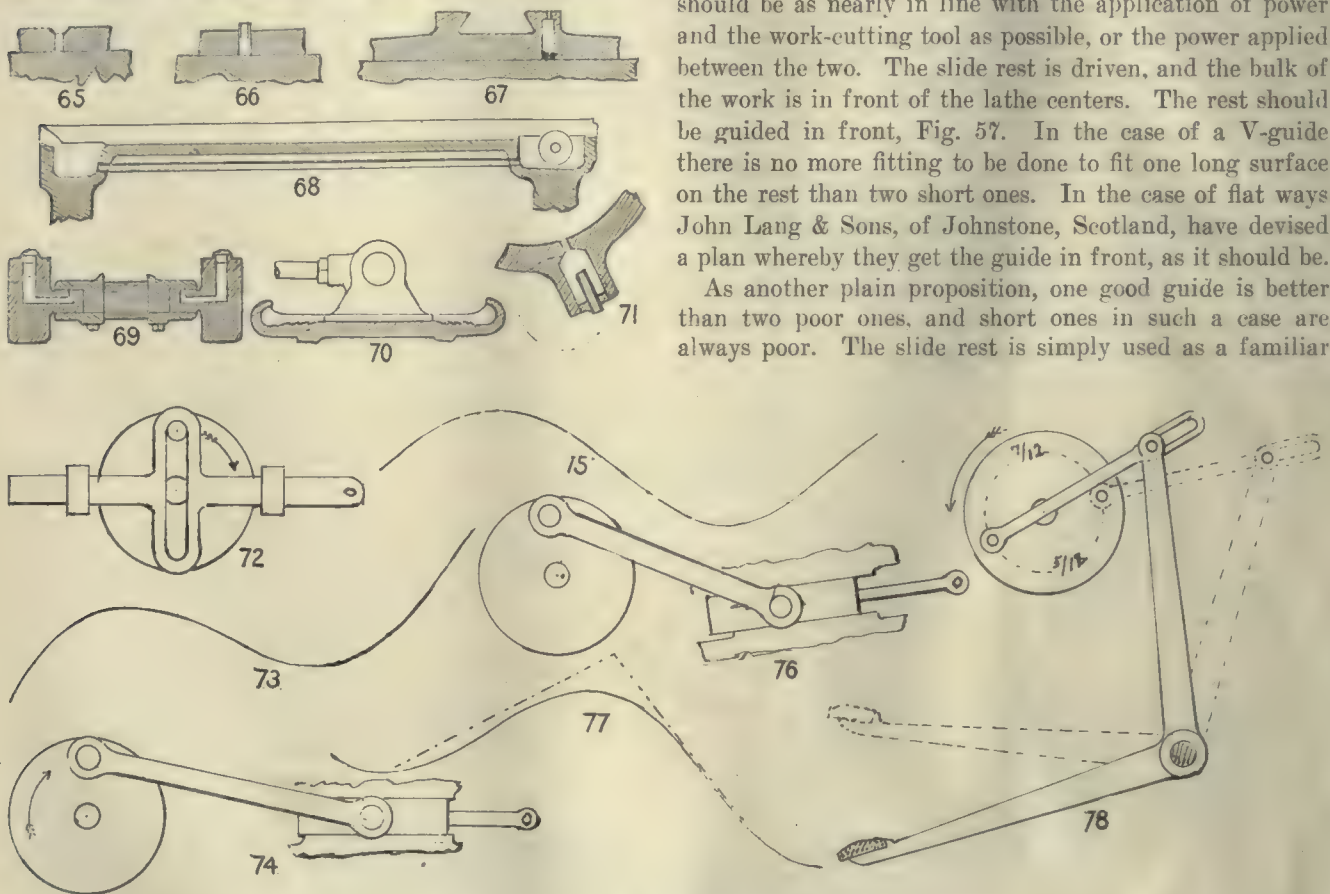
Designers keep extending the length of the crossheads and forget that it is of equal importance to cut off the guides. Instead of following common practice, which might have been the best years ago, this should not be done without giving each case separate consideration. Methods of doing work, stronger framing, better methods of lubrication may present valid reasons for changing. As a general proposition wearing surfaces should be of equal length, but a proper process of reasoning demon-

strated that in the case of planers and millers deviations from this rule are necessary.

In short-stroke high-speed engines this rule is right and can be followed where the splashing of oil can be controlled. In the case of high-speed engines where a slipper guide is used, Fig. 55, a considerable weight is below the center of the crosshead pin; the momentum tends to rotate the crosshead around the crosshead pin, and this throws all the wear at the end of the stroke on the back half

the width of the center cross-slide, Fig. 56, or probably about twice the usual length. Then, if the ways were cut off so as to come only to the headstock and an equal amount short of the other end of the bed, the lathe would be a great deal better for so doing, provided the slide casting was sufficiently rigid. The almost universal practice in guiding a slide rest, whether on vees or on flat ways, is anything but right. The same holds good in numerous examples. As a plain proposition the guiding elements should be as nearly in line with the application of power and the work-cutting tool as possible, or the power applied between the two. The slide rest is driven, and the bulk of the work is in front of the lathe centers. The rest should be guided in front, Fig. 57. In the case of a V-guide there is no more fitting to be done to fit one long surface on the rest than two short ones. In the case of flat ways John Lang & Sons, of Johnstone, Scotland, have devised a plan whereby they get the guide in front, as it should be.

As another plain proposition, one good guide is better than two poor ones, and short ones in such a case are always poor. The slide rest is simply used as a familiar



FIGS. 65 TO 78. VARIOUS CRANK AND OILING MECHANISMS

Figs. 65 to 67—Oil holes for slides. Fig. 68—Oiling arrangement for planer table. Fig. 69—Unsuccessful oiling arrangement for crosshead. Fig. 70—Ratchet teeth on lower surface of crosshead guide. Fig. 71—Oil well for part having circular motion. Figs. 72 to 77—Crank motions and their curves. Fig. 78—Quick-return motion for machine treadle and its curve

of the crosshead. In starting back, the inertia that has to be overcome by the piston rod will throw the wear in the same place; at the other end of the stroke the same action takes place, and where there is any elasticity in the piston rod all the work and metal put upon the guide beyond the length of the stroke are wasted, only if the crosshead runs over a pocket of oil it splashes worse than when it simply runs over a small distance at the end of the stroke.

Observation will show probably that the bulk of all sliding surfaces consist of a long guide and a comparatively short sliding piece. No doubt this is largely due simply to following precedent and generally without a thought as to whether it is in any way justified by reason. If all were governed by reason and if all were as nearly correct as the uncertainties of use, space and conditions would permit, the majority would be of equal length.

There are certain places where the slide cannot be as long as the guide, such as the slide rest of a lathe or the crosshead of a 12-ft. stroke engine; but the slide rest can usually be twice the whole length of the headstock and

example. Whether a flat way, a vee or a dovetail is the best depends upon the conditions.

In the case of a small lathe the vee, however much worn, does not permit shake—a merit that cannot be claimed for the flat and square-edge guide. On the other hand, the flat guide has more wearing surface and runs more easily; but if the vees were as long and large as they ought to be, there would not be much difference. Dovetail slides are sometimes preferable to square ledges, because when the strain is in one general direction, Fig. 58, the slide will be rigid, however much worn; the bevel edges prevent shake, but wear faster, and a little wear gives a good deal of looseness. When the guide must be free from shake in all directions, the right-angle guides, Fig. 59, with double gibs are best. Where the tendency is to wear away unequally, as is the case in a shaper ram, Fig. 60, the only remedy is to have surface enough where the pressure is greatest, and little enough where it is light. Wearing surfaces, like foundations, should be in proportion to their load, where it is desirable to keep them true, as is of course always the case.

Most of our modern designers realize the importance of liberal wearing surface where it is needed, but very few have the courage to cut it away where it does more harm than good.

The slide of a taper attachment—of all things—should be free from shake, and it is easy to make it so when it is new. In service, except on rare occasions, they are used for only a very few inches of their length and are made with a sliding block not one-fourth the length of the guide,

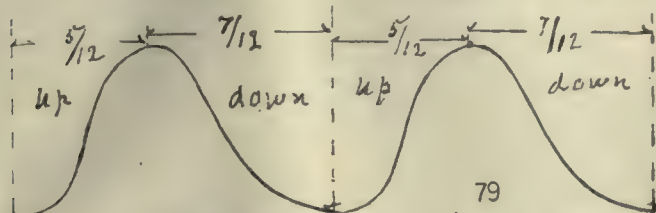
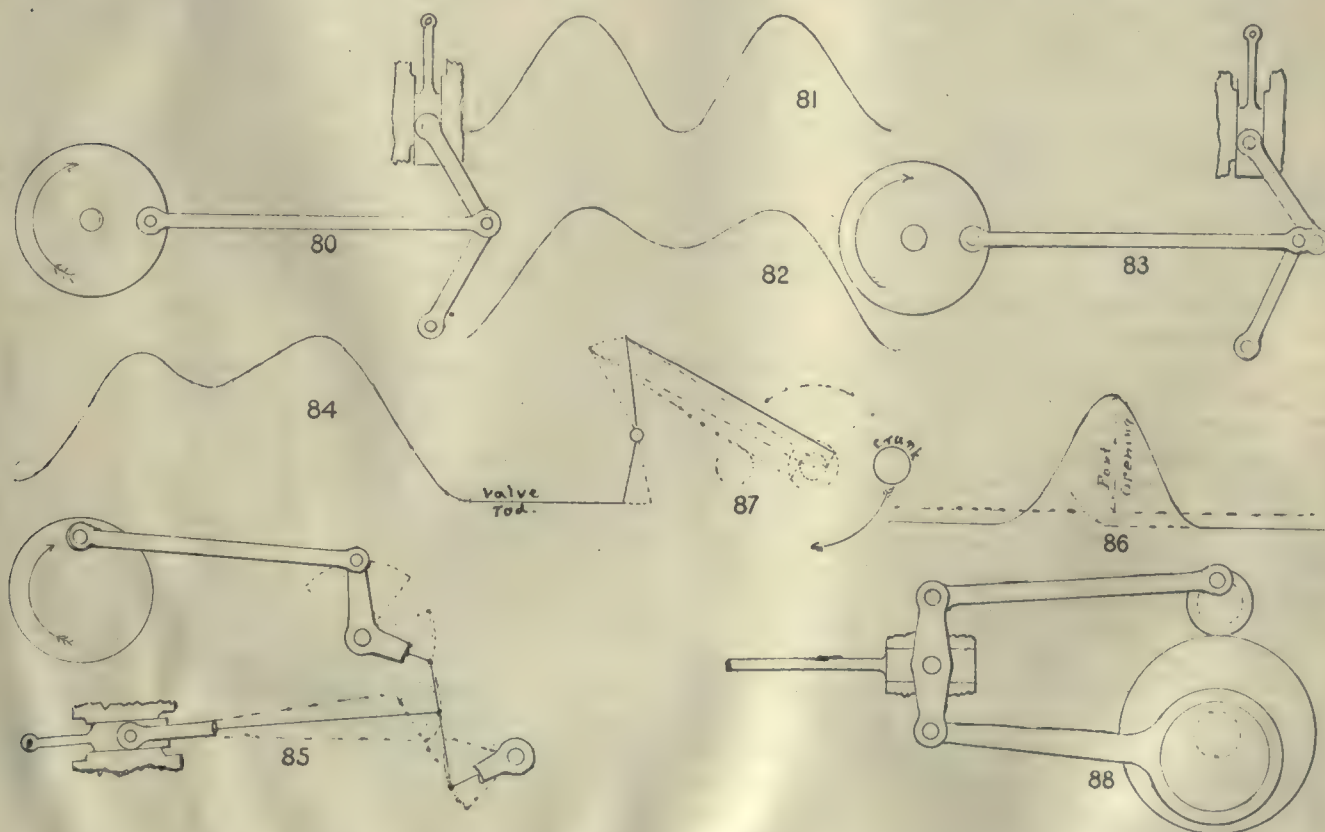


FIG. 79. CURVE FOR FOOT-LATHE PEDAL MOTION

and are left with their ends even, the wearing surfaces are perfectly protected from dirt and injury.

Slides subject to twisting as well as to side strain are not uncommon and are often treated in a very indifferent manner. A most common example is that of the valve-rod slide of steam engines, Fig. 63. The offset in the line of motion puts on a side strain, and the angularity of the eccentric rod a twisting one. The side strain can best be resisted by two bearings as far apart as possible and with equal-length bearing surfaces, Fig. 64; and the twisting strain better by a wide, thin slide than a square one. The twisting strain can be largely neutralized by connecting the eccentric rod at an angle, putting the end pressure on the eccentric and wristpin in the slide.

The proper lubrication of sliding surfaces is too often left a matter of chance. The designer plans everything else and then lets the workman scheme the oil holes himself. He always puts them in too small, and then to make



FIGS. 80 TO 88. MOTIONS AND CURVES OF TOGGLE-JOINT AND CRANK MECHANISMS

Figs. 80 to 84—Toggle-joint motions and their curves. Figs. 85 to 87—Modified crank motions and curves. Fig. 88—Engine-valve gear

or for, say, a 26-in. guide a 6-in. slide (see Fig. 61). This would permit turning a taper 20 in. long if one should ever want to do that. Even then the guide is sure to wear in the middle and leave the slide slack; or if set up, fail to go at the ends. In this construction there is 32 in. of surface to fit, and there is never but 6 in. of bearing surface. If the two pieces were each 16 in., Fig. 62, or one 18 in. and the other 14 in., then there would be only the 32 in. to fit, the bearing would vary from 16 in. to 14 in., where mostly used, to the same 6 in. when run the extreme 20 in., which would seldom if ever come. The wear would be insignificant, and when taken up would work equally freely throughout. A further advantage of no mean importance is this: When the two are of a length

them convenient countersinks them to hold dirt, Fig. 65. A projection is better than a countersink, and this is easily made by drilling the hole large enough and inserting a short piece of tubing, Fig. 66.

When the travel of a slide is less than its length, the large hole will hold quite a little oil, which is desirable when oiling from a squirt can. Oiling the slide rest of lathes, a place where builders seldom make provision for oiling, is a conspicuous example of—not to say half doing a job, but not doing it at all. Oil pockets that would introduce the oil near the middle and compel it to work out at the ends, Fig. 67, would save oil, wash out the grit better and insure better lubrication than any amount of care in trying to coax oil in at the ends.

Modern planers with the oiling wheels buried in oil pockets are more like it, but they should have oil pipes leading from the end pockets back to the middle ones, Fig. 68, as the oil has a tendency to work out and overflow the end pockets.

Oiling the crossheads of high-speed engines presents some difficulties, as the action is one tending all the while to scrape off the oil rather than to gather it in. Rounding up the ends so as to run over the oil means to run over any dirt that may collect on the guides. An attempt to oil by carrying the oil down below the wearing surface along a canal and then up underneath produced an unlooked-for result in a long crosshead, Fig. 69. No oil, of course, would reach the surface until the outer chamber was filled up as high as the wearing surface; and after it had reached that point, the crosshead acted as a pump and would then at once pump out most of the oil into the chamber and the canal.

A method whereby the lower guide is made short and the splashing of the oil pretty effectually prevented is one where the surface at the ends is slightly lower than the moving surface and crosscut in the form of ratchet teeth; Fig. 70.

Where an oil pocket is made in a connecting-rod or eccentric strap, the circular path through which it travels tends to throw the oil out. If an oil-tight cap is forced into the top and a small tube extended down a little below the center, Fig. 71, the oil cannot be thrown out by the circular motion.

A true crank motion—that is, a crank working in a slotted crosshead, Fig. 72, or Scotch yoke, as it is called—produces what, if drawn out in the form of a diagram, would be a true sinuous line with both the upper and lower curves alike, Fig. 73; but if the motion is communicated through a connecting-rod, Fig. 74, it is modified to a greater or less degree, dependent upon the length of the connecting-rod and the angle of the guide. If the slide is, as usual, moving directly back and forth toward the shaft, then the sinuous curve will be contracted at one—say the lower—part of the curve, Fig. 75, and to a similar amount expanded on the upper part.

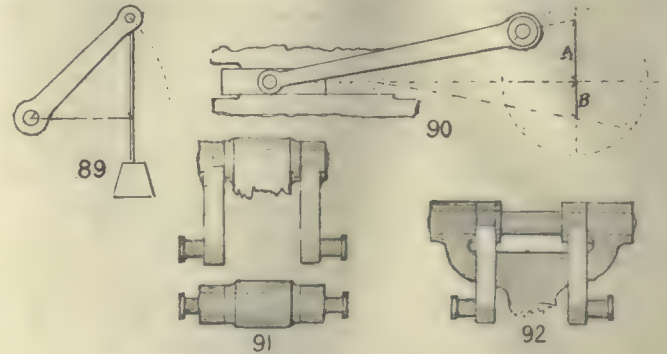
The lines each side of the dead-center line will be alike in curvature. But if the slide travels at an angle, Fig. 76, then the right and left sides of the curves, Fig. 77, will be unequal. Any number of variations of these curves can be made by changing the length of the rod or the angle of the slide. As many different curves as can be made, so many different motions of this character can be produced—some of them useful. Not only a quick return, but a quick reversal at one end and a slow one at the other can be obtained. Utilizing this feature makes one of the best possible treadle motions for a foot lathe, Fig. 78. Arranged as shown by the diagram, Fig. 79, there is not only a quick return, the pedal making the up journey in less than a half revolution and the down taking more than a half, but what adds more to its value (and that cannot be accomplished in any other or cheaper way), the change from up to down is the quick change when the leg is in a position to act quickly, and a slow reversal from the down to the up where a quick change would be tiresome. In this example the rocker arm takes the place of a slide acting at an angle. Almost any conceivable motion can be obtained from a crank or eccentric in connection with links and levers.

In connection with a toggle joint, Fig. 80, two complete reciprocating motions are obtained for each revolution.

It will be seen that the motion is a peculiar one, Fig. 81. The reversals are very quick, and for about five-sevenths of the travel the motion is nearly uniform.

By so locating the toggle in relation to the length of the connecting-rod that it moves farther past the center one side than the other, a slight recoil only is given at one point and then a complete return, Fig. 82.

The use of the toggle in connection with the crank for producing two motions has been used to save a pair of gears. By a modification of the attachment of the toggle



FIGS. 89 TO 92. ROCKER ARMS AND LEVERS

Fig. 89—Weighted lever. Fig. 90—Tendency of connecting-rod to rotate crankshaft. Fig. 91—Rocker arm that gives twisting motion. Fig. 92—Rocker arm with spread bearings

to the connecting-rod, Fig. 83, another diagram is made. The slide moves forward and then recoils, Fig. 84, then goes forward the second time, but farther than the first time for receding.

A still more marked deviation from the simple crank motion is in the valve motion of an engine, Fig. 85, where the result is exactly that of a cam motion, Fig. 86. While the eccentric or crank moves continuously, the valve is quickly opened and closed and quietly brought to rest, then remains without motion while the engine completes the remainder of its revolution.

By using a shifting eccentric in the place of the crank, the action is as perfect in every feature as the drop motion of the Corliss machine. Shifting the eccentric in the proper direction gives a constant lead or a variable lead, as may be required, and controls the cutoff as perfectly as any shaft-governed engine. All the foregoing diagrams are produced by a single revolution of the crank, and the whole length of diagram is used for one revolution. The diagram illustrates the motion. While this motion is like a cam motion in its best form, it is better, because it is quiet and all the journals have liberal wearing surfaces, whereas with the closed cam, wear soon permits lost motion and a noise. Another form of using the crank motion and angular lever for valve motion is when a constant lead is obtained from the use of a shifting eccentric, Fig. 87. When the crank of the engine is placed on either dead center, the eccentric can be moved from its greatest travel to its least and back without giving motion to the valve. Variable motions may be obtained by the combination of cranks or eccentrics.

By gearing an engine with an eccentric to a second shaft, Fig. 88, revolving three times as fast, carrying a crank and connecting the rods from the eccentric and crank to a link, and from the middle of the link attaching the valve-rod slide, with the proper adjustment a motion that will give a short cutoff and prolonged exhaust is obtained. This provides for almost any sort of desirable steam distribution. The port opening and closing is rapid.

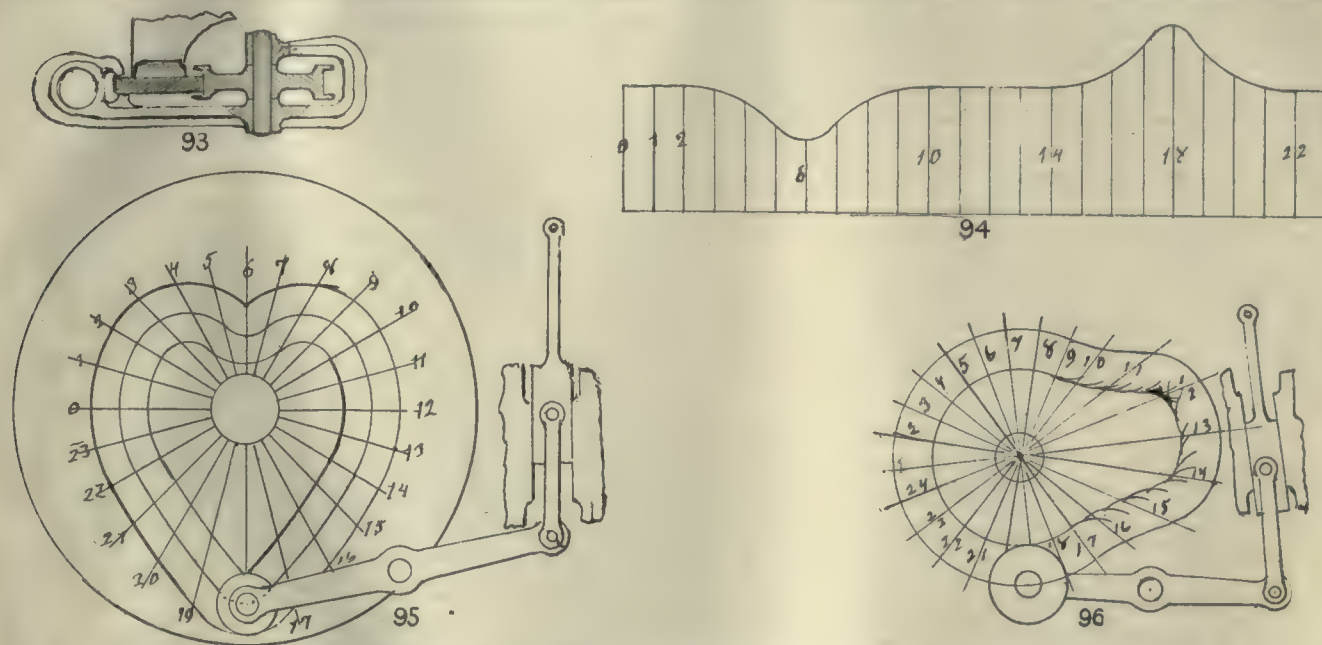
The objection to it is the rapid rotary motion of the crankshaft.

By the combination of two cranks running at varying speeds, or one shaft through the center of another at varying speeds, the inner one carrying a crank, an oval turning lathe or a lathe for relieving taps and cutters can be made to work more quietly and as perfectly as cam motions.

At times when lever arms work at an angle, as in the above case, it is not a simple proposition readily to figure

lar section. Or a double arm or forked arm, so as to take both ends of the pin with the line of strain central, is better. Under certain conditions it is advisable to have the pin fast in the link and two bearings in the rocker arm.

This, too, is the correct way to arrange the journals of sheaves, Fig. 93, tightening pulleys and the like. Where the sheave, such as used in overhead pulleys, is simply a loose fit running on a fixed pin, the hole soon wears bell muzzle on each side and allows the sheave to wobble.



FIGS. 93 TO 96. MECHANICAL ARRANGEMENTS FOR SHEAVES, CRANKS AND CAMS

Fig. 93—Good arrangement for journals of sheaves. Fig. 94—Variable motion not obtainable from crank. Fig. 95—A cam motion. Fig. 96—Development of cam path

the rate of motion, power required or work done at any particular point, but this can readily be determined graphically. A weight may be sustained at the end of a lever set at an angle, Fig. 89. Its tendency to rotate it around its center is the same as if attached to a horizontal lever of the length of the horizontal line from the center of the shaft to the sustaining line, but this is modified in the case of a connecting-rod and crank. Assume the example to be a horizontal engine, Fig. 90. The tendency the connecting-rod has to rotate the shaft is measured the same as if the rod extended to a crank the length of the vertical line directly above the shaft A, or on the return stroke the same as if it was working on a crank only of the length from the center of the shaft to the center line of the rod B.

Often, rocker arms are used so as to put a twisting strain on the journal, Fig. 91, causing an unnecessary wear, lost motion and objectionable action. A case of this kind is where the driven and driving arms are on the same side of the rockshaft. Where this arrangement is imperative, as is the case in one-half the valve motion of a duplex pump, the only remedy is to give two bearings to the rockshaft, Fig. 92, and to set them as far apart as possible.

When possible to put the arms on opposite sides of the shaft, a single bearing for the rockshaft will do, provided a line drawn through the center of the two wristpins in the rocker arm falls through the center of the rockshaft journal.

Where considerable work comes on rocker arms with the wristpins in the sides, a twisting strain comes on the arms, and a good form for the arm would be a hollow rectangu-

Besides, they are difficult to oil except from the inside of the shaft out, and this method receives too much neglect in such places to depend upon that system; moreover, the system of two bearings is correct.

Where reciprocating motions are required so variably as not to be obtainable from a crank or eccentric, Fig. 94, the form of the surface of the cam where it works upon the roller is never in accord with the motion required, but modified so as to give the proper motion to the center of the roller, Fig. 95. The method of developing the form is shown by this illustration, Fig. 96, and this whether the cam is on the face or edge of a disk or the surface of a cylinder.

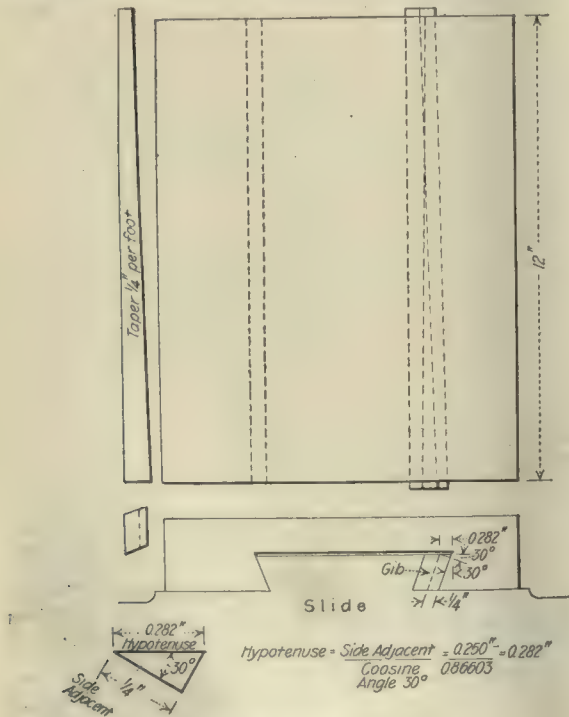
An open cam—that is, where the roller follows the cam surface to move the roller in one direction and gravity serves to bring it back—will do for slow motion, but not for fast, as gravity may not act rapidly enough. Often a spring will not do so; hence a closed cam must be used. The objection is that the roller has to reverse its direction twice every revolution. Sometimes a shuttle is used in the place of a roller, but in this case the cam must be laid out the same as for a roller.

Change in Mexican Taxes on Metals—Mexico has suspended the export tax on metals from Dec. 10, 1916, until Dec. 31, 1917; but has assessed the following internal taxes: Gold and silver bullion, 5 per cent. of assay value; gold and silver ores, 7 per cent.; copper bullion, 5 per cent.; copper ore, 6 per cent.; and other metals, 3 per cent. The determination of values for revenue purposes by the Treasury Department is on the basis of New York prices: Silver and copper, market price without deduction; zinc on 75 per cent. assay result and value calculated on New York price after deducting costs of treatment and freight charges; other metals at export prices.

How To Plane a Taper Gib Correctly

BY WILLIAM P. WINTERS

In the illustration is shown a slide that is fitted with a tapered gib of $\frac{1}{4}$ in. taper per foot; the slide, as an example, is shown to be 12 in. long. In planing this slide the first thing the planer hand will do is to get a taper gib and use that in setting over the slide when planing the dovetail on the taper gib side. It is natural for him to do this, as he believes the taper of the gib to be $\frac{1}{4}$ in. per ft., and the drawing specifies a taper $\frac{1}{4}$ in. per ft. I have shown the proper distance to set over a slide 12 in. in length for a taper of $\frac{1}{4}$ in. per ft. and with the dovetail angle at 30 deg. It will readily be seen that when the gib is put into the slide the taper per foot becomes changed



THE SLIDE AND GIB

on account of the angle of the dovetail and, as in this case, the proper taper for planing is 0.282 in. per ft. I have shown the example clearly and further explanation is not necessary. For figuring out the set-over the following method can be used, no matter what the taper per foot and angle of the dovetail. Divide the taper per foot of the gib by the cosine of the dovetail angle, and that will give you the proper taper for planing the slide. When you have found this taper, make as many gibs as you need with this special taper and use these for setting over the slides. If you do this, the trouble of fitting the taper gibs will be all over for the vise hand. It is not necessary for me to mention the amount of time saved, as there is nothing that gives more trouble than fitting a taper gib when the taper of the work is not the same.



Ethical Business Principles

[The following "business creed" was drawn up by Prof. Vladimir Karapetoff, of the Electrical Engineering Department, Sibley College, who dedicated it to the Junior Engineers of the New England Westinghouse

Co., when he left the employ of the company this September.—Editor.]

Accuracy—We believe in accuracy in all our acts, statements, reasoning, workmanship, appointments, promises, drawings; in fact, in everything that is associated with our name.

Veracity—We believe in veracity toward our associates, superiors, subordinates, clients, competitors, beggars, benefactors, members of our family, and especially toward our own conscience when it is accusing us.

Fulfilling a Promise—We believe that fulfilling one's promises in spite of all obstacles and against one's own advantage is the greatest single asset and virtue in business.

Initiative—We believe in initiative, which in the business world usually means helping everyone around you without being told to do so and without being obnoxious.

Keeping Superiors Posted—We believe in keeping our superiors posted on what we are doing so as to simplify their supervision over us. Having finished a task we report at once, or if the job could not be done we notify the head man without delay. We train our boss so that when he does not hear from us he knows that everything is O. K.

Surprises Should Not Be Sprung—We believe that no surprises should be sprung on our business associates in the form of an unexpected official act or letter. It is both wise and honorable to discuss a matter with a person informally and to find his attitude toward it before taking a decisive step.

Harmonizing Views—We believe in harmonizing views whenever possible and in foregoing a distinct name for the sake of friendship with those to whom this name may be offensive.

Coöperation—We believe that a lasting monument is usually a result of wise and unselfish coöperation wherein everyone works on the part he is best suited for and is so busy and interested in the work that he forgets to hew his name on the stone.

System, Order and Self-Discipline—We believe in system, order and self-discipline for the sake of those with whom we are associated. This is but a specific case of the Golden Rule and it works fine. We do not tax our memory beyond reason because an omission or a misstatement may hurt a friend of ours.

Being Openminded—We believe in being openminded because we remember many a case when we were glad that things did not turn out our way and sorry when they happened the way we wanted them to.

Giving Full Credit to Others—We believe in giving full credit to others because real worth cannot be hidden very long, and a professional thief is not a very far-sighted individual.

Persuasion Rather Than Command—We believe in persuasion rather than command for the same reason for which we prefer an electrically started automobile. Incidentally, the most efficient organizations are those in which the men understand what they are doing and believe in the method of procedure.

Mobilizing Resources—We believe in mobilizing the resources of our organization when an important problem arises. We see to it that those whose skill or knowledge exceeds ours are drawn into the discussion and not kept out for a selfish reason.—*The Sibley Journal of Engineering.*

United States Munitions

The Springfield Model 1903 Service Rifle

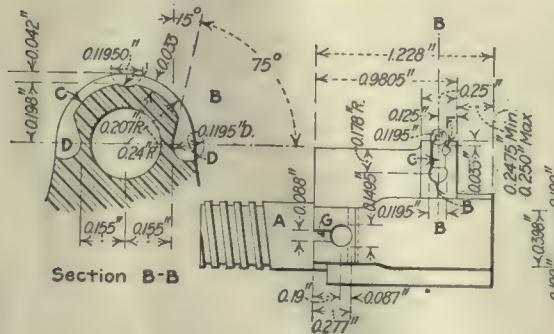
The Springfield Model 1903 Service Rifle

Operations on the Sleeve--I

SYNOPSIS—In this article is begun the description of manufacturing operations on the sleeve, giving full data concerning operations, speeds, feeds, etc. Jigs, tools, fixtures and gages are shown.

The sleeve, which becomes a part of the bolt so far as the operation of the firing mechanism is concerned, is

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Forged Steel, Case Harden

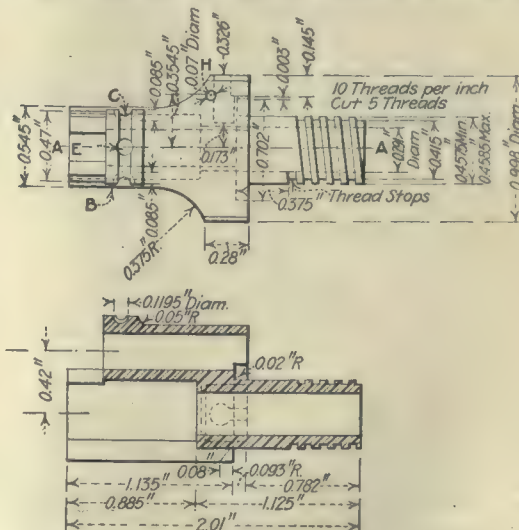


FIG. 749



FIG. 750. OP.A

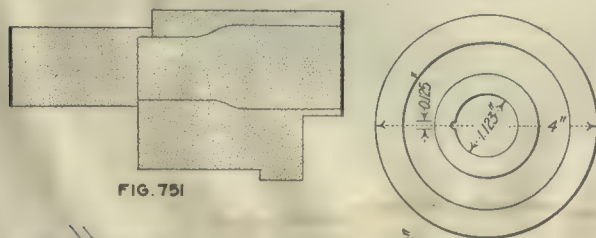


FIG. 751

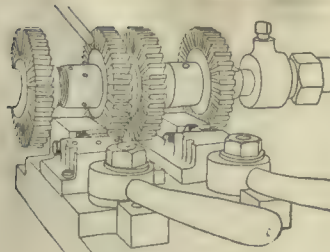


FIG. 752

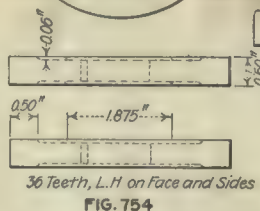


FIG. 754

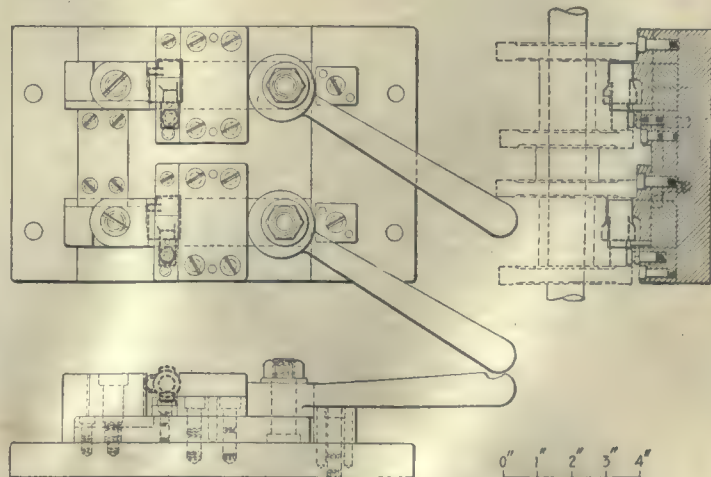
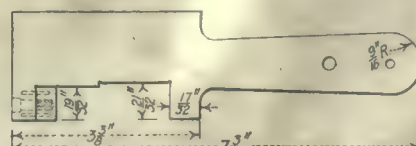


FIG. 753



STEEL (Harden)

OPERATION 1

OPERATION A. FORGING FROM BAR

Transformation—Fig. 750. Number of Operators—One. Description of Operation—Forging sleeve from bar; size of bar, 0.80 in. square. Apparatus and Equipment Used—Billings & Spencer 400-lb. drop hammer. Production—120 per hr.

OPERATION B. ANNEALING

Number of Operators—One. Description of Operation—Packed in cast-iron pots with powdered charcoal; heated to

850 deg. C. (1,562 deg. F.) and left over night to cool. Apparatus and Equipment Used—Cast-iron pots; Brown & Sharpe annealing furnaces.

OPERATION B-1. PICKLING

Number of Operators—One. **Description of Operation**—Sleeves are placed in wire baskets and then in wooden tanks holding the pickling solution, in which the sleeves are left about 10 min.; only one pickling; pickling solution is 9 parts

water to 1 part sulphuric acid. Apparatus and Equipment Used—Wire basket, wooden pickling tanks, hoisting-pulley blocks.

OPERATION C. TRIMMING (COLD)

Machine Used—Bliss back-geared press. Number of Operators per Machine—One. Punches and Punch Holders—Punch held by square shank. Dies and Die Holders—Held in shoe by setscrew. Average Life of Punches—15,000 pieces at one grinding. Dies—Same. Production—500 per hr.

OPERATION 1. MILLING ENDS

Transformation—Fig. 751. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Operators per Machine—One. Work-Holding Devices—Cam-operated vise jaws, Fig. 753. Tool-Holding Devices—Standard arbor. Cutting Tools—Four side-milling cutters. Fig. 754. Number of Cuts—One. Cut Data—60 r.p.m.; $\frac{1}{8}$ -in. feed. Coolant—Cutting oil, $\frac{1}{16}$ -in. stream. Average Life of Tool Between Grindings—1,500 pieces. Gages—Fig. 755. Production—60 per hr.

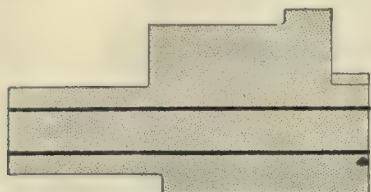


FIG. 756

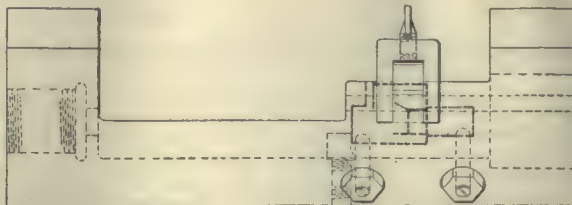


FIG. 757

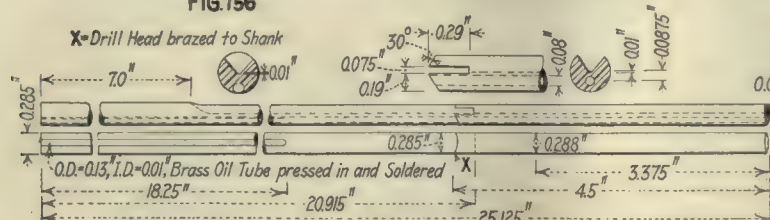
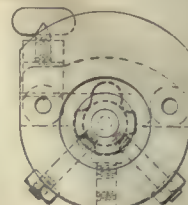


FIG. 758



FIG. 760

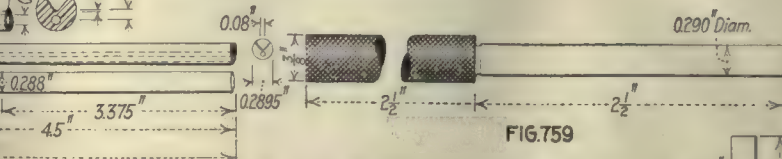
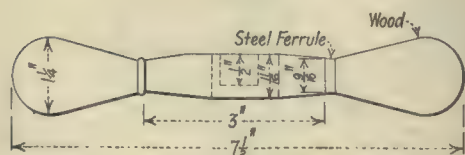


FIG. 759

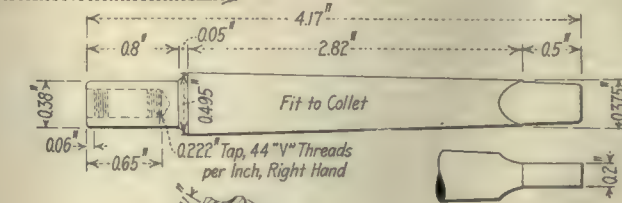


FIG. 761

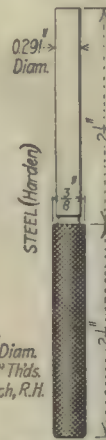


FIG. 762

OPERATION 2

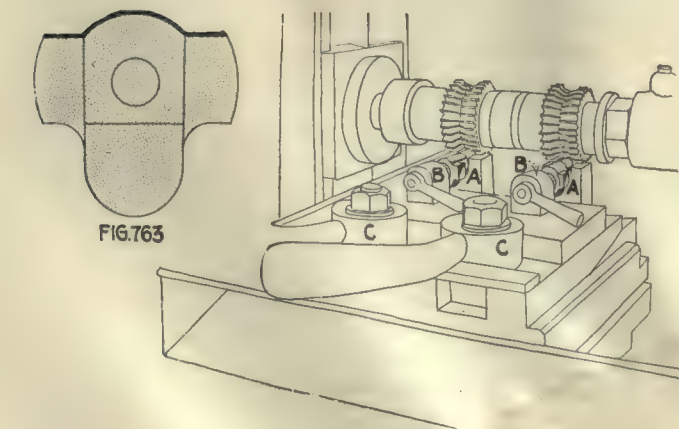


FIG. 763

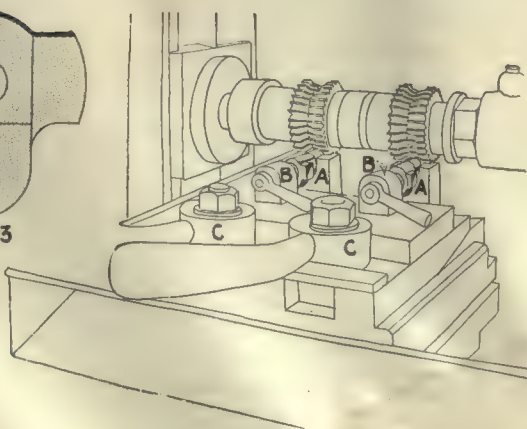


FIG. 764

OPERATION 5

OPERATION 2. DRILLING LARGE HOLE

Transformation—Fig. 756. Machine Used—Pratt & Whitney horizontal drilling machine, similar to Fig. 582. Number of Operators per Machine—One. Work-Holding Devices—Work held on pins, clamped to revolving fixture, Fig. 757. Tool-Holding Devices—Drill held in collet by setscrew. Cutting Tools—Barrel type of drill, Fig. 758. Number of Cuts—One. Cut Data—1,200 r.p.m.; $\frac{1}{8}$ -in. feed. Coolant—Cutting oil, $\frac{1}{4}$ -in. stream. Average Life of Tool Between Grindings—25 pieces. Gages—Fig. 759. diameter of hole. Production—40 per hr.

OPERATION 3. REAMING LARGE HOLE

Transformation—Same as Fig. 756. Machine Used—Drilling machine made at shops. Number of Operators per Machine—One. Work-Holding Devices—Work held by hand in special holder, Fig. 760. Tool-Holding Devices—Reamers held in collet by setscrew. Cutting Tools—Scrape reamer, Fig. 761. Number of Cuts—One. Gages—Fig. 762. Production—40 per hr.

OPERATION 5. MILLING BOTTOM LENGTHWISE

Transformation—Fig. 763. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Operators per Machine—One. Work-Holding Devices—On stud at A and mandrel B; clamped on ends by cam C, Fig. 764; details in Fig. 765. Tool-Holding Devices—Standard arbor. Cutting Tools—Form cutters, Fig. 766. Number of Cuts—One. Cut Data—90 r.p.m.; $\frac{1}{8}$ -in. feed. Coolant—Compound, two $\frac{1}{4}$ -in. streams. Average Life of Tool Between Grindings—2,000 pieces. Gages—Fig. 767; A, position

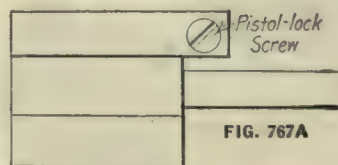
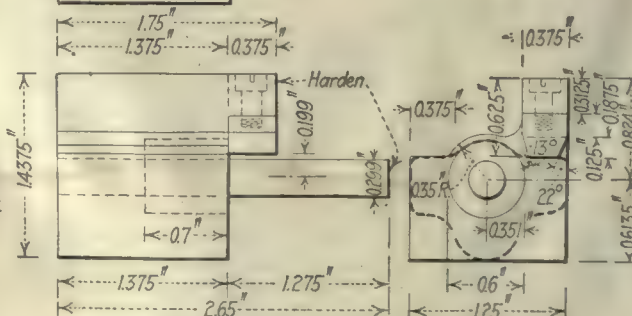


FIG. 767A



of under side with relation to bore; B, radius of bottom. Production—80 per hr. Note—Work-holding points, hole and under side.

OPERATION 6. MILLING RIGHT AND LEFT SIDES OF LUGS

Transformation—Fig. 768. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Operators per Machine—One. Work-Holding Devices—On stud and mandrel clamped to end, Fig. 769; Fig. 770 shows details of fixed stud A, movable mandrel B and cams C. Tool-Holding Devices—Standard arbor. Cutting Tools—Two form cutters, Fig. 771. Number of Cuts—One. Cut Data—90 r.p.m.; $\frac{1}{8}$ -in. feed. Coolant—Compound, two $\frac{1}{4}$ -in. streams. Average Life of Tool Between Grindings—2,000 pieces. Gages—Fig. 772, radius of right and left lugs. Production—80 per hr. Note—Work-holding points, hole and under side.

made of Class D steel, 0.80 in. square in the rough, and drop forged in the usual manner. Full details of the sleeve are shown in Fig. 749. The material is treated in

in the back end of the bolt; but instead of being screwed firmly to the bolt, as is the case with the receiver and the barrel, the bolt has a 90-deg. movement in the sleeve be-

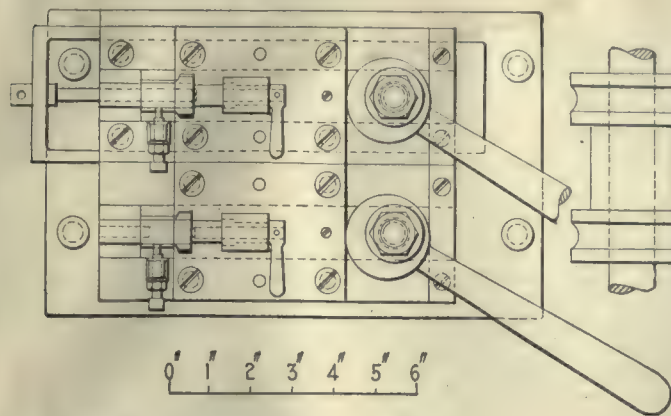


FIG. 765

OPERATION 5

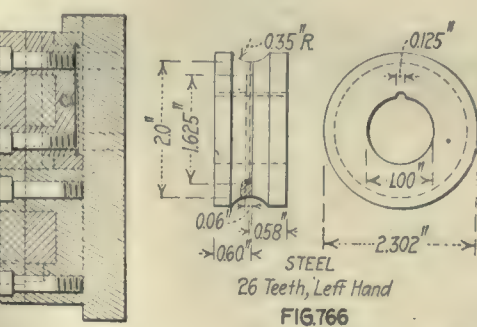


FIG. 766

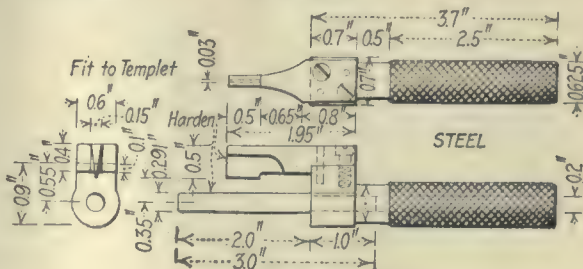


FIG. 767-B

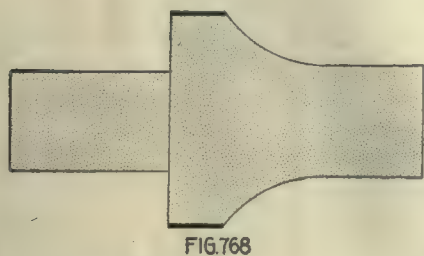


FIG. 768

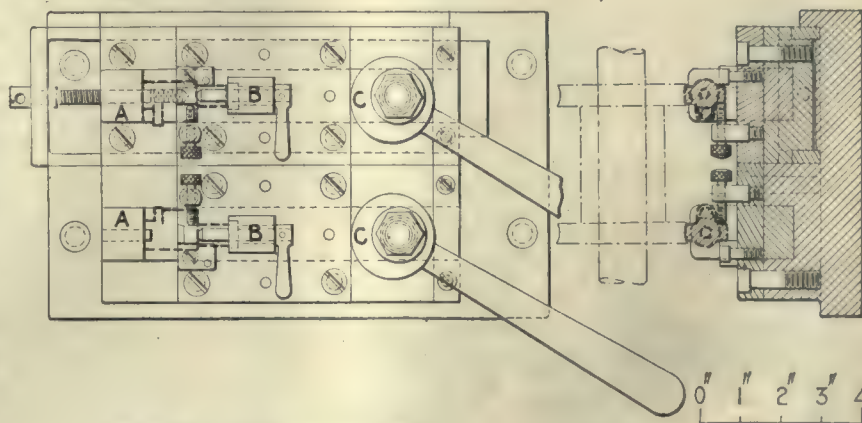


FIG. 770

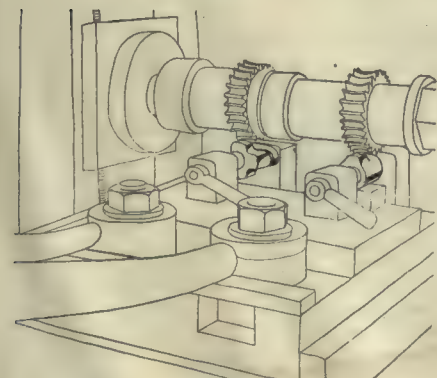
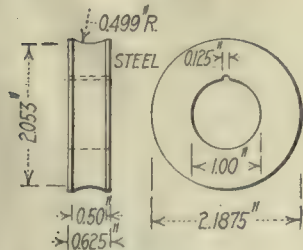


FIG. 769



24 Teeth, Left Hand
FIG. 771

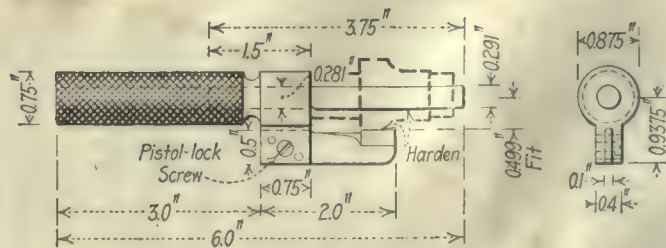


FIG. 772

OPERATION 6

the same way as all other steel of the same class and is casehardened in much the same way as the receiver already described. The sleeve is threaded to fit the tapped hole

between its loading and its firing position. The working points are the hole and under side of the right-hand lug. These are also used in gaging the various operations.

The main points of the sleeve are the barrel *A*, safety-lock seat *B*, safety-lock plunger groove *C*, recess *D* for retaining the safety lock when turned to the right or left, the recess *E* for retaining the safety lock in dismounting the bolt mechanism, the bevel *F* for dismounting the safety lock from the sleeve, the sleeve-locking recess *G* and the sleeve-locking pin hole *H*. There are also the safety-lock spindle and the firing-pin hole, the cocking-piece groove and the undercut for the rear end of the bolt, but none of these, as it happens, are shown in Fig. 749.

OPERATION AA. REMOVING BURRS FROM FIRING-PIN HOLE

Number of Operators—One. Description of Operation—Removing burrs thrown up around firing-pin hole. Apparatus and Equipment Used—File and reamer, Fig. 773. Production—Production grouped with operations 5 and 6.

OPERATION 4. FACING REAR END

Transformation—Fig. 774. Machine Used—Pratt & Whitney 10-in. speed lathe. Number of Operators per Machine—One. Work-Holding Devices—Held on pilot with a wooden hand holder, Fig. 775; details of holder, Fig. 776. Tool-Holding Devices—Stud in tailstock. Cutting Tools—End mill, taper shank, Fig. 777. Number of Cuts—One. Cut Data—320 r.p.m.; hand feed. Coolant—Cutting oil, $\frac{1}{8}$ -in. stream. Average Life of Tool Between Grindings—3,500 pieces. Gages—Fig. 778 length. Production—175 per hr.

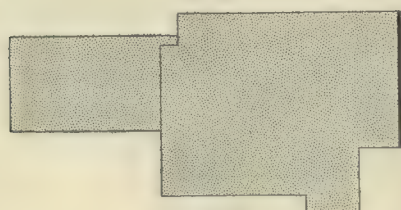
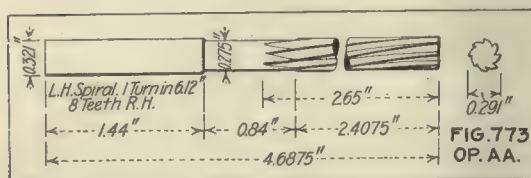


FIG. 774

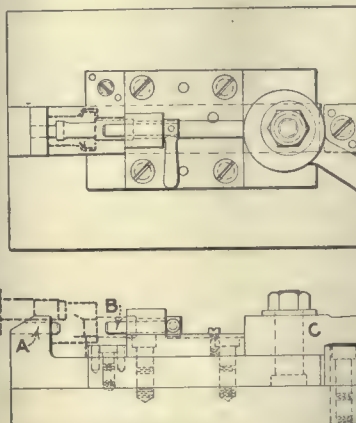


FIG. 775

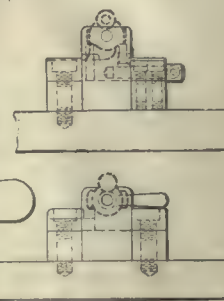
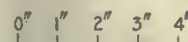


FIG. 776

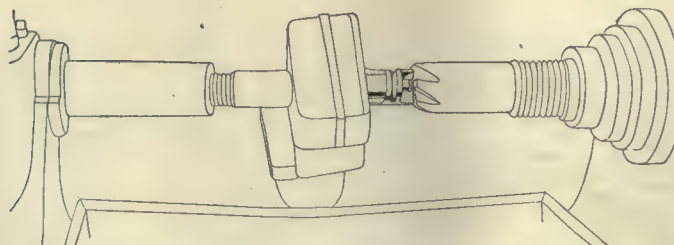
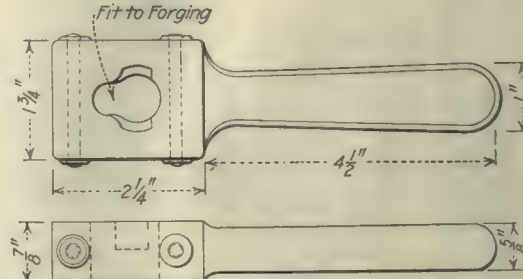
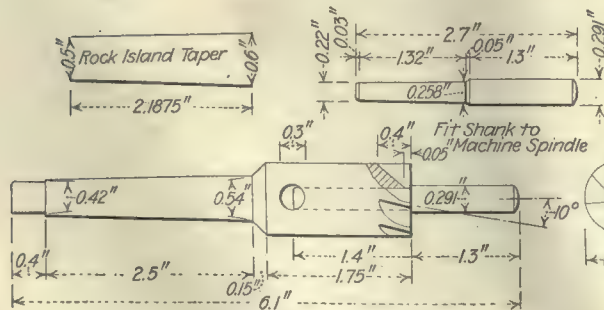


FIG. 777



Holder (Wood)



Cut 7 Teeth in End, R.H.

FIG. 779

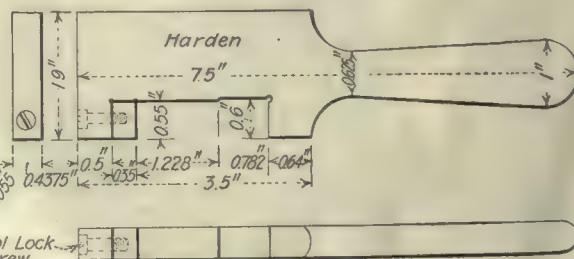


FIG. 778

OPERATION 4

OPERATIONS ON THE SLEEVE

- | | | |
|--|----|--|
| Operation | 21 | Drilling three holes for safety-lock spindle |
| A Forging from bar | 22 | Hand-milling groove for safety-lock spindle spring |
| B Annealing | 15 | Drilling sleeve-lock and pin holes |
| B-1 Pickling | GG | Removing burrs from sleeve-lock pin hole |
| C Trimming | 17 | Profiling locking-lug slot |
| 1 Milling ends | HH | Removing burrs left by operation 17 |
| 2 Drilling large hole | 18 | Threading barrel |
| 3 Reaming large hole | 19 | Counterboring cocking-piece seat |
| 5 Milling bottom lengthwise (5, 6, AA combined) | 20 | Milling cocking-piece slot |
| 6 Milling right and left sides of lugs | II | Removing burrs left by operation 20 |
| AA Removing burrs from firing-pin hole | JJ | Removing burrs from firing-pin hole |
| 4 Facing rear end | 23 | Milling matching groove recesses for safety-lock spring spindle |
| 7 Hollow-milling barrel and facing to length | 24 | Filing edges of cocking-piece slot and safety-lock thumb-piece bearing |
| BB Removing burrs left by operation 7 | 25 | Reaming safety-lock spindle hole and countersinking firing-pin and safety-lock spindle holes |
| 8 Hand-milling for safety lock, rough | 26 | Rotary-filing matching safety-lock spindle recesses with spindle groove. |
| 9 Drilling, reaming and counterboring safety-lock spindle hole in gang driller | 27 | Polishing exterior surfaces |
| DD Reaming burrs from firing-pin hole | 28 | Filing, general cornering |
| 10 Milling right and left sides of body | 29 | Casehardening |
| 13 Profiling over safety-lock spindle hole | 30 | Assembling with sleeve, lock pin and spring, and safety lock |
| EE Removing burrs left by operation 10 | | |
| 14 Hand-milling seat for safety lock | | |
| 11 Profiling over top of lugs and safety-lock spindle hole | | |
| FF Removing burrs from firing-pin hole | | |



FIG. 779

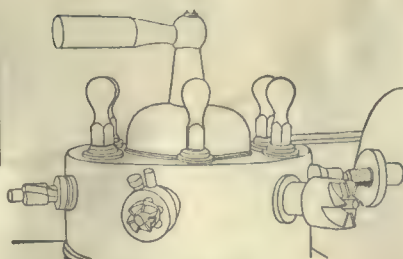


FIG. 780

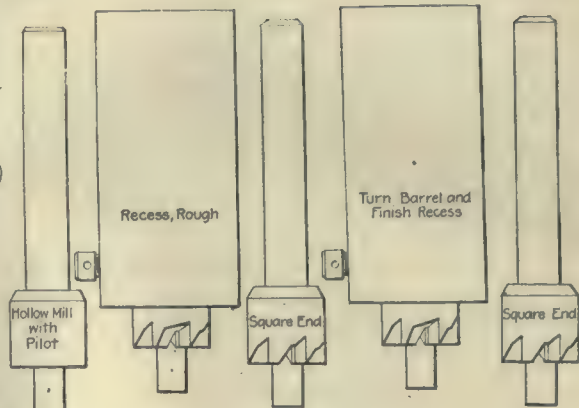


FIG. 780A

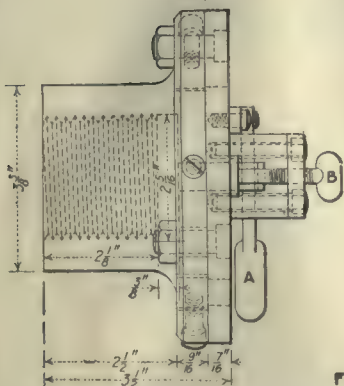


FIG. 781

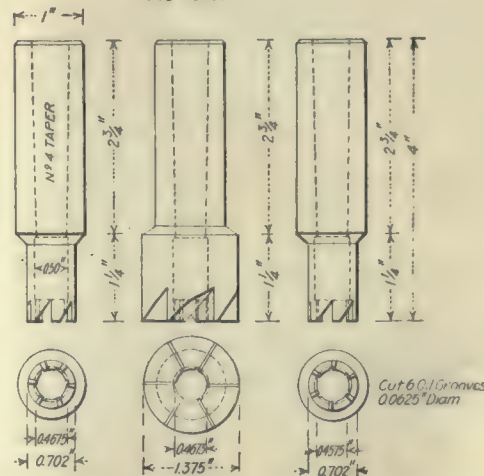
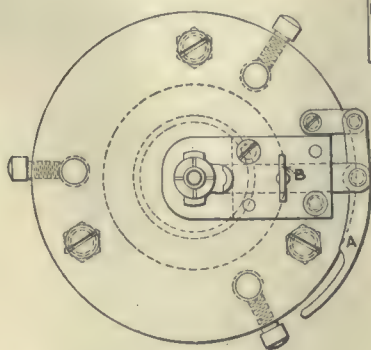


FIG. 782

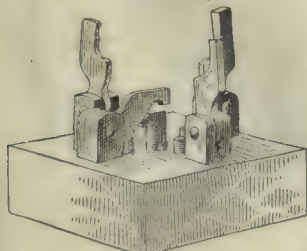


FIG. 783

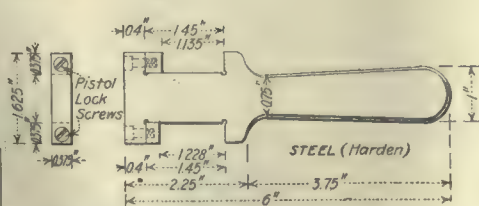


FIG. 783B

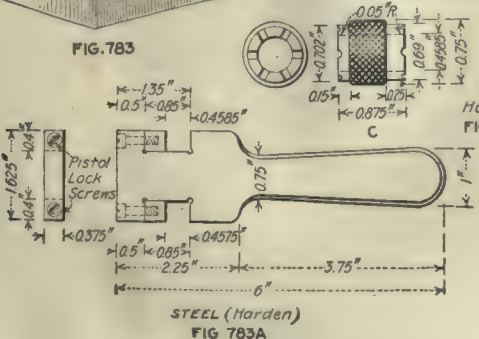


FIG. 783A

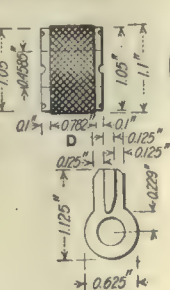


FIG. 783C

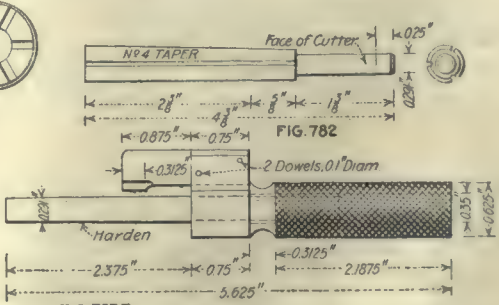


FIG. 783E

OPERATION 7



FIG. 784

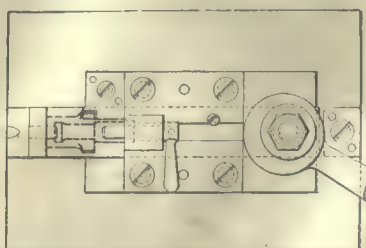


FIG. 785

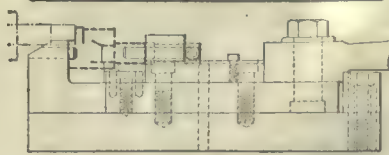
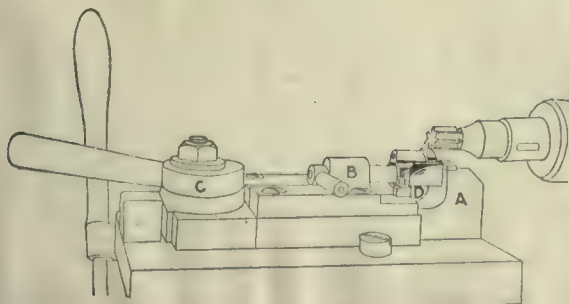


FIG. 786

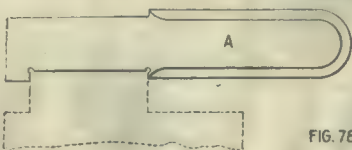
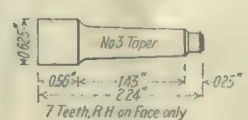
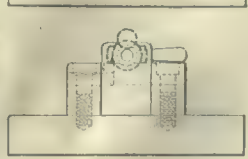
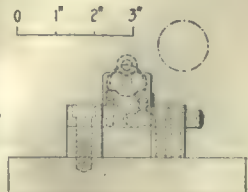


FIG. 787



OPERATION 8

OPERATION 7. HOLLOW-MILLING BARREL AND FACING TO LENGTH

Transformation—Fig. 779. Machine Used—Pratt & Whitney 16-in. hand screw machine. Number of Operators per Machine—One. Work-Holding Devices—On stud in special chuck; Fig. 781, which is fastened to faceplate by three setscrews on studs; jaw is moved by lever A and held by thumb-screw B. Tool-Holding Devices—Turret of machine, Fig. 780; machine diagram, Fig. 780-A. Cutting Tools—Cutters, Fig. 782. Cut Data—200 r.p.m.; hand feed. Coolant—Cutting oil, $\frac{1}{4}$ -in. stream. Average Life of Tool Between Grindings—200 pieces. Gages—Fig. 783; A, barrel diameter; B, length of body; C, length of barrel from undercut; D, length of barrel from shoulder; E, concentricity of barrel and hole. Production—20 per hr.

OPERATION BB. REMOVING BURRS LEFT BY OPERATION 7

Number of Operators—One. Description of Operation—Removing burrs thrown up by operation 7. Apparatus and Equipment Used—File. Production—Grouped with operation 8.

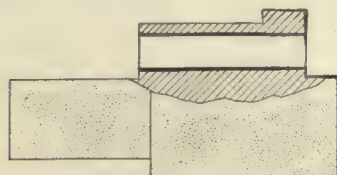


FIG. 785

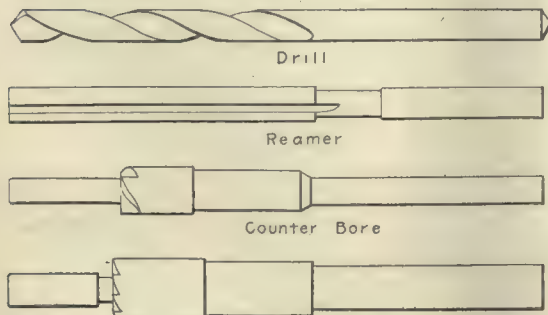


FIG. 786A

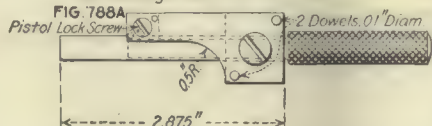


FIG. 793B

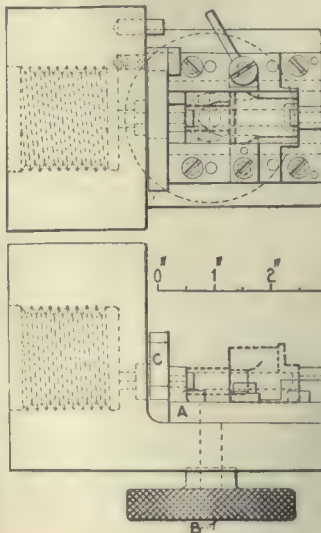
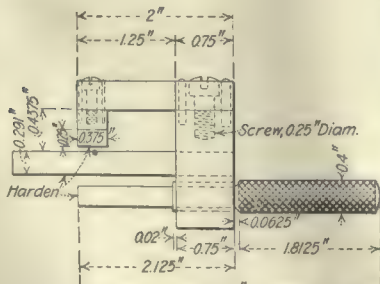
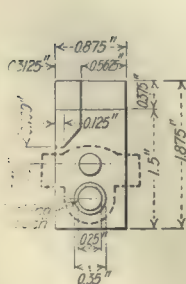


FIG. 790

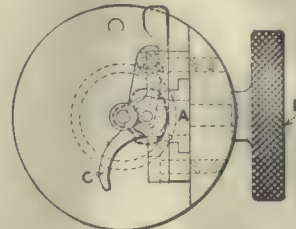


FIG. 789

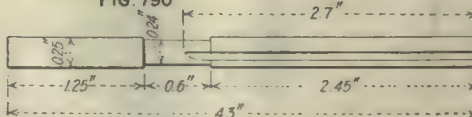


FIG. 791

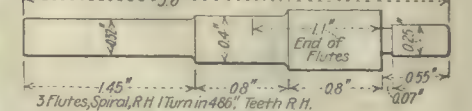


FIG. 792A

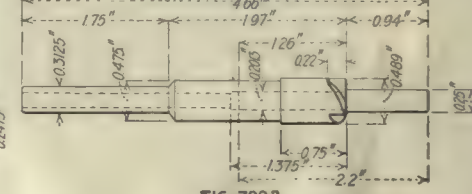


FIG. 792B

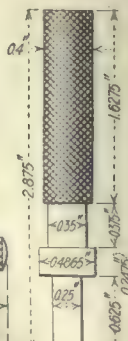


FIG. 793A

OPERATION 9

OPERATION 8. HAND-MILLING FOR SAFETY LOCK ROUGH

Transformation—Fig. 784. Machine Used—Pratt & Whitney No. 2 hand miller. Number of Operators per Machine—One. Work-Holding Devices—On stud in A, mandrel B, the jaw carrying A being drawn in with cam C, the under side is located by stop D, Fig. 785; details in Fig. 786. Tool-Holding Devices—Taper shank, Fig. 787. Cutting Tools—One end mill. Number of Cuts—One. Cut Data—600 r.p.m.; hand feed. Coolant—Cutting oil, drop at a time. Average Life of Tool Between Grindings—500 pieces. Gages—Fig. 787; A, length of top of body. Production—350 per hr.

OPERATION 9. DRILLING, REAMING AND COUNTERBORING SAFETY-LOCK SPINDLE HOLE IN GANG DRILLER

Transformation—Fig. 788; machining diagram, Fig. 788-A. Machine Used—Pratt & Whitney 16-in. hand screw machine. Fig. 789. Number of Operators per Machine—One. Work-Holding Devices—In fixture on stud, Fig. 790; slide A carries a stud and is moved into the hole in sleeve by a cam operated by knurled handle B; lever C is dropped behind the slide A and locks it in place. Tool-Holding Devices—Holes in turret. Cutting Tools—Drill, counterbore and bottoming tool, Fig. 791; A, reamer; B, counterbore shown in Figs. 792 A and B; C, counterbore for safety-lock seat; drill guided in bushing A, Fig. 789.

Cut Data—Two speeds (150 r.p.m. and 250 r.p.m.), fast for drilling; slow for reaming; hand feed. Coolant—Cutting oil $\frac{1}{2}$ -in. stream. Average Life of Tool Between Grindings—20 pieces. Gages—Fig. 793; A, diameter of hole and counterbore. B, alignment of both holes with working point on under side. Production—40 per hr.

OPERATION DD. REMOVING BURRS FROM FIRING-PIN HOLE

Number of Operators—One. Description of Operation—Removing burrs from firing-pin hole left by operation 9. Apparatus and Equipment Used—Hand reamer (see Fig. 773) and file. Production—Grouped with operation 9.

OPERATION 10. MILLING RIGHT AND LEFT SIDES OF BODY

Transformation—Fig. 794. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Operators per Machine—One. Work-Holding Devices—On stud B, clamped at end by cam lever C, Fig. 795; located by stop A; details in Fig. 796. Tool-Holding Devices—Arbor. Cutting Tools—Form cutters, Fig. 797. Number of Cuts—One. Cut Data—60 r.p.m.; $\frac{1}{8}$ -in. feed.

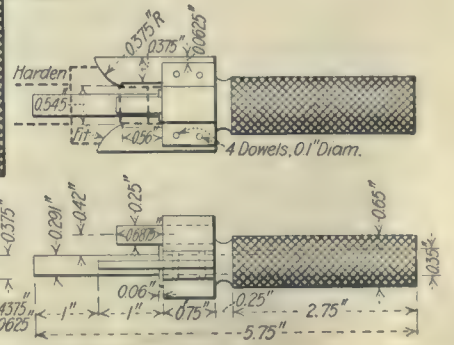
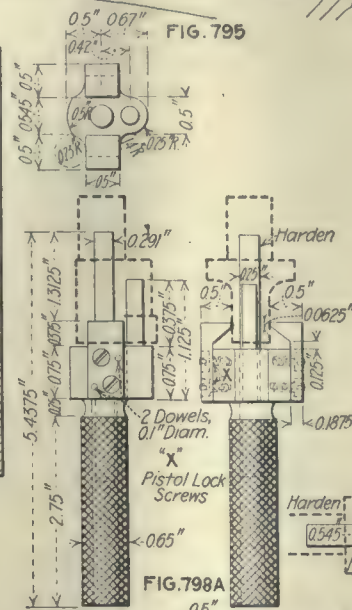
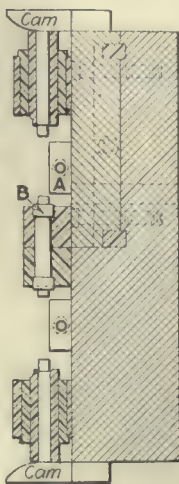
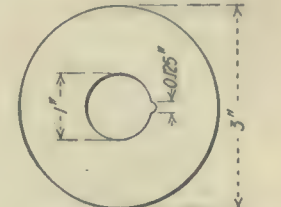
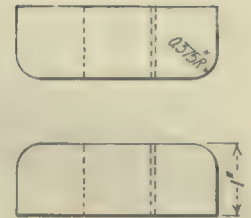
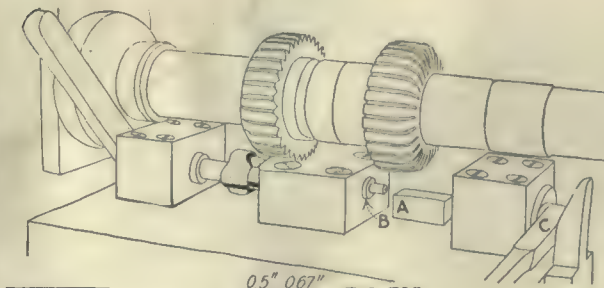
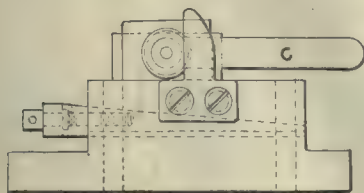
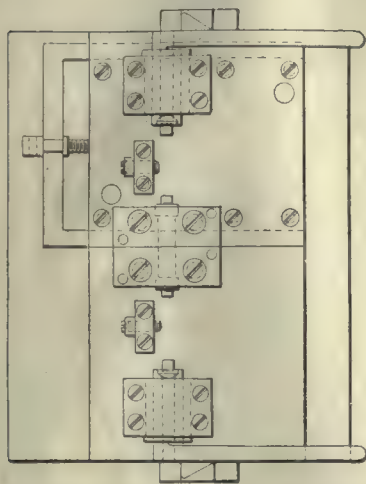
Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—2,000 pieces. Gages—Fig. 798; A, relation of sides to bore; B, contour of sides and bore. Production—50 per hr. Note—Work-holding points, hole and side.

OPERATION 13. PROFILING OVER SAFETY-LOCK SPINDLE HOLE

Transformation—Fig. 799; machining diagram, Fig. 799-A. Machine Used—Pratt & Whitney No. 2 profiler. Number of Operators per Machine—One. Work-Holding Devices—In vise jaws at neck of sleeve, Fig. 800; details in Fig. 801; work is located on pins in holes. Tool-Holding Devices—Taper shank; Cutting Tools—End mill, Fig. 802. Cut Data—1,000 r.p.m.; hand feed. Coolant—Compound, two $\frac{1}{4}$ -in. streams. Average Life of Tool Between Grindings—300 pieces. Gages—Fig. 803; sleeve slides on plug A and under side of sleeve seats against a stop behind sleeve; finger B drops over sleeve and rests on post C to show contour; the sleeve is then reversed, the finger slid along on bar D until it seats on post E and other side is gaged. Production—70 per hr.

OPERATION EE. REMOVING BURRS LEFT BY OPERATION 10

Number of Operators—One. Description of Operation—Removing burrs thrown up by operation 10. Apparatus and Equipment Used—File. Production—Grouped with operation 14.



OPERATION 10

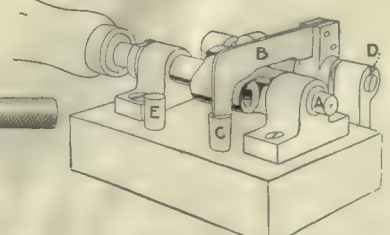
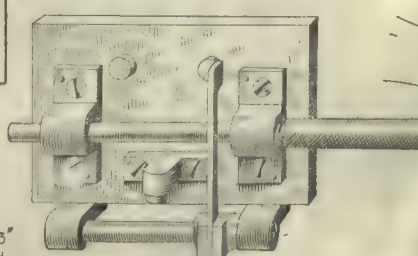
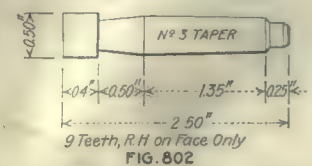
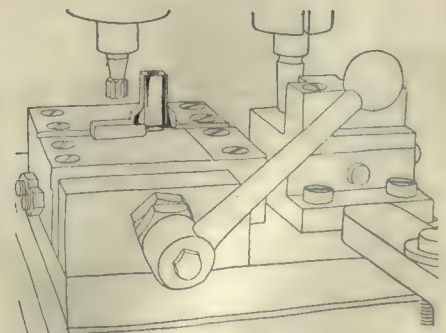
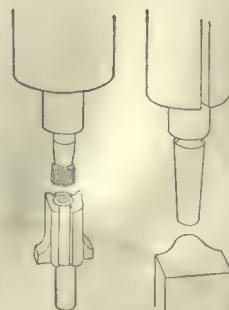
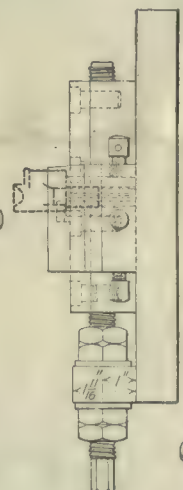
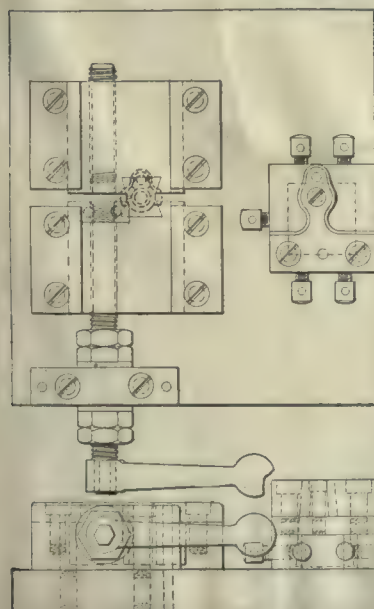
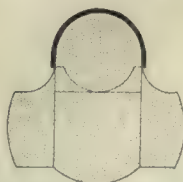


FIG. 801

OPERATION 13

FIG. 803



FIG. 804

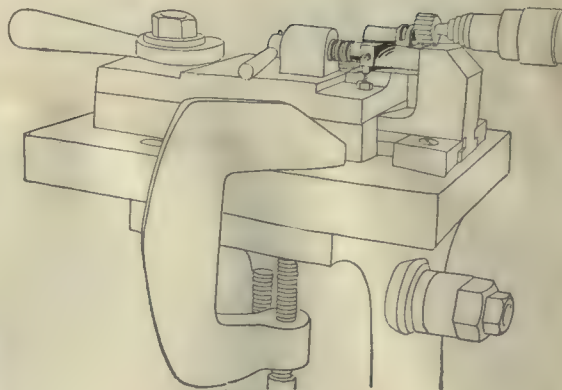
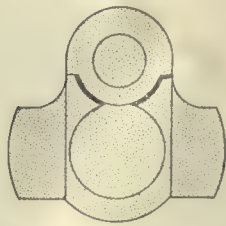


FIG. 806

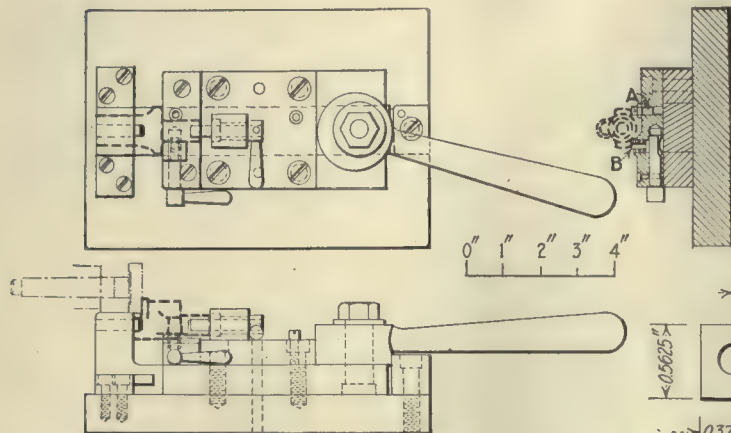


FIG. 807

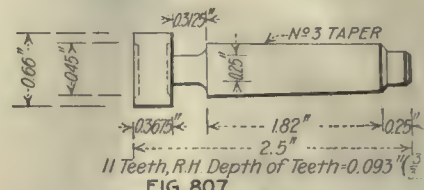


FIG. 808

OPERATION 14

OPERATION 14. HAND-MILLING SEAT FOR SAFETY LOCK

Transformation—Fig. 804. Machine Used—Pratt & Whitney No. 2 hand miller. Number of Operators per Machine—One. Work-Holding Devices—Held on pins, clamped at end by cam, Fig. 805; located by stop A under left side and held by spring pin B, Fig. 806. Tool-Holding Devices—Taper shank. Cutting

Tools—End mill, Fig. 807. Number of Cuts—One. Cut Data—600 r.p.m.; hand feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—2,500 pieces. Gages—Fig. 808, relation of seat to bore. Production—350 per hr. Note—The milling fixture is held to table by C clamp.

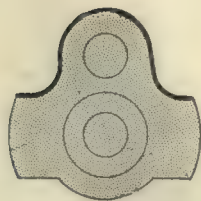


FIG. 809

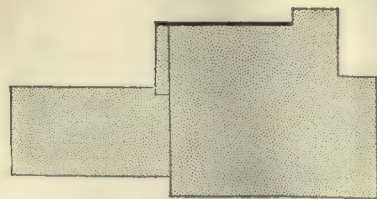


FIG. 810

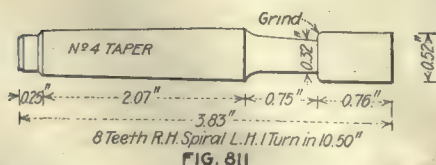


FIG. 811

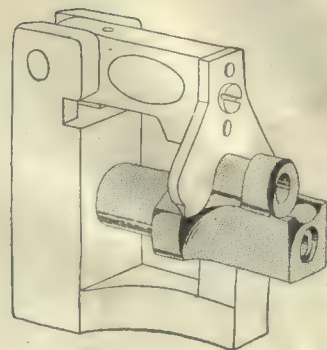


FIG. 812

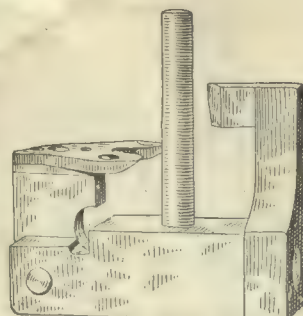


FIG. 812B

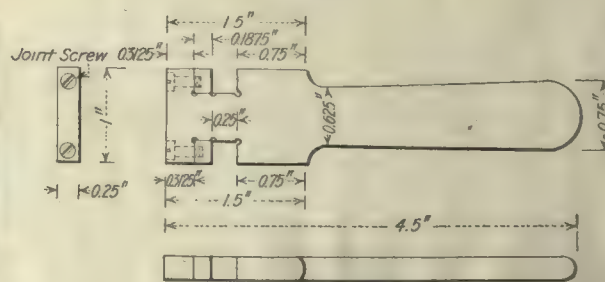


FIG. 812A

OPERATION 11

OPERATION 11. PROFILING OVER TOP OF LUGS AND SAFETY-LOCK SPINDLE HOLE

Transformation—Fig. 809; machining diagram, same as Fig. 799-A. Machine Used—Pratt & Whitney No. 2 profiler. Number of Operators per Machine—One. Work-Holding Devices—In vise jaws by neck, Fig. 810; for details see Fig. 801. Tool-Holding Devices—Taper shank. Cutting Tools—End mill, Fig. 811. Number of Cuts—One. Cut Data—1,000 r.p.m.; hand feed. Coolant—Compound, two ¼-in. streams. Average Life of Tool Between Grindings—200 pieces. Gages—Fig. 812; A, length of safety-lock projection; B, contour from firing hole, an arm swings back to clear projection while sleeve is placed on gage. Production—40 per hr.

OPERATION FF. REMOVING BURRS FROM FIRING-PIN HOLE

Number of Operators—One. Description of Operation—Removing burrs thrown up around firing-pin hole. Apparatus and Equipment Used—File. Production—300 per hr.

✱

The Planer Gage and Its Uses

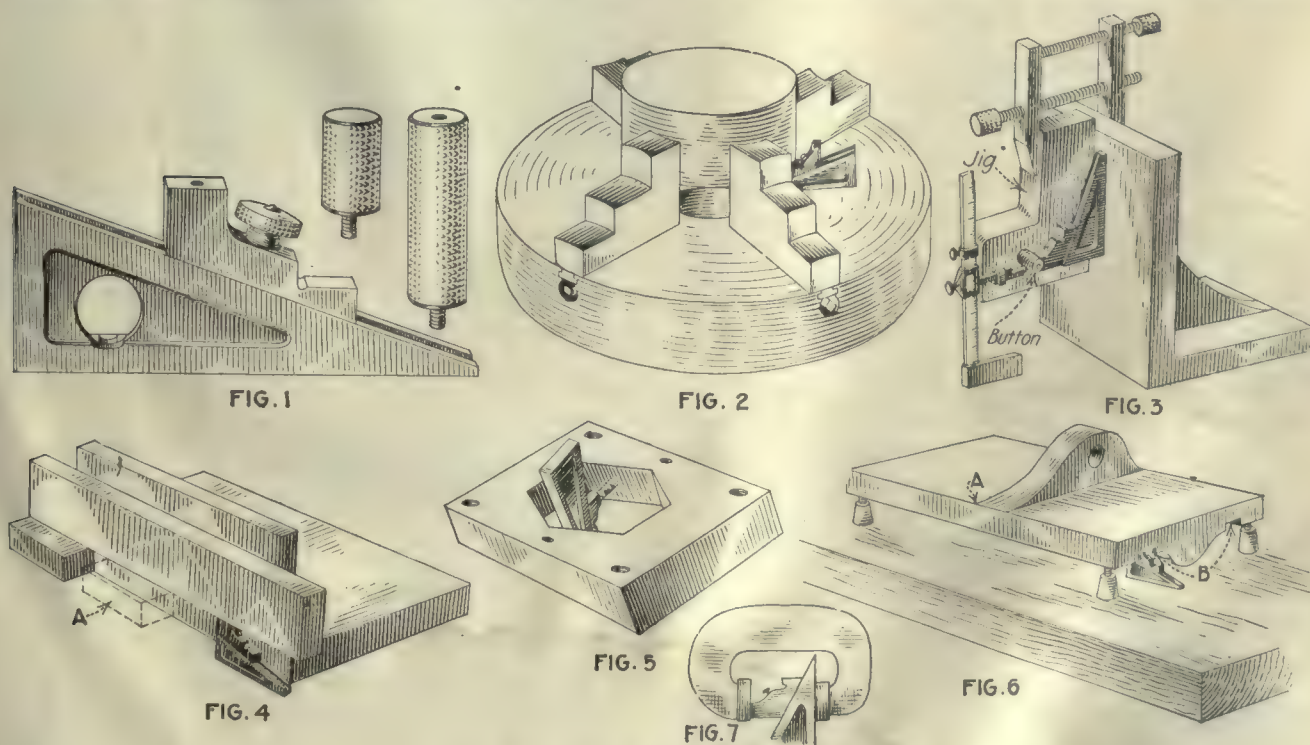
By HUGO F. PUSEP

The little inexpensive tool illustrated in Fig. 1 can be made to give a great variety of service to machinists and tool makers. I do not know how I could get along without one after being accustomed to use it nearly every day for several years on all kinds of tool and die work. But strange to say, a majority of mechanics have not yet grasped its possibilities. I will try to show here different applications of this tool in the machine shop and the tool-room.

In Fig. 2 is shown how a piece of round stock having one end already machined can be rechucked to run true,

When a tongue for a fixture or vise is to be a snug fit in the T-slot of a miller table, it is not necessary to waste time with inside calipers. A far better way is to adjust the planer gage to fit the T-slot, then clamp the sliding member by the knurled nut. The record of the size of the T-slot can be carried around to any part of the shop and can be referred to by measuring with a micrometer. This plan eliminates many unnecessary steps for the machinist. It often happens in the large shop that a tool maker or a repairman is required to go to some other department and take measurements for a repair part. Very often this part has to be a fit between parallel surfaces in a slot, or of a fixed height. In most cases the planer gage with its extensions will take care of the job.

In Fig. 3 is presented a quick way to set buttons on a jig with the aid of a planer gage and a height gage. In this instance the base of the jig is clamped to an angle plate, the planer gage being set with a micrometer to the distance of the button from the base minus half the diameter of the button, while the height gage is set from a certain finished surface within the body of the jig. This sketch also brings out one fact quite forcibly—namely, the possibility of setting buttons without the use of a height gage—that might well be remembered when a job of this kind occurs in a small shop where the height gage has not yet made its appearance and its value is unknown.



APPLICATIONS OF THE PLANER GAGE

so that the final facing cut will bring both faces parallel. Feeling with the gage from the chuck face between jaws and at the same time tapping slightly with the hammer where the gage is loose will soon do the trick.

This method is better than calipering, as regards convenience and speed. When the face of the chuck runs true, the job will be parallel; but if that is not the case, the chuck can be tried out by feeling between a lathe tool and the chuck face with the gage—differences noticed at four points and allowances made accordingly when chucking the work.

When a plate jig or a die is to be clamped to an angle plate with one of the finished sides parallel with and not resting on the surface plate (preparatory to laying out) and only one parallel block of suitable size can be found in the shop, the planer gage is set to the same size as the parallel and supports the job, as in Fig. 4. The work can then be clamped in position. If the job is so heavy as to be liable to damage the gage by its weight, place the parallel so that the job will nearly balance, as shown by dotted lines at A, Fig. 4, and use the planer gage under the heavier end merely to prevent its toppling

over. In this way quite a heavy job can be handled without damaging the gage. In Fig. 5 is given a method of gaging the opening in a hexagon forming die while finishing it. The same method can be applied to any die having parallel sides in its opening and coming within the scope of the gage. In Fig. 6 an irregular job is set up on a surface plate. The casting *A* is resting on four jacks, while the planer gage is used to determine whether the machined slots *B*—extending the full length of the casting—are parallel to the surface plate. As may be seen in Fig. 7, a snap gage can be measured without going to the expense of making a special sizing block.

As its name implies, the gage was originally designed by its makers for service on a planer, and it is assumed that its various uses in planer work, such as getting the height of the planer tool from the table, locating the tool a correct distance from finished faces, etc., are well known to every good planer hand. It is often the case that a tool, because of its simplicity and because it was originally made for a single purpose, is used for nothing else—not because it lacks adaptability, but simply because no one thinks of other applications.

Who Ever Discards a Micrometer?

BY W. D. FORBES

While I was returning from Washington, a short time ago, I entered into conversation with several men in the smoking car, and soon the talk turned to curious things, all with a bearing on mechanical work. The men were manufacturers, and one of them had been to Washington to look up the matter of an invention, an improvement on an article he had long been making. To his great surprise he found that a patent covering the invention had been issued as far back as 1876. What surprised him was that the improvement had never been put on the market.

Another of the men had a few months before, with several others, started an investigation of coal-handling machinery, and it became necessary to get in contact with a certain individual whose whereabouts were unknown. Ten minutes after the decision that the man must be found had been reached he walked into the room where he was being discussed.

A third of the travelers said: "The most extraordinary thing that I have ever seen was this: I was standing beside my scrap pile when a machinist, who had been in my employ for ten years, came to a lower window and threw something out on the pile. It struck a casting, bounded off, and lit almost at my feet. What do you think it was? A micrometer! I believe it was the only one that was ever thrown away. I picked it up, and going to the man asked him why he threw it away, as it looked all right. His answer was that he had been using it for ten years and that it was worn out. You cannot beat that, gentlemen, for strangeness."

The sequel to the story is interesting, however, as I found that the micrometers in my own works needed attention and overhauling. I issued an order that all the micrometers in the plant must be tagged with the owner's name and sent into the toolroom for inspection. Sixty-six were handed in, and only about 10 per cent. proved to be correct and in good condition. The others were out

from three to seven thousandths when tested at $\frac{1}{4}$, $\frac{1}{2}$ and $\frac{3}{4}$ with Swedish gages. One thing that was rather strange was that the three most accurate micrometers were of the old style, in which the screw is exposed.

Following this up, I found that the owners of these three micrometers were among my best tool makers, men who took extreme care and pride in their tools. I decided then to send all the micrometers back to their makers for adjustment, but one of my men offered to do the work, in his own time, at so much apiece. This plan worked very well, and I found that a great deal of trouble in regard to close fits was thereby averted. I have established the system of a monthly inspection of all micrometers.

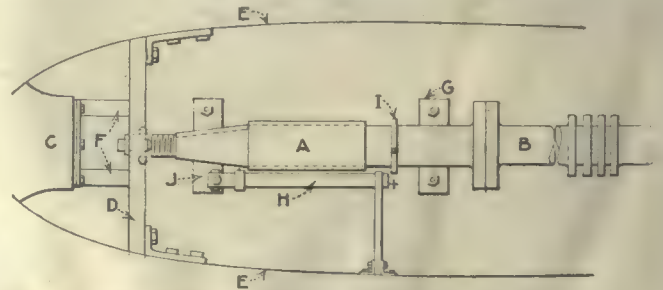
I carry the idea a good deal further and now have all my bar and snap gages periodically tested. Of course, I had been doing this to a certain extent before, but never systematically. I am rather inclined to think that a statue ought to be erected to the man who threw away the micrometer, and I am of the opinion that it would be the only one in the world.

Turning a Propeller Shaft at Sea

BY VINCENT FAMA

In Wellington, New Zealand, the Government has a sea-going training ship that was at one time a cruiser in the British navy. At the annual inspection in dock, the bronze liner *A* of the tail shaft for the propeller was found to be badly scored, and it was decided to turn it. As it would have been necessary to remove a good part of the propelling machinery or else cut away a part of the superstructure to remove the shaft, it was decided to do the turning aboard ship.

Since some time was required to get ready the gear with which to do the job, the intermediate shaft between the tail shaft *A* and the thrust shaft *B* was disconnected



HOW THE SHAFT WAS TURNED

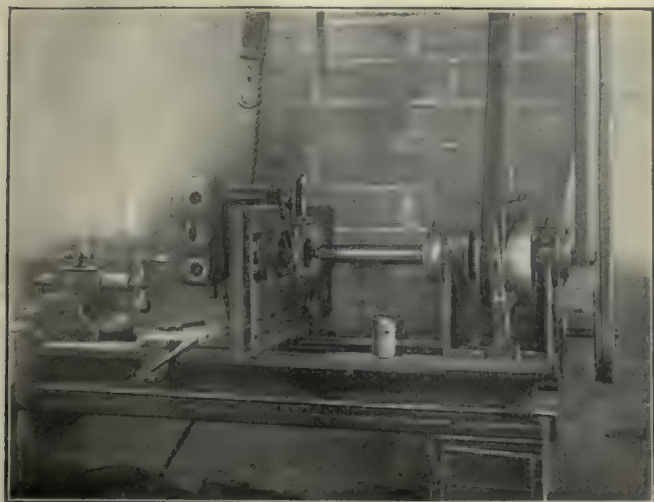
and let down on the floor of the shaft alley. The propeller shaft was drawn inboard, the stern gland *C* was made water-tight by a blind flange, and the ship was refloated. The tail shaft was then connected up to the thrust shaft: a center was made and fitted to a channel iron *D* bolted to the tunnel walls *E* and backed up from the stern frame by hardwood shores *F*. The shaft was set to run true, and a steady bearing was placed on the pedestal stand *G*, which had previously held a bearing for the intermediate shaft.

A heavy boring bar *H* was secured by brackets to the pedestal *J* and the ship's frames. A flange *I*, with a projecting stud, was bolted to the shaft to engage the star wheel of the boring bar. The tool was set to depth, and the main engines were started up at a slow steady speed. A very good job was the result.

Letters from Practical Men

A Home-Made Cylinder Grinder

Probably in no field of endeavor does the small shop play so important a part as in that devoted to the automobile. In practically every village will be found a garage, and in connection a small shop supplied with at least a small lathe and an emery wheel, if nothing more. Some of these shops are run by skilled men who have



THE BORING AND GRINDING MACHINE

worked in manufacturing establishments and were desirous of getting into business for themselves.

One of these shops, located in Lima, Ohio, makes a specialty of regrinding automobile cylinders and supplying pistons and rings. The shop is equipped with a lathe, drill press, emery wheel and, in particular, the grinding head shown in the illustration. The business is owned and operated by a man who was formerly in charge of one of the largest toolrooms in the state. The grinding head, which was designed and built by the owner, is mounted on the rear end of the lathe bed and is driven by a special countershaft.

The lathe itself is not of recent design, as will be noticed from the position of the lead screw, which is at the back. The carriage on which the cylinders are mounted is essentially an angle plate, and it is equipped with a split nut that closes in the same manner as the regular apron nut. A small pinion at the front engages the feed rack, for moving by hand. To get the proper feeds without interfering with the action of the lathe a drive is provided at the end for the lead screw, which is thrown out of engagement when it is desired to use the lathe for thread cutting.

The main spindle runs in large bearings and is provided with tight and loose pulleys and a belt shifter. The sleeve that carries the grinding spindle is pivoted in the main spindle at the rear end and is moved across for the different diameters by two set screws at the forward end. The small belt at the back drives the wheel spindle, and as the pulley has a heavy crown no trouble is experienced

with the spindle being at an angle. Directly above the grinding wheel is shown the diamond for truing.

On the lathe bed is shown the head for carrying the boring tools when taking the roughing cuts. This screws onto the end of the sleeve after the wheel is removed, but does not in any way hinder the wheel spindle. As the lathe has a rather long bed the apparatus does not interfere with regular jobs. The machine turns out an excellent class of work.

D. O. BARRETT.

Lima, Ohio.

❧

Metric Conversion Chart

Where I am employed, the metric system is used. In some cases we have to convert our dimensions into inches, especially when ordering stock. All our parts and tools are dimensioned in millimeters; and when we wish to know what size stock we want, we must convert it into inches. The sketch here shown will readily explain itself.



METRIC CONVERSION CHART

With this chart, millimeters can be converted roughly into inches at a glance.

This idea has been used with great satisfaction by various departments, especially in the drafting room and production departments.

WILLIAM ROBERTS.

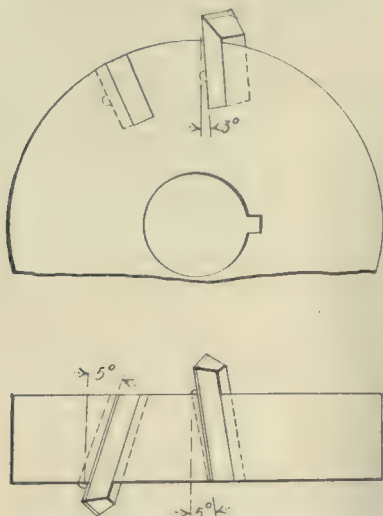
Springfield, Mass.

❧

A Slot-Milling Cutter

The accompanying illustration shows an adjustable slot-milling cutter that can also be used as a side-milling cutter. The feature is to have the blades set at angles in two directions, thus giving a cutting effect on both sides and not a cutting effect on one side and a scrape on the

other. Some would hesitate on account of the necessary greater distance between the teeth, but with good arbors and hardened collars we have had good success in cutting



THE SLOT-MILLING CUTTER

steel, leaving good surfaces, with feed up to 20 in. per min.

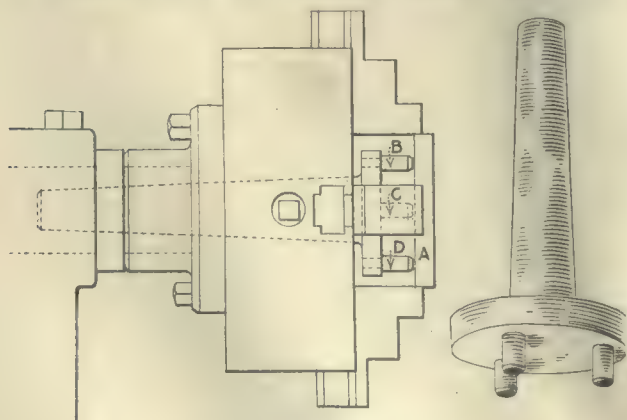
The blades are held in by the well-known taper-pin method. The cutters have been in use about six years.

Schenectady, N. Y.

GEORGE W. HARDY.

Chuckling Work Parallel

The accompanying illustration shows a fixture for holding blanks *A* in a chuck to face them accurately parallel. The tapered shank fits the lathe spindle and extends



THE CHUCKING DEVICE

through the chuck. It carries three pins *B*, *C* and *D*, of equal length, making a three-point seat for the work *A*, which has already been faced on the side next the pins

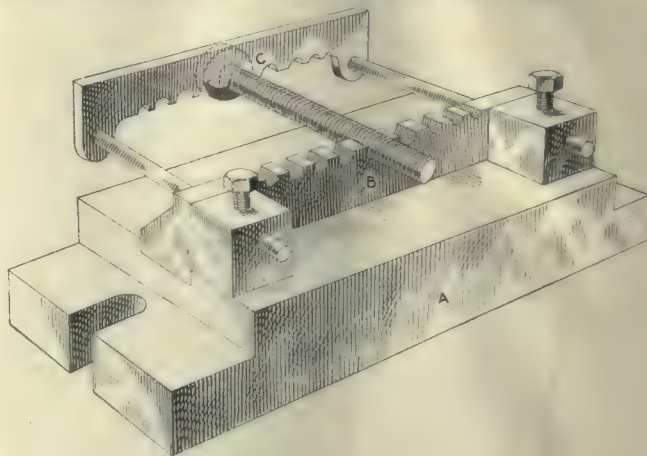
Brockton, Mass.

HOWARD P. JOHNSON.

Shear for Cutting Screws to Length

Inconvenienced by not being able to obtain screws of the required lengths, the shear shown in the accompanying illustration proved to be highly satisfactory for cutting screws to any required length, without injuring the threads. The shear *B* is secured on a bedplate *A*. This shear tapers toward the top. The seats for the various

sizes of screws are drilled and tapped and the top half cut away, exposing the half holes threaded for the various sizes of screws. The beveled side can be used for stamping the sizes so that the operator has a clear view of them when working. Two blocks and rods carry the length gage *C*. The bottom edge of the length gage is provided with half holes in line with the threaded half holes in the shear plate. The gage should be thin and flexible enough



THE SHEAR

to allow the thread of the screw to be pressed into the threads in the shear plate by the upper shear blade. In this way screws can be cut to length within half a thread.

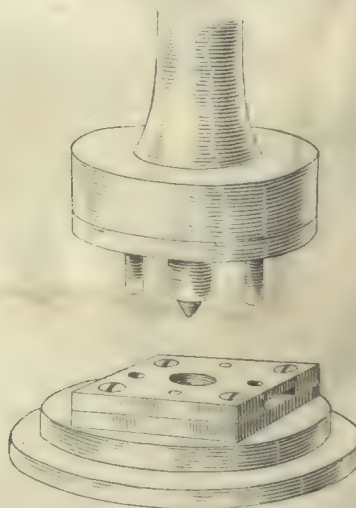
Brooklyn, N. Y.

JAN SPAANDER.

A Special Washer Die

The accompanying sketch is of a die that was made to blank two special washers that had the same outside diameter but different center holes.

By running the stock through from either side, the die being set accordingly, and using the correct pilot in the



THE SPECIAL DIE

blanking punch, either size of washer can be blanked. The holes can be varied in size or shape as desired.

In operation, the scrap stock passes the second piercing punch without being touched, as the washer has already been punched out of it.

CHARLES W. LECK.

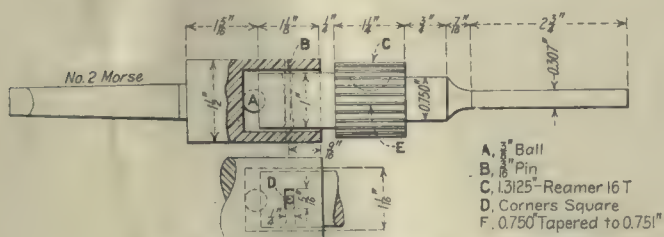
Newark, N. J.

Discussion of Previous Question

Floating Reamer Holder

I have read with interest Mr. Curry's description, on page 779, of his floating reamer holder. During the past three weeks we have had considerable trouble in reaming the valve hole in a valve-in-head motor cylinder head in the proper relation with the valve-stem hole.

Prior to my experimenting, six and eight men were required to meet the production schedule by line reaming the valve hole by hand. After several trials I decided to use the holder illustrated. The pilot of the reamer enters the valve-stem hole about $1\frac{3}{4}$ in. before the reamer



THE FLOATING REAMER HOLDER

C begins to cut. The shank has $\frac{1}{16}$ -in. float by bearing on the ball A. The holder is held in the shank by a $\frac{3}{16}$ -in. pin B. The hole in the holder is drilled and reamed $\frac{3}{16}$, then taper reamed from each side in to the center. The slot D is made square to keep the pin B from centering in any particular location, at the same time acting as a driver. This arrangement was used on a small sensitive drilling machine, and wonderful results were obtained.

Our next move will be to put eight of these holders in a multiple-spindle drilling machine and finish line ream all eight holes in one operation. We can hold the valve-seat hole to within 0.001 in. of dead true with the valve-stem hole. The shank and holder are made of openhearth steel, carbonized, hardened and ground.

Flint, Mich.

A. R. KELSO.

A Question of Lathe Design

On page 692 J. H. Davis asks why the hand wheel on American lathes is placed on the left-hand side of the apron. This is not the common practice, as all American workmen know, but it so happens that in my shop there are two lathes built in that way. Both are New Haven lathes, one an 18-in., the other a 38-in.

Most of the men in the shop find it a little unhandy to manage the small lathe, but the position of the hand wheel makes no difference on the large one, as the carriage is heavy and the hand wheel is down on the floor. It is therefore more handy to make adjustments with the compound rest, as is the practice with our English brothe. The reason they do this is because the carriages on English lathes are hard to move by hand, owing to the dovetailed ways; so a long crank is furnished with

which to move the carriage. The wheel or crank is on the right-hand side of English lathes for the reason that most of these lathes have gaps; therefore, there is no left-hand side to the carriage.

As to left-hand lead screws, I do not believe I ever saw more than one, and that was made in that way because the screw could run in only one direction. There was no reverse motion, so it had to be left-hand in order to move the carriage forward. I have always thought that most of the lead screws on small lathes should be left-hand, because the rod runs one way for feeding, and if it is desired to cut a thread it is necessary to reverse the motion for the screw. This makes a lot of unnecessary work when one is feeding and cutting threads all day, and sometimes causes trouble when it is not remembered to make the change.

There are two things in screws that should be changed—tailstock screws and chuck screws. Some of these are left-hand and some are right-hand, which causes considerable trouble when the men change from one lathe to another. If the men were kept on the same lathe all the time it would not matter. These screws should all be either right- or left-hand.

JACK SMITH.

Dade City, Fla.

Thickness and Weight of Sheet Copper

On page 602, H. B. Kellam illustrates a system with which I am strongly in concord, because there are in use today far too many methods employed in designating copper sheets and plates. Various gages and weights are used for the purpose, whereas it would be more satisfactory and greatly lessen the liability to error to do away with gages and specify all copper sheets and plates by their actual thickness, either in millimeters or decimal parts of an inch.

Having had upward of thirty years' experience in the sheet-copper trade, I found it interesting to compare the table compiled by Mr. Kellam, which is nearly identical to a table that I have used for many years. The slight difference is probably due to the condition of the sheet copper selected, as the density of hard-rolled sheet copper is greater than that of soft-rolled sheets of the same thickness. The specific gravity of hard-rolled sheet copper is 8.93, and one cubic foot weighs approximately 558 lb.

One of the most perplexing ways that I find of designating sheet copper is when an order comes through to the coppersmith's shop, stating that articles are to be made from a certain weight copper in pounds. This does not, as you might imagine, mean sheet copper weighing so many pounds per square foot, but is an indication of the weight of a standard 2x4-ft. sheet. For example, the weight given may be either 10-lb. or 14-lb. sheet copper. Now approximately 10-lb. sheet copper equals 0.027-in. in thickness and 14-lb. equals

0.037-in. in thickness. The weights for these thicknesses per square foot are 20 oz. and 28 oz. respectively.

The accompanying table illustrates decimal, metric and fractional equivalents of an inch, Imperial standard wire

WEIGHT AND THICKNESS OF COPPER SHEETS

Thick- ness in Decimal Parts of an Inch	Thick- ness in Milli- meters	Thick- ness in Fractions of an Inch	Weight in Oz. per Sq.Ft. No.	Imperial Stand- ard Gage Decimal Parts of an Inch	Weight per Sq.Ft. Lb. Oz.	Sheet Copper Gage Decimal Parts of an Inch	Weight per Sq.Ft. Lb. Oz.
1 000	25.400	1	744				
0.9375	23.812	15/16	697 1/2				
0.875	22.225	7/8	651				
0.8125	20.637	13/16	604 1/2				
0.750	19.050	3/4	558				
0.6875	17.462	11/16	511 1/2				
0.625	15.875	5/8	465				
0.5625	14.287	9/16	418 1/2				
0.500	12.700	1/2	372	7/0	0.500	23	4
0.484375	12.303	31/64	360 1/2				
0.46875	11.906	15/32	348 1/2	6/0	0.464	21	9 1/2
0.453125	11.509	28/64	337 1/2				
0.43750	11.112	7/16	325 1/2	5/0	0.432	20	1 1/2
0.421875	10.715	27/64	313 1/2				
0.40625	10.318	13/32	302 1/2	4/0	0.400	18	9 1/2
0.390625	9.921	25/64	290 1/2				
0.375	9.525	3/8	279	3/0	0.372	17	4 1/2
0.359375	9.128	23/64	267 1/2				
0.34375	8.731	11/32	255 1/2	2/0	0.348	16	3
0.328125	8.334	21/64	244 1/2	0	0.324	15	1
0.31250	7.937	5/16	232 1/2				
0.296875	7.540	19/64	220 1/2	1	0.300	13	15 1/2
0.28125	7.143	9/32	209 1/2	2	0.276	12	13 1/2
0.265625	6.746	17/64	197 1/2				
0.250	6.350	1/4	186	3	0.252	11	11 1/2
0.234375	5.953	15/64	174 1/2	4	0.232	10	12
0.21875	5.556	7/32	162 1/2	5	0.212	9	13 1/2
0.203125	5.159	13/64	151 1/2				
0.1875	4.762	3/16	139 1/2	6	0.192	8	14 1/2
0.171875	4.365	11/64	127 1/2	7	0.176	8	3
0.15625	3.968	5/32	116 1/2	8	0.160	7	7
0.140625	3.571	9/64	104 1/2	9	0.144	6	11
0.125	3.175	1/8	93	10	0.128	5	15 1/2
0.1171875	2.976	15/128	87 1/2	11	0.116	5	6 1/2
0.109375	2.778	7/64	81 1/2				
0.1015625	2.579	13/128	75 1/2	12	0.104	4	13 1/2
0.100	2.540	1/10	74				
0.09375	2.381	3/32	69 1/2	13	0.092	4	4 1/2
0.090	2.286		66 1/2				
0.0859375	2.182	11/128	63 1/2				
0.080	2.032		59 1/2	14	0.080	3	11 1/2
0.078125	1.984	5/64	58 1/2				
0.0703125	1.785	9/128	52 1/2	15	0.072	3	5 1/2
0.070	1.778		52 1/2				
0.0625	1.587	1/16	46 1/2	16	0.064	3	0
0.060	1.524		44 1/2				
0.0546875	1.389	7/128	40 1/2	17	0.056	2	9 1/2
0.050	1.270		37 1/2				
0.046875	1.196	3/64	34 1/2	18	0.048	2	4
0.040	1.016		29 1/2	19	0.040	1	13 1/2
0.0390625	0.9921	5/128	29 1/2	20	0.036	1	10 1/2
0.03125	0.7937	1/32	23 1/2	21	0.032	1	7 1/2
0.030	0.7620		22 1/2	22	0.028	1	4 1/2
0.0234375	0.5953	3/128	17 1/2	23	0.024	1	1 1/2
0.020	0.5080		14 1/2	24	0.022	0	10 1/2
0.015625	0.3968	1/64	11 1/2	25	0.020	0	14 1/2
0.010	0.2540		7 1/2	26	0.018	0	13 1/2
0.009	0.2286		6 1/2	27	0.0164	0	12 1/2
0.008	0.2032		6	28	0.0148	0	11 1/2
0.007812	0.1984	1/128	5 1/2	29	0.0136	0	10 1/2
0.007	0.1778		5 1/2	30	0.0124	0	9 1/2
0.006	0.1524		4 1/2	35	0.0084	0	6 1/2
0.005	0.1270		3 1/2	40	0.0048	0	3 1/2
0.004	0.1016		3	42	0.004	0	3
0.003	0.0762		2 1/2	44	0.0032	0	2 1/2
0.002	0.0508		1 1/2	45	0.0028	0	2
0.001	0.0254		0 1/2	50	0.001	0	0 1/2

gage, also a gage generally used by the copper trade with approximate weights in ounces and pounds per square foot.

Manchester, England.

A. EYLES.

The Metric System

I have read W. B. Greenleaf's article on the metric system on page 915, and the editorial comment that "the metric system is not established to the exclusion of all others in any country that we know."

From the editorial statement it appears as if the following data would be of some interest:

The metric system was established in Sweden about 1888, to the exclusion of all other systems of measurements. The law allowed a period of five years in which to make the change. Thereafter, any contract made in any other system is illegal and has no standing in court. If a sale in any other system than the metric is executed, say in a market place, store or office, both the buyer and the seller are fined and the contract if any is void.

At the time when this law was passed I was connected with the Gothenburg Mechanical Works, employing between 1,000 and 1,200 men. The lines of manufacture were steam engines, steamboats, rolling stock for railroads, bridges and other structural work, paper-making machinery, agricultural implements, etc. The change from inches to millimeters was immediately started. All new drawings were made in the metric system, and when an old drawing was to be used the dimensions in inches were inclosed by parenthesis and the dimensions in millimeters added. At that time Swedish, English and Prussian inches were used in shop work. It was a relief to throw them out and use millimeters. In this shop the metric system reduced the number of errors in the drafting room and the cost of manufacture.

The change was carried through with practically no expense whatsoever. The taps in the Whitworth system were kept, as they had to be used for repair work. Later on metric taps were gradually substituted. The only direct outlay was for scales, as a greater number had to be procured at once than were required for replacing worn ones. This extra expense did not amount to \$200.

In connection with the change to the metric system the following incident is worth mentioning: An English firm, from whom we used to order structural iron, was requested to deliver a large order in the metric system, but answered that they did not desire to deliver the order in metric measure. The order was placed in Germany, and the English firm never got another order.

For export business Swedish catalogs as a rule are printed in the language of the country to which they are sent, and data are given in the metric system and for information also in the measurements of the foreign country, if the latter has not yet adopted the metric system.

The *American Machinist* by discussing the disadvantages and advantages of the metric system has actively assisted in bringing it to the front. The able and interesting editorial articles that have appeared against the adoption of the metric system have caused many to look more thoroughly into the matter.

It is surprising to see how the use of the metric system is spreading in this country, and the time seems to be drawing near when its adoption will be general. There will, of course, always be persons who from sentimental or other reasons satisfactory to themselves, will adhere to the old system.

The metric and the English systems of measuring stand in about the same relation to each other as do the monetary systems of the United States and England. I dare say that there are now extremely few persons in the United States who prefer the English monetary system of guineas, pounds, crowns, shillings and pence instead of dollars and cents. The decimal monetary system of the United States is admittedly an improvement on the English mixed system; in spite of that people in some parts of the United States even at the present time continue to count in shillings.

The metric system is used exclusively in the chemical laboratory at the Washington Navy Yard. The English system of measurement is still used in the physical laboratory at the yard, as this system is in accordance with general commercial practice.

CARL F. JEANSEN.

Ordnance Engineer.

Washington Navy Yard, D. C.

Editorials

Turning Back the Clock

Unless you are an astronomer as well as a machine-shop man, you have probably never heard of the "comet exchange." Some thirty years ago, a gentleman in Boston, himself a student of the stars, formed an association of astronomers jocularly termed the "comet exchange." The moment a heavenly body was discovered, the news was wired to a central bureau, from which telegrams were sent to every member of the exchange, telling him where to find the newcomer. The newly acquired knowledge of one man was made immediately available to his fellow workers, no matter how remote their locations.

The editorial pages of a technical journal form the comet exchange through which new and improved methods devised by a few become available to thousands. The isolated astronomer and the twentieth-century machine-shop man both need this interchange of information so that each may see with vastly multiplied eye-power.

The twentieth-century mechanic differs from his thirteenth-century ancestor in two essentials: He has better tools and a better knowledge of how to use them. These tools are themselves the result of applied knowledge, so that the two points of difference become but one. Knowledge is developed from ignorance through the spread of information. Any legislative act hampering the spread of information turns back the hands of civilization's clock.

The zone system of postage, as is now proposed for our second-class mail, was originated in England in 1635. The charges on a letter were twopence for a distance under 80 mi., fourpence between 80 and 140 mi., and sixpence for a greater distance. This, in 1635, was progressive legislation, but in 1680 it was already behind the times.

On this date an enterprising individual, William Dockwra, on his own initiative established in London and vicinity a flat-rate penny post whereby letters and parcels *up to a pound in weight were collected, registered, carried, insured and delivered for a penny each!* He established mail boxes with hourly collections and made ten city deliveries daily and four to outlying villages. Can you grasp these facts? In 1680, without facilities of any kind—no railroads, trolley cars, postal tubes, mail wagons or automobiles—one man did for London what the Congress of the United States, aided by every imaginable facility, cannot do for us today. Was he encouraged by the government? No; his enterprise was too profitable, and it was confiscated and discontinued.

Industrial progress is always in one direction; it never goes backward. Sometimes it creeps along slowly, hampered by unwise legislation; and sometimes it stops for a period, when the clock is turned back too far. But it never retrogrades. Can we say as much for legislative progress?

Go back to 1837, to the time when Sir Rowland Hill began the first real government postal reform in England. This gentleman, whose name and fame are forever connected indissolubly with postal matters, analyzed the cost of carrying mail and announced the fact that 90 per cent. of the total cost was due to terminal expense and had nothing to do with the distance carried. This truth, known in England in 1837, is apparently unknown to some of our legislators of 1916, who would compel information to travel on a mileage ticket!

Go back to 1851, when England had a tax on advertisements that prevented the circulation of newspapers to workingmen. Inspired by the example of the *New York Tribune* and protesting against this tax on information, Bright, in the House of Commons, interrogated his fellow members as follows:

How comes it, and for what good end, and by what contrivance of fiscal oppression is it that while the workmen of New York can have such a paper on their breakfast tables every morning for a penny, the workman of London must go without, or pay fivepence for the accommodation? How is it possible that the latter can keep up with his transatlantic competitor in the race if one has daily intelligence of everything that is stirring in the world, while the other is kept completely in ignorance? Are we not running a race in the face of the world with the people of America? And if while such a race is going on, the one artisan pays fivepence for the daily intelligence which the other obtains for a penny, how is it possible that the former can keep his place in the international rivalry?

England repealed this tax on advertising, because it impeded the spread of information. Today, American legislators propose to turn back the clock, and inflict upon the artisans of the United States the handicap that our neighbors found unbearable a half-century ago!

The editorial pages of the technical journal form the comet exchange for the industry that it represents, and the advertising pages form its star map of established constellations. The advertising pages are the exhibition booths at the weekly industrial convention at which user meets builder. Facts are facts, whether old or new; information does not deteriorate with age—it becomes more firmly established. The Randall rider would penalize the repetition of established facts as found in advertising, forgetting that all textbooks from the simplest arithmetic to the most abstract scientific treatise are based on the repetition of facts. Every machine shown in the advertising pages of the *American Machinist* is a vindication and proof of the laws of mathematics and mechanics—the actuality, not the theory—embodied in iron and steel.

Financial loss arising from the canceled subscriptions of those of our readers who will find their cost of information doubled is not what impels us to make this protest. This, while serious, will not be comparable with that due to the increased cost of paper, on which we made no editorial comment. But we protest against the turning back of our national clock for the adoption of the

zone system of 1635 and the tax on information of 1851. Ours is as much an industrial as it is an agricultural nation. We encourage agriculture as a national principle and a sound policy, but we distinguish between the seed and the crop. Why, then, classify information and merchandise on the same level and forget that information is the industrial seed from which merchandise springs?

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You are one of our 25,000 partners in the distribution of technical information. You are vitally interested with us in preventing the turning backward of the national clock. We are doing our part to prevent it; will you not do yours? Write your Congressman today that you disapprove of the Randall rider on the Post Office Bill.

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The Shop Medical Examination

Medical examinations of employees in shops are being conducted for three reasons: In some states where the compensation laws require that for his own good a manufacturer shall have a knowledge of the physical condition of his workmen, medical examinations are given before admission for work. In this way physical defects that might constitute a hazard in certain lines of work are discovered, and the applicant treated accordingly. Some plants which have an active mutual relief association require that employees undergo a medical examination before they can enter the association and become eligible to its benefits. In still other cases the medical examination is conducted by a regular department, which in effect runs an all-day shop clinic.

The need for a physical examination before an employee is hired and placed at work was indirectly brought out by the representative of a large machine shop in Pennsylvania who wrote:

It might be well to mention that some of the accidents classed as due to carelessness could really be classed as the result of employees misrepresenting their experience on being hired, and therefore being given work for which they are hardly qualified. This sort of thing of putting one over on the boss and getting away with it is actually looked upon by those who do so as a real mark of ability, and an actual asset of which they boast to their fellows.

An illustration of what such examinations might show up is hernia. A man who is developing this defect gradually is surely not the one to hire for work that requires heavy lifting. Not only might his work bring the trouble to its acute stage, but any one of many small things, as sneezing, coughing, slipping, falling and so on, might be the final cause. It is evidently to the interest of both employee and employer to know of such a defect before a man is put to work.

The extent to which physical defects are found among shop employees is not even imagined unless the records of some medical department are consulted. It is not beyond the truth to say that hardly one-third of all persons working in factories are up to their possible normal standard of health.

In one factory where dental work was started, it was found that a majority of all those examined had some trouble in the mouth. To give a single item, 36 per cent. of the men suffered from pyorrhea.

A rather cynical comment in regard to this condition is that it is foolish to supply filtered or sterilized drinking water in shops, when this water is merely used to wash pus from the mouth into the stomach.

C. B. Auel, of the Westinghouse Electric and Manufacturing Co., in a paper presented a few weeks ago at a conference in Harrisburg, gave statistics of defects that had been discovered in a medical examination of the employees at his plant. This examination, Mr. Auel stated, is required of everyone who desires to enter the mutual Welfare Association.

Defects in men encountered during the last year or two classify as follows:

Classification	Per Cent.	Classification	Per Cent.
Hernia	44.5	Hearing	0.5
Teeth	0.3	Amputation	4.1
Varicose veins	3.3	Nerves	0.3
Eyes	36.3	Venereal	4.1
Defective generally	4.6	Hydrocele	1.8
Refusal to be examined	0.8		

A similar classification for defects found in women employees is as follows:

Classification	Per Cent.	Classification	Per Cent.
Eyes	31.7	Goiter	2.9
Malnutrition	28.8	Suspected pregnancy	2.9
Vermin	5.8	Nose and throat	14.4
Heart	5.8	Hernia	1.9
Lungs	5.8		

The prevalence of hernia among men, and of malnutrition and vermin among women, provides the striking items in the classifications.

The advantages of the shop medical examination are not only those that have already been pointed out, but also the opportunity that is offered to assist the worker in coming back to normal health, and thus increasing his capacity for effective production. This cannot be measured in dollars and cents, but many an employer who has established a system of medical examination in his plant testified to his belief that it is one of the best paying institutions of his plant.

Where the medical examination is given as one of the requirements for getting work, there is the danger of one abuse which unfortunately has been observed in some places. An applicant asks for work, is examined, and is rejected. The abuse lies in the failure of the physician to tell the rejected person what is the matter with him. This should be done, and possibly the way pointed out to obtain relief from the trouble, whatever it may be. But the mere rejection of an applicant because of some discovered defect, without letting him know what is the matter, savors of brutality.

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Long Service and Accidents

"Investigations show that the average of disabling accidents in our works result in a loss of nine days to the injured, and that those occurring to employees who have been less than one year in the service are 39 per cent. more severe in this respect than are accidents occurring to employees older in point of service. It will thus be seen how important a factor labor turnover is, not only in its relation to accident prevention, but in its effect upon output as well."

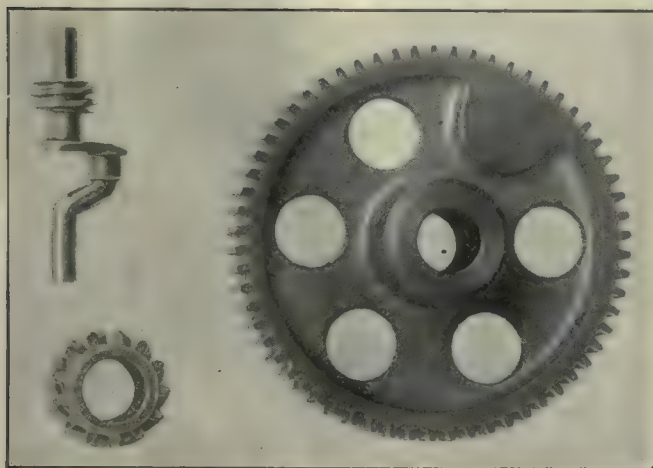
This paragraph is taken from a paper read by C. B. Auel at a safety conference recently held in Harrisburg, Penn. It is based on the experience of the Westinghouse Electric and Manufacturing Co.

The fact brought out by this record has been mentioned and commented upon before. But emphasis is given to its importance by the figures that accidents to employees having served less than one year are 39 per cent. more severe than to those having had longer employment. Experience and skill are not only necessary to do one's work, but are likewise essential to safety.

Shop Equipment News

"Do-Di" Brass and Bronze Die Castings

The Doehler Die Casting Co. announces the evolution of a new process for die casting brass and bronze from the experimental to the commercial stage. During the past year this company has been delivering brass and bronze die castings to some of its customers, although the product had not been advertised. Some of these parts are shown about half size in the accompanying illustration. This new product will be known under the trade name of "Do-Di" castings. The process is not limited to any particular alloy; in fact, castings of yellow brass,



COMMERCIAL BRASS AND BRONZE DIE CASTINGS

red brass, phosphor bronze, aluminum bronze and manganese bronze have been made.

A striking and remarkable characteristic claimed for this new product is that the castings are absolutely solid and free from air holes of any kind. The claim is not made that all parts now cast in white metal can be die cast in brass economically, but it is definitely stated that

brass die castings are now a commercial possibility. The range of usefulness of this process is likely to be extended as the experience of both makers and users shows new fields and possibilities for it.

Four-Spindle Boring Machine for Bearing Work

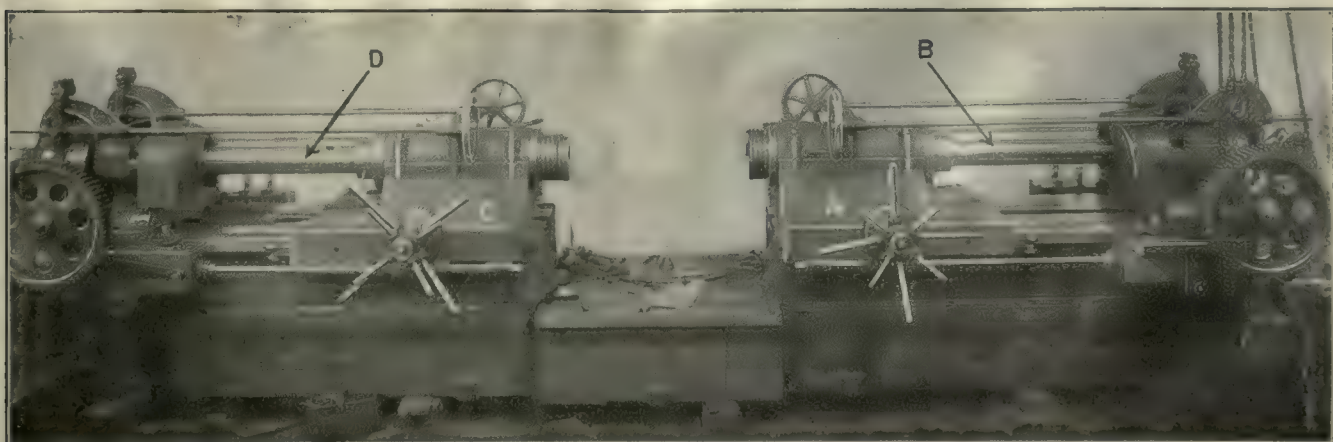
The four-spindle street railway and mine locomotive boring machine shown in the illustration is a recent design of the Newton Machine Tool Works, Philadelphia, Penn. It is particularly intended for boring axle bearings, armature shaft bearings and field bearings on street railway and mine motors. To suit particular requirements, slight changes are made, such as the inclusion or omission of back gears in the drive of the main end bearing boring spindles, rapid traverse to spindle saddles, gear feed boxes, hollow or solid spindle noses, auxiliary boring spindles inside the sleeve, and the location of the operating levers.

All spindles or sleeves have exterior threads on the nose for carrying cutter heads or boring bars, and each spindle has an independent clutch-worm and wormwheel drive and is provided with a bushed bearing.

The main spindle heads *A* and *C* have fixed positions in their saddles and coincide in alignment, although in special cases the spindle in *C* is provided with a large sleeve having a threaded nose to carry a boring head. In such instances boring bars are screwed into the nose of this spindle. The spindle head *A* is hollow bored and is bushed to serve as support to the outer end of the bars.

The saddles and rear driving gear brackets of spindles *D* are adjustable crosswise, to give the bearing distances between centers required when boring axle bearings. Provision is made for the use of spacing blocks to facilitate the accurate duplication of center distances.

These machines may be arranged with a separate motor for each spindle, one motor at each end for a pair of spindles, or for a belt drive.

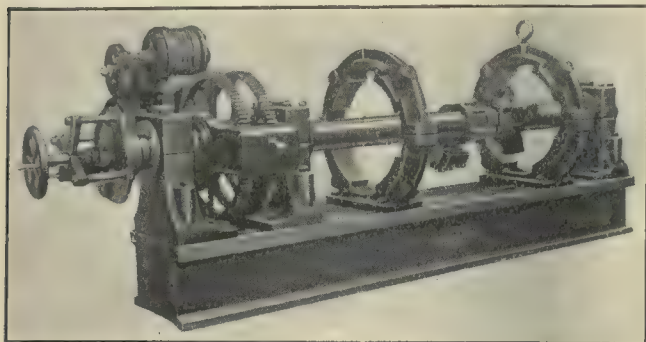


FOUR-SPINDLE BORING MACHINE FOR RAILWAY AND MINE LOCOMOTIVE MOTORS

Tube Boring and Facing Machine

The illustration shows a new tube boring and facing machine that is being placed on the market by the Pedrick Tool and Machine Co., Philadelphia, Penn.

The machine is of substantial construction and is designed especially for accurate boring work such as torpedo tubes, cylinders, liners, bushings, sleeves, etc. Pil-



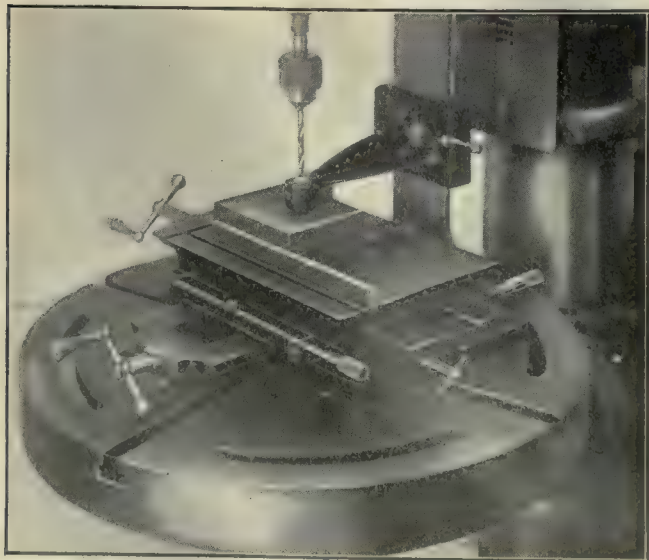
MACHINE FOR ACCURATE BORING

low blocks and pedestals may also be handled. The bar is gear driven, and the machine is arranged for either belt or motor drive. The cutter head is controlled by an automatic reversible feed having three speed changes. Owing to the fact that a traversing-head boring bar is embodied in the machine, the length that can be bored is nearly equal to the length of the bar.

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Adjustable Drilling Fixture

The illustration shows a fixture for locating and drilling holes in jigs, fixtures, dies, etc. It is being placed on the market by the Wadell & Bowen Co., of Newark, N. J.



ADJUSTABLE DRILLING FIXTURE

The fixture consists of a work table mounted on two slides at right angles to each other, both of which are provided with micrometer adjustments. A vertical post at the back carries a vertically adjustable bracket, the outer end of which is bored for a drill bushing. The fixture is used in connection with a drilling machine for drilling holes in jigs, dies and templet work.

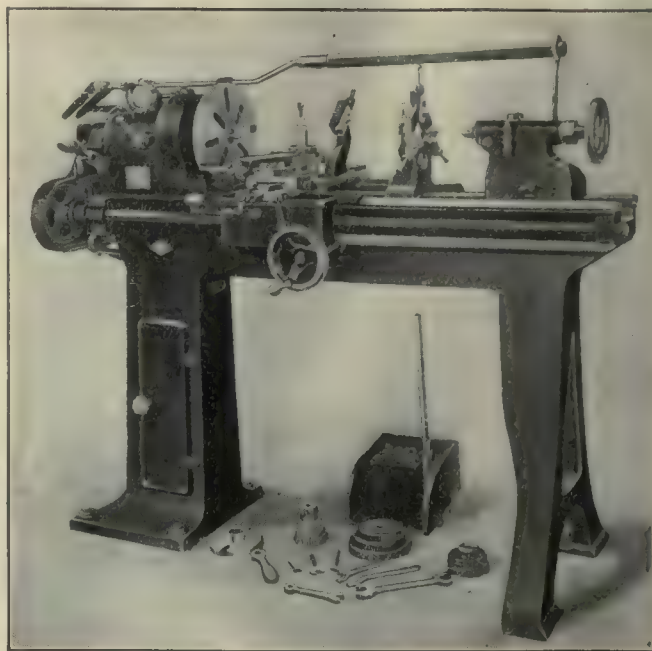
The adjustment of the work with relation to the drill bushing is obtained by a series of length bars varying by increments of 1 in. and a 1-in. micrometer screw on each of the slides. The size of the table is such as to take care of work within a range of $6\frac{1}{2} \times 7$ in., with holes up to $\frac{5}{8}$ in., but larger machines are built to meet special requirements.

✽

Lathe for Toolroom and Light Manufacturing

The lathe shown in the illustration is manufactured by the Master Machine Works, 110 West 40th St., New York City.

The belt passes direct from the main lineshaft to tight and loose pulleys on the headstock, which is supplied



LIGHT 12-IN. TOOLROOM LATHE

Swing over bed, 12 in.; swing over carriage, $6\frac{1}{2}$ in.; length of bed, 4 ft. 8 $\frac{1}{2}$ in.; distance between centers, 2 ft. 6 in.; hole through spindle, $\frac{1}{2}$ in.; front bearing of spindle, $1\frac{1}{4} \times 2\frac{1}{4}$ in.; back gearing of spindle, $1\frac{1}{4} \times 2\frac{1}{4}$ in.; width of belt, 2 in.; ratio of back gearing, 5.38 to 1; net weight, 800 lb.

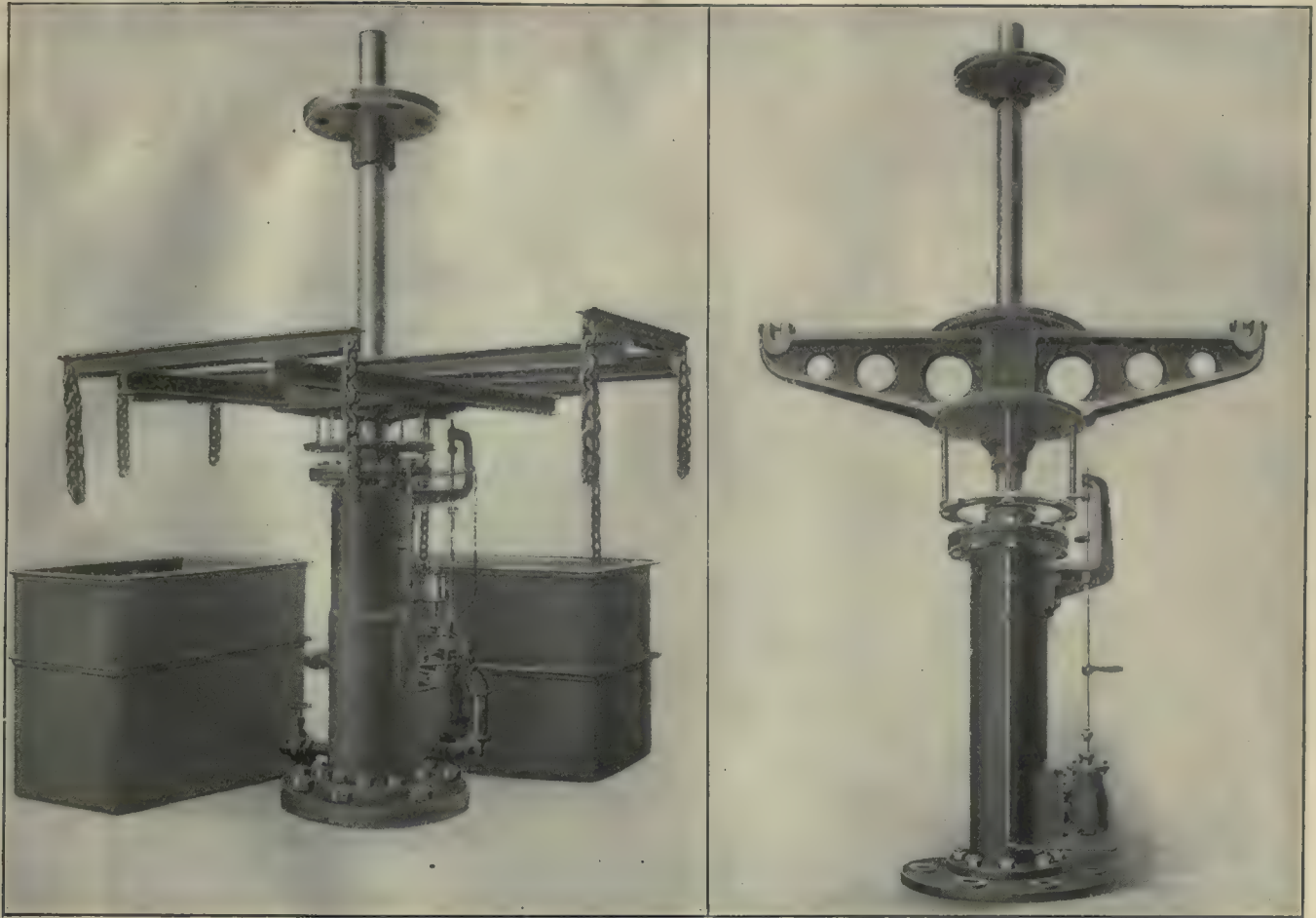
with a belt shifter, thus eliminating a countershaft. The drive passes through a number of steel headstock gears that provide for six spindle speeds obtainable by means of two controlling levers. The apron of the machine is arranged for screw cutting and has longitudinal and cross power feeds.

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Metal-Goods Washing and Pickling Machine

The machines here shown are designed to wash and pickle in quantities small parts such as punchings, stampings and the like. They are arranged for operation with either steam or compressed air as motive power. When steam is used, the exhaust from the machine is utilized to heat the coils in the vat containing the pickling fluid.

These machines are built of two types, as shown in the illustrations, either of which may be furnished with arms of length and number to suit special requirements. The vats or cages are also specially designed to meet the requirements of the products to be handled.



FIGS. 1 AND 2. TYPES A AND B METAL-GOODS WASHING MACHINES

Type A—Height of ceiling required, 12 ft.; capacity, unbalanced loads, 4,000 lb.; steam or air pressure required, 60 lb.; length and number of arms to suit requirements; maximum agitating stroke, 7 in. Type B—Height of ceiling required, 9 ft. 11 in.; capacity, unbalanced loads, 500 lb.; steam or air pressure required, 60 lb.; length and number of arms to suit requirements; maximum agitating stroke, 7 in.

In addition to the elevating stroke of the plunger that raises the cages of material there is a rotating motion upon ball bearings, which enables the work to be introduced into successive pickling and washing vats or to be swung to the loading or unloading stations.

There is also an agitating stroke that may be set for any depth up to 7 in., which keeps the fluid in the vats in circulation and insures even and thorough cleansing. These machines are built by the Howard Iron Works, Buffalo, N. Y.

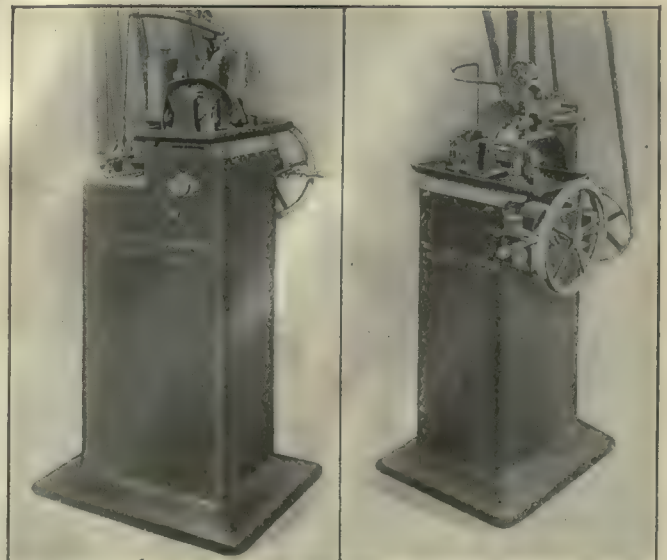
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Automatic Hob Grinder

In the machine illustrated, which is a recent addition to the line of special grinders built by the H. E. Harris Engineering Co., of Bridgeport, Conn., the grinding and indexing of hobs, taps and the like are controlled automatically. The wheel spindle is mounted in ball bearings which are placed upon a horizontal slide that has micrometer adjustment. This slide is in turn mounted in a vertical slide also provided with adjustment by a micrometer screw. These two adjustments permit the machine to accommodate any required degree of rake on the faces of hob or cutter teeth.

The work table is moved back and forth with a uniform motion by means of a cam operated by a wormwheel driven by a belt from the countershaft. The indexing of the work is operated by the same camshaft.

Grinding is done under flooded lubrication, the base of the machine containing a tank from which the lubricant is pumped to the wheel guard. Unevenness of belt tension is avoided by an idle pulley on the slack side. A setting block is provided for setting the work in the proper position. It drops out of the way after the work is correctly

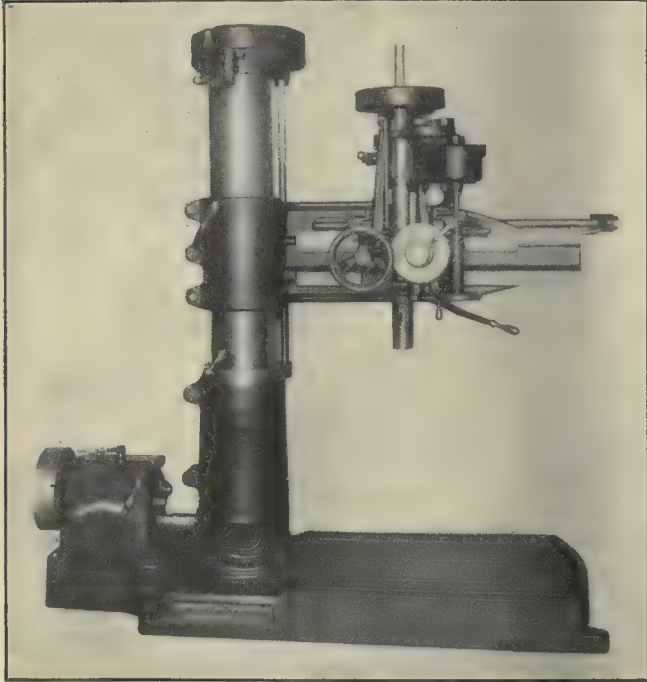


AUTOMATIC HOB-GRINDING MACHINE

placed. The work is supported at its outer end by a rigid center carried on a swinging arm. An extra attachment may be provided to grind spirals of either right or left hand.

Radial Drilling Machine

A new line of radial drilling machines in 2½-, 3- and 3½-ft. sizes is being placed on the market by the Morris Machine Tool Co., Cincinnati, Ohio. These machines will handle tapping, facing and counterboring work, all operating levers being placed within easy reach of the



RADIAL DRILLING MACHINE

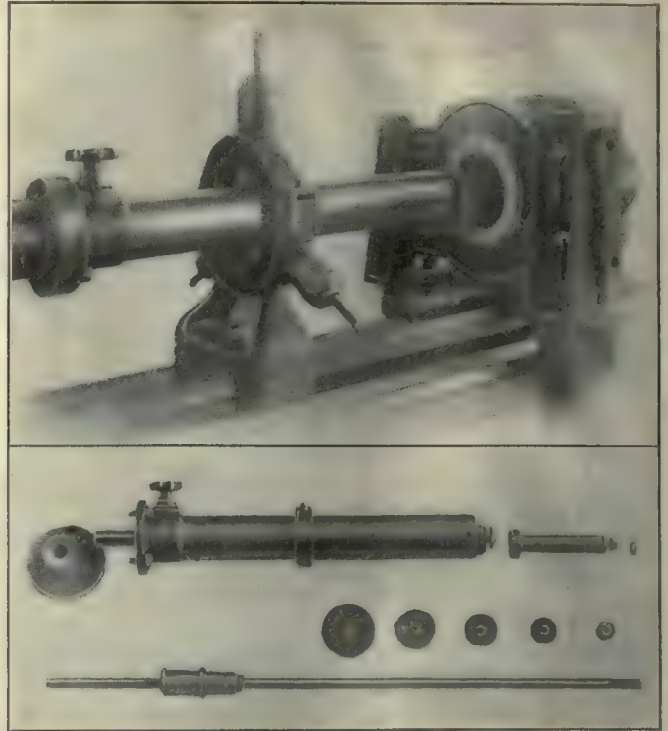
Maximum distance between spindle and base, 52½ in.; minimum distance, 15½ in.; maximum distance between spindle and table, 31½ in.; spindle traverse, 12 in.; spindle speeds, cone drive, 19 to 400; speed-box drive, 18 to 400

operator. The column swivels on roller bearings. The gears for operating the arm are so arranged that they have a tendency to disengage, thus forcing the operator to keep his hand on the operating handle while the arm is in motion. Ten spindle speeds are provided with the cone drive and 12 with the speed-box drive. The feed box has four speed changes. All gears run in oil, and the bearings are of phosphor bronze with oil chambers and felt wipers.

Cylinder-Grinding Attachment for Lathe

The grinder attachment shown in the illustration will fit any ordinary engine lathe with a 14-in. swing or over, having a hollow spindle. On the carriage of the lathe is mounted an angle plate to which the cylinders are bolted. This is of an adjustable type to fit any shape or size of carriage. This grinding attachment will grind cylinders from 2 to 6½ in. in diameter. A steadyrest is used on the main bar to eliminate chatter or vibration. A micrometer adjustment is provided so that the grinding wheel may be adjusted to the thousandth part of an inch.

An extension is provided for grinding small cylinders such as are used in motorcycles or in 8- or 12-cylinder cars. This extension is attached by removing the grind-



CYLINDER GRINDING ATTACHMENT FOR ENGINE LATHES

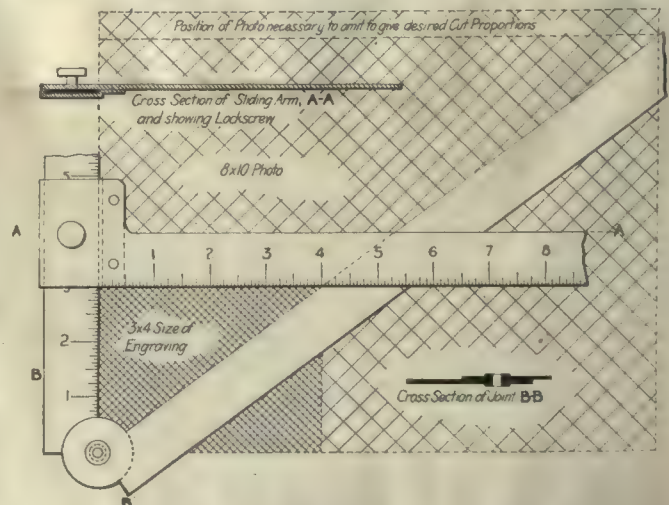
Diameter of grinding bar, 3½ in.; length over all, 28½ in.; diameter of grinding-bar extension, 1½ in.; length over all, 11 in.; driving shaft pulley, 1½x2½ in.; emery wheels, 2 to 5 in. in diameter by ½-in. face

ing wheel and the threaded collar from the main bar and screwing the extension in place.

This is a recent product of the Wood & Safford Machine Works, Great Falls, Mont.

Measuring and Calculating Scale

The illustration shows a proportional scale consisting of a horizontal sliding arm on which is mounted a lock screw and two swinging arms held together by a small eyelet. It is used for solving problems that involve pro-

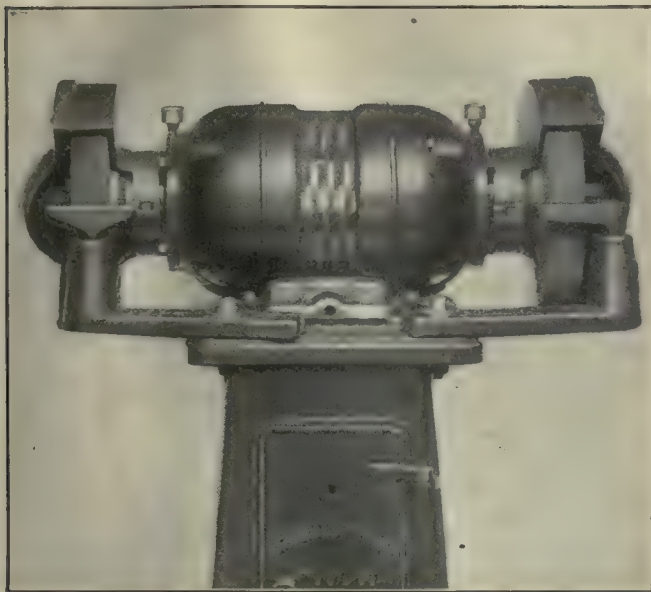


SCALE FOR MEASURING AND CALCULATING

portion, and is operated by laying the scale on a desk or table and manipulating the two sliding arms. It is designed particularly for those who have to solve numerous problems involving proportion. It is being placed on the market by W. E. Meadwell, Ithaca, N. Y.

Ball-Bearing Grinder

The grinder shown in the illustration is being placed on the market by the United States Electrical Tool Co., Cincinnati, Ohio. These grinders and buffers are made

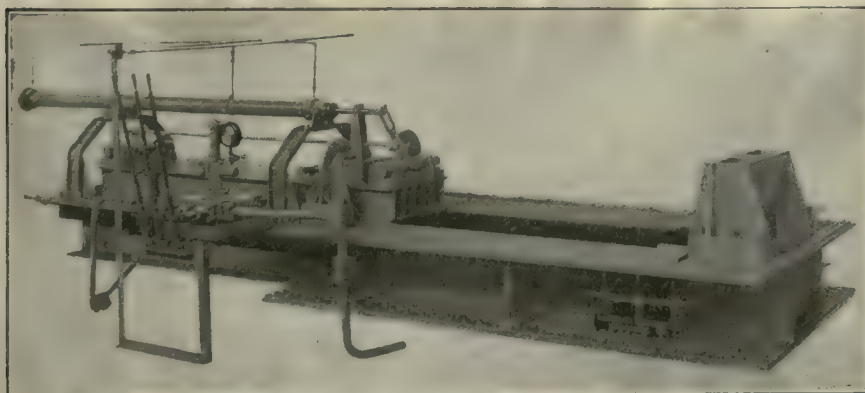


ELECTRIC GRINDER

in sizes of 2-, 3-, 5- and 7½-hp. capacity, the motors being wound for either direct or alternating current. Gurney ball bearings are used. Standard machines are fitted with a knife switch located in the base, but the grinders will be furnished with a push-button control when so ordered.

Hydraulic Scrap-Metal Bundling Press

The machine illustrated is designed for bundling scrap copper, brass, aluminum, sheet steel and other material. It compresses the pieces into compact ingots for purposes of remelting. The compression is accomplished by first forcing the scrap into a flat shape by one hydraulic ram,



HYDRAULIC CHIP AND SCRAP-BALING PRESS

after which a second powerful ram operating at right angles finishes the bundle and produces a solid ingot. This machine is made in two sizes, one producing a bundle 5x5x13 in. and the other 10x18x19 in. The latter machine, which appears in the illustration, weighs 62,000 lb.

These bundling presses are built by Logemann Brothers Co., Milwaukee, Wis.

Templets for Irregular Shapes

By CARL J. LAISUR

I would call your attention to a wrinkle in making templets of irregular-shaped machine frames, etc., that has saved lots of time for the writer.

Although known to the art, it appears to be very little employed; therefore, a reminder might help somebody and won't be amiss.

It consists simply in using a strip of lead, say ¼x½ in., and of suitable length, fitting it to the shape of which a templet is required; draw the outline from the form thus obtained, cut out, and very little filing or cutting, if any, is required.

Electric Plants in Japan

The tabulation below shows the amount of money spent in Japan for electric generating plants up to June, 1916.

	In Yen*
For power and lighting supply, by water power.....	240,777,000
For power and lighting supply, by fired boiler.....	14,847,000
For railway, by water power.....	13,892,000
For railway, by fired boiler.....	16,549,000
For both of above, by water power.....	148,362,000
For both of above, by fired boiler.....	121,642,000
Total, by water power.....	403,032,000
Total, by fired boiler.....	153,039,000
Grand total.....	556,072,000

* The yen is practically 50c. in United States currency.

Change in S. A. E. Thread Standards

We believe that many of our readers will be interested in a slight change that has been made in the S. A. E. standards for screws and bolts.

Some difficulty has been experienced because of the short length of thread formerly provided on the bolts. This length was 1½ times the diameter of the bolts, and it was found that many bolt makers were in the habit of providing even less full thread, measuring the thread to the extreme point that had been marked by the die. The inconvenience was particularly apparent when the bolts were used in connection with castings that were spotted at drilled holes and not finished accurately to thickness. Because of these things the standard was changed to require that the effective thread shall be 1½ times the bolt diameter plus ¼ in. It is believed that this new standard will provide sufficient leeway to meet the needs and that the difficulties, spoken of above, which have been previously encountered will be overcome in future manufacturing.

Young Men of Today--A Brief Defense

BY BURTON A. PRINCE

The make-up of a boy is the result, to a considerable extent, of his surroundings. For this reason, I do not believe that the general character of the boy of today has deteriorated, but that it has merely changed to meet the new conditions.

It was not so very long ago that a majority of the boys were brought up on the farm, where there was always a lot of work to be done of every conceivable kind, from splitting kindling to shingling a roof. In this way a boy was given a wonderfully practical education, and what is more to the point, he felt his responsibility and learned how to work.

This condition has undergone considerable transition. The boy today who does any amount of work before he goes into a shop for the first time is the exception rather than the rule; and as a result you get boys who lack preliminary training and who have not only to learn the job itself, but also have to learn how to work.

The manner in which we live in the present decade has scarcely any tendency to make a boy think or do anything for himself. The boys seem to have lost all initiative and the desire to make things for themselves. When I was a boy and wanted to play "shinny," I used to go out into the woods and cut a shinny stick; and the gang all went too. Today the youngsters all ask "dad" for half a dollar to buy a varnished one, and after they get it, it has to be taped to keep from hurting their hands. Their play is supervised from the kindergarten until they are supervised to death.

There is little work to be done around the house today that tends to bring out any manly qualities in the boy.

We either burn gas or buy our wood all sawed and split. We buy our milk from the creamery, so there are no cows to milk and feed. The Board of Health forbids us to keep a pig, and the Ford has replaced the horse. We may mow our own lawn and shovel the snow, but these are only semi-occasional jobs.

Times and conditions have changed, and the boy has only changed to meet them. Get the old-style boy, and you can start with him where he used to start; but with the later type you have to begin low in the scale and expect less of him, or wait and take him when he is two or three years older.

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The Benefit of a Small Fillet

BY HENRY LEE

A small part in the mechanism of a certain product was continually breaking. As it was one of the most vital parts of the article, and one of the first parts to be assembled, its weakness caused considerable trouble and delay in production. This piece of work was milled to a sharp 45-deg. corner, in which worked a part about $\frac{1}{8} \times \frac{1}{16} \times \frac{1}{2}$ in. in dimensions. The completed article would not allow of this part of the mechanism being made any larger.

Experiments were entered upon with various grades of steel, with practically the same result—on being tested an average of 5 per cent. broke.

Finally, a fillet of 0.005-in. radius was given to the working part, and a similar radius was given to the holder. The altered piece occupied the same space as that taken up by the original, but it was surprising to note how that small fillet strengthened the part.

A lot of 10,000 made with this fillet was proved by the same test under which the former part broke. Not one of the lot showed any signs of weakness.

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Personals

John H. Grayson has resigned as president and general manager of the Grayson Tool and Mfg. Co., of Indianapolis, Ind., and Charleston, W. Va.

Carpenter and Woodward, dealers in machinery and equipment, have moved from 135 Broadway, New York City, to 3411-14 Woolworth Bldg., New York City.

John Gelzenlichter, for the past three years superintendent of the plant of the Gillette Safety Razor Co., has become superintendent of the H. E. Harris Engineering Co., of Bridgeport, Conn.

S. B. Taylor, sales manager of the S K F Ball Bearing Co., Hartford, Conn., has been appointed vice-president of the company, succeeding F. B. Kirkbride, who remains on the board of the company.

Arthur H. Young, who for some years has been supervisor of labor and safety of the Illinois Steel Co., of Chicago, will take up his new duties as Director of the American Museum of Safety on Jan. 1.

Charles B. Carlson has resigned the position of general foreman of the Duplex Engine Governor Co., Brooklyn, N. Y., to represent the Union Petroleum Co., Mineral Lard Oil Department, as demonstrator.

G. A. Ungar, former representative of the S K F Ball Bearing Co. in Cleveland, Detroit and Pittsburgh, has been appointed technical manager and chief engineer, succeeding Uno Forsberg, who returns to Sweden.

L. A. Green, of 1405 First National Bank Bldg., Pittsburgh, Penn., has become district representative of the Bedford Foundry & Machine Co., manufacturers of overhead electric traveling cranes. Mr. Green will cover the states of Pennsylvania, West Virginia and eastern Ohio.

James O. Smith, who for more than 10 years has been in the service of the American Emery Wheel Works, Providence, R. I., latterly as vice-presi-

dent, has left this company and taken a position of sales manager with the Hampden Corundum Wheel Co., Brightwood, Springfield, Mass.

Business Items

The United Hammer Co., 141 Milk St., Boston, Mass., has purchased the power-hammer business of the E. & T. Fairbanks Co., St. Johnsbury, Vt. It is prepared to furnish complete Fairbanks power hammers of all sizes, and also to furnish repair parts for Fairbanks hammers already in use. The name "Fairbanks," which was applied to these hammers in 1902, will be continued.

Stocker-Rumely-Wachs Co. is the successor to the H. A. Stocker Machinery Co., and the Rumely-Wachs Machinery Co., effective Jan. 1, 1917. This firm will be located at 117-119-121 North Jefferson St., Chicago, Ill. H. A. Stocker, president; William N. Rumely, vice-president; H. J. Reeve, treasurer; O. A. Wachs, assistant treasurer; Edw. H. Wachs, Jr., secretary. Capital stock of the new organization will be \$225,000.

Trade Catalogs

The Simplex Sine Bar. Model Tool and Gauge Co., 183 John St., Bridgeport, Conn. Circular. Illustrated.

Beaudry Power Hammers. Beaudry & Co., Inc., 141 Milk St., Boston, Mass. Booklet. Pp. 16; $3\frac{1}{2} \times 6$ in.; illustrated.

Vises, Wrenches, Bench Grinders, Etc. Athol Machine Co., Athol, Mass., Catalog No. 32. Pp. 60; 6×9 in.; illustrated.

Anderson Vertical Tapping Machine. The Anderson Die Machine Co., Bridgeport, Conn. Bulletin No. 4. Pp. 8; 6×9 in.; illustrated.

Anderson Die Forming Machine. The Anderson Die Machine Co., 590 Water St., Bridgeport, Conn. Pamphlet entitled "Evidence of Efficiency" containing letters from users.

Forthcoming Meetings

Society of Automobile Engineers. Annual meeting, Jan. 9-11. United Engineers Building, New York City. Colver F. Clarkson, secretary, 29 West 39th St., New York City.

American Society of Mechanical Engineers. Monthly meeting, first Tuesday. Calvin W. Rice, secretary, 29 West 39th St., New York City.

Boston Branch National Metal Trades Association. Monthly meeting on first Wednesday of each month, Young's Hotel. W. W. Poole, secretary, 40 Central St., Boston, Mass.

Providence Association of Mechanical Engineers. Monthly meeting, fourth Wednesday of each month. J. A. Brooks, secretary, Brown University, Providence, R. I.

New England Foundrymen's Association. Regular meeting, second Wednesday of each month, Exchange Club, Boston, Mass. Fred F. Stockwell, 205 Broadway, Cambridgeport, Mass.

Engineers' Society of Western Pennsylvania. Monthly meeting, third Tuesday; section meeting, first Tuesday. Elmer K. Hiles, secretary, Oliver Building, Pittsburgh, Penn.

Rochester Society of Technical Draftsmen. Monthly meeting, last Thursday. O. L. Angevine, Jr., secretary, 857 Genesee St., Rochester, N. Y.

Superintendents' and Foremen's Club of Cleveland. Monthly meeting, third Saturday. Philip Frankel, secretary, 310 New England Building, Cleveland, Ohio.

Western Society of Engineers, Chicago, Ill. Regular meeting, first Wednesday evening of each month, excepting July and August. J. H. Warder, secretary, 1785 Monadnock Block, Chicago, Ill.

Philadelphia Foundrymen's Association. Meetings first Wednesday of each month. Manufacturers' Club, Philadelphia, Penn. Howard Evans, secretary, Pier 45 North, Philadelphia, Penn.

Technical League of America. Regular meeting, second Friday of each month. Oscar S. Teale, secretary, 35 Broadway, New York City.

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